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ZOMBIE FIRMS AND THE INTEREST RATE CHANNEL

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by

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ABSTRACT

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In this paper we investigate the interaction between interest rates and the prevalence of so called 'Zombie' firms. Zombie firms are relatively unproductive, insolvent firms, who nevertheless remain in the market. The past several decades have witnessed a steady rise in the prevalence of these firms across advanced economies. Significant evidence now exists of their detrimental effects on healthy firms within their industries and on the economy as a whole through allocative inefficiencies and drags on productivity growth. Notably, this zombie phenomenon coincides with the long-term lowering trend in benchmark interest rates, providing a theoretical life-support mechanism through which zombie firms are nurtured. Using firm-level panel data from the Compustat-Capital-IQ database, we confirm that there has been rise in the share of zombie firms and show that there exists a significant inverse relationship between interest rates and zombie firms. Presenting a possible challenge for conventional monetary policy as central banks

are faced with a tradeoff between dampening productivity in the long term and invigorating it in the short term.

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CHAPTER 1

INTRODUCTION

For the past few decades, there has been a rise in insolvent, relatively unproductive firms across advanced economies. There is mounting evidence that these 'zombie' firms impose depressing effects on otherwise healthy firms within industries, and on the economy as a whole through capital misallocation and drags on productivity growth (Caballero et al:2008, Ahearne and Shinada:2005, McGowan et al:2017, Storz et al:2017, Andrews and Petroulakis:2017, and Banerjee and Hofmann:2018). Coincident with the rise in zombie firms, there has been a noticeable and persistent global decline in benchmark interest rates. These low interest rates create a reasonable channel through which these unproductive firms are kept 'alive'. Following Banerjee and Hofmann (2018), this research investigates the interaction between the movement of interest rates and the manifestation of zombie firms in the United States from 1970-2019. It hopes to provide some insight into the question: to what extent, if any, are interest rates responsible for the rise of zombie firms and their anemic effect on productivity growth?

Understanding firm dynamism in the face of monetary policy is undoubtedly essential for proper policy action. Banerjee and Hofmann (2018) is the only study thus far that has explicitly investigated the role of interest rates in the proliferation of zombie firms. The significance of this research lies not only in the highlighting of the subject matter, but it attempts to strengthen or weaken their contention that central banks play an important

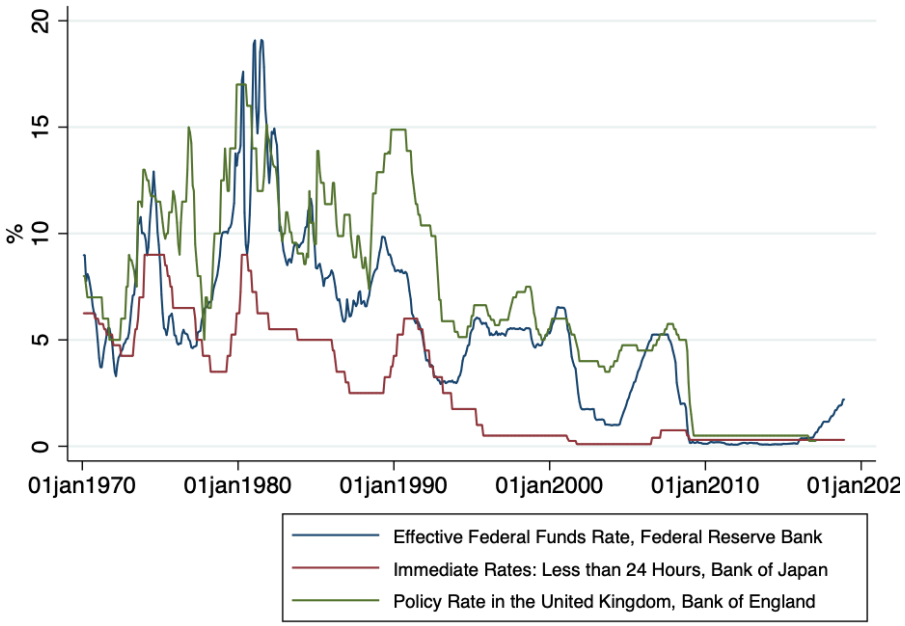
role in the livelihood of insolvent and unproductive firms, and consequently, on sluggish productivity growth.

Conventional monetary policy by the central bank in the United States aims at steering the economy by relying on a *traditional* monetary policy transmission mechanism, i.e. changes in money change the policy rate, and that leads to changes in other interest rates via the term structure, Fisher and liquidity effects. The traditional view of monetary policy transmission places a central role on the interest rate channel (Tobin: 1978, Taylor: 1995, Mishkin:1995). Transmission is characterized as occurring via the following schema; expansionary monetary policy (open market purchase, required reserve ratio decrease, discount rate decrease) increases the money supply, which lowers the targeted federal funds rate. The lowering of the rate affects the real side of the economy through the intertemporal investment and consumption channels (Modigliani: 1971). A lower rate reduces the cost of capital, thereby spurring investment and consumption spending in the real economy. The final expected effect being the stimulation of productivity and employment. The federal reserve uses these policy tools to maneuver the economy and smoothen business cycle fluctuations.

The effective federal funds rate is crucial in the movement of bond markets and the prime lending rate, on which economic agents depend in their consumption and investment pursuits and expectations. It is through this interest rate channel, and the evident downward trend in long-term real interest rates over the era of the Great Moderation to the present, that the central bank can be hypothesized to play a central role in the proliferation of zombie firms. This could imply that paradoxically, the central bank dampens productivity in the

long term in its attempt to invigorate it in the short term. It is the statistical significance of this trade-off that is considered in this paper.

Figure 1.1: The Fall of Global Benchmark Interest Rates, 1970-2019 [1]



[1] Monthly, Not seasonally adjusted. Source: FRED. Federal Reserve bank of St. Louis

If this trade-off is significant, it can conceivably imply a vicious cycle of higher order effects whereby the increasing proliferation of zombie firms and their anemic economic effect leads to further depression of the interest rate, as central banks further attempt to stimulate the economy through conventional policy channels. The global lowering trend in benchmark interest rates and financial crises have already prompted central banks to increasingly use unconventional policy tools as they attempt to energize the economy by any means necessary. Born of necessity, these policy tools show that central banks are left with other options, thought the effectiveness and consequences of

those tools, and their relation to zombie firms, is beyond the scope of this paper. See Gambacorta et al (2014), Peersman (2011), and Acharya et al (2019) for introduction to these effects.

The rest of the paper is organized as follows: Section 2 provides a survey of the relevant literature. The section following presents the data and descriptive statistics. Section 4 presents the methodology. And lastly, sections 5 and 6 provide the results and concluding remarks, respectively.

CHAPTER 2

LITERATURE REVIEW

The 'Zombie' phenomenon is relatively new in economic theory. The term 'Zombie firm' was explicitly used to explain economic stagnation in the Japanese economy in the late twentieth century (Caballero et al:2008, Ahearne and Shinada:2005). Zombie firms are defined as relatively unproductive, insolvent firms who, despite their ailment, fail to exit the market due to financial life-support mechanisms. At its peak in the mid 1990s, Caballero et al (2008) identified nearly 35 percent of firms as being on life support mechanisms and thus zombies, in the Japanese economy. Notably, this was at the height of the Japanese liquidity trap. The situation when conventional monetary policy is rendered essentially ineffectual as nominal interest rates approach the zero-lower bound (Krugman:1998, Hicks:1937). Caballero at al further highlighted the role of misdirected bank lending practices in the creation of insolvent borrowers, and the congestion effect these zombie borrowers have on job creation and industry productivity. They suggest that increase in the spread of zombie firms has a depressing effect on investment and employment growth of healthy firms. Further firm-level evidence supports the hypothesis that productivity growth is low in industries with heavy concentrations of zombie firms within the Japanese economy (Ahearne and Shinada:2005).

There has been other work studying the presence of zombie firms, albeit indirectly. The work of Decker et al hint at their existence as they examine the apparent decline in firm dynamism and fluidity since the 1980s. They conclude that this decline in dynamism

is associated with a rise in allocative inefficiencies at the firm level. And further suggest that these inefficiencies can constrain productivity growth even amidst robust economic expansions. Additionally, Benmelech and Bergman (2011), in their investigation into insolvent firms, indicate of a 'collateral channel' through which bankrupt firms impose negative externalities on non-bankrupt competitors industry wide, as their failure imposes a contagion effect through the cost of debt financing in the industry. These studies all suggest the existence and negative effects of unproductive, insolvent firms i.e. zombies.

Later investigations into the proliferation and consequences of zombie firms in OECD countries and Eurozone economies come to strikingly similar conclusions (McGowan et al: 2017, Storz et al:2017, Andrews and Petroulakis:2017). The findings of the cross-country analyses show the rise of zombie firms since the mid-2000s and the rise of the amount of resources sunk in them. McGowan et al identified Spain, Belgium, and Italy as the European countries with the highest prevalence of zombies with 10, 8, and 6 percent, respectively. They confirm that this increase is associated with investment, employment, and capital allocation distortions. They also link the zombie influence on the decline in OECD output growth through business investment and multi-factor productivity channels. The suggested effects of zombies and their growth are in line with evidence of overall total factor productivity slowdown in the U.S. and globally (Gilbert:2015, Cardarelli and Lusinyan:2015, Cette et al:2015, Connoly and Gustafson:2013, Diewert and Fox:1999, Syverson:2017). All evidence thus far points to the zombie phenomenon as the prime culprit.

With significant evidence of the adverse effects of zombie firms on economies presented, we can now turn to the possible causes of their rise. The most reasonable life-

line for zombies can be said to be credit networks. It is not unusual for firms to rely, at least partly, on financial leverage in their capital expenditure and investment. Financial intermediaries are the most important source of financing for firms. These financial institutions, however, face significant asymmetric information problems. Since failing or struggling firms are more probable to seek out external funding, and thus more likely to be selected. This effect can be magnified with further agency problems in bank risk management.

Following Caballero et al (2008) and Andreas and Petroulakis (2017)'s call for attention to bank lending practices, we consider factors that most influence bank behavior. In particular, the interest rate sensitivity of bank risk management. There has been increasing attention in the literature to what Borio and Zhu (2008) have termed the 'risk-taking channel'. This channel describes the effects of monetary policy on bank behavior, particularly as it pertains to shifts in risk-taking and lending practices. Recent empirical evidence supports the relationship between interest rate movements and bank risk-taking. Jimenez et al (2014) analyzed the low interest rate environment in Spain and found that this is associated with spurs in credit risk-taking by banks. Since low interest rate environments can be said to incentivize banks to seek out higher yields more aggressively, and thus increase their risk tolerance. This relationship was further confirmed elsewhere including the U.S. by Dell'Ariccia et al (2013), Angeloni et al (2015), Afanasyeva and Guentner (2015), and Buch et al (2014). More recently, Aghion et al (2018) identified the counteracting effects of credit access on productivity growth. Traditional literature on the subject argues for the virtually unambiguous positive investment effect of credit access.

However, they indicate that the negative reallocation effect of credit on productivity growth through the support of less productive firms may be greater than previously considered.

This bank risk-taking effect provides a direct line to the life of zombie firms. Firms, who otherwise would be considered too speculative for lending, are given greater access to credit by banks' greater appetite for risk. This is the life-support mechanism that keeps zombies alive. The interest rate channel of monetary policy alters bank risk tolerance, and this strengthens the lifeline of unproductive and insolvent firms. We can follow Andrews and Petroulakis (2017) and suggest bank strengthening efforts and insolvency regime reform to address the rise in zombie firms.

To our knowledge, Banerjee and Hofmann (2018) were the first to explicitly suggest the role of the interest rate channel. Their investigation took a more global perspective. Covering 14 advanced economies, and both broad and narrow zombie identification methods, they again noted the evident upward cross-country trend in the share of zombie firms since the 1980s. Their findings indicate that the global incidence of zombies rose from 2 percent in the 1980s to 12 percent in 2016. They noted that this trend tends to escalate through economic downturns and fails to reverse through recovery periods. Their estimates indeed suggest that lower nominal interest rates predict a significant increase in the share of zombie firms. The fact that it is the only major study that investigates their relationship with interest rates, however, calls out for greater exploration. This research aims precisely at expanding the knowledge of this area by further establishing or refuting their hypothesis.

CHAPTER 3

DATA AND DESCRIPTIVE STATISTICS

Historically, identifying zombie firms adequately has been a challenge. Each proposed method has its downsides, depending on the research goals. The literature has used various measures as indicators for zombie firms: if a firm uses subsidized credit (Caballero et al:2008), if its interest coverage ratio (ICR) is less than 1 for at least 3 consecutive years (McGowan et al:2017), negative return on assets (ROA) and negative return on investment (ROI) (Andrews and Petroulakis:2017), debt servicing capacity (EBITDA/Total debt) less than 5 percent for at least 2 years (Storz et al:2017), and Tobin's q below the median within their sector (Banerjee and Hofmann:2018).

Subsidized credit measures are inherently difficult to measure accurately and although that method was appropriate for Caballero et al given that they intended to assess the zombie effects on the economy, the goal of this research is closer to that of Banerjee and Hofmann (2018), McGowan et a (2017), and Andrews and Petroulakis (2017). Therefore, profitability and efficiency measures are most appropriate to our research interest and to our available data.

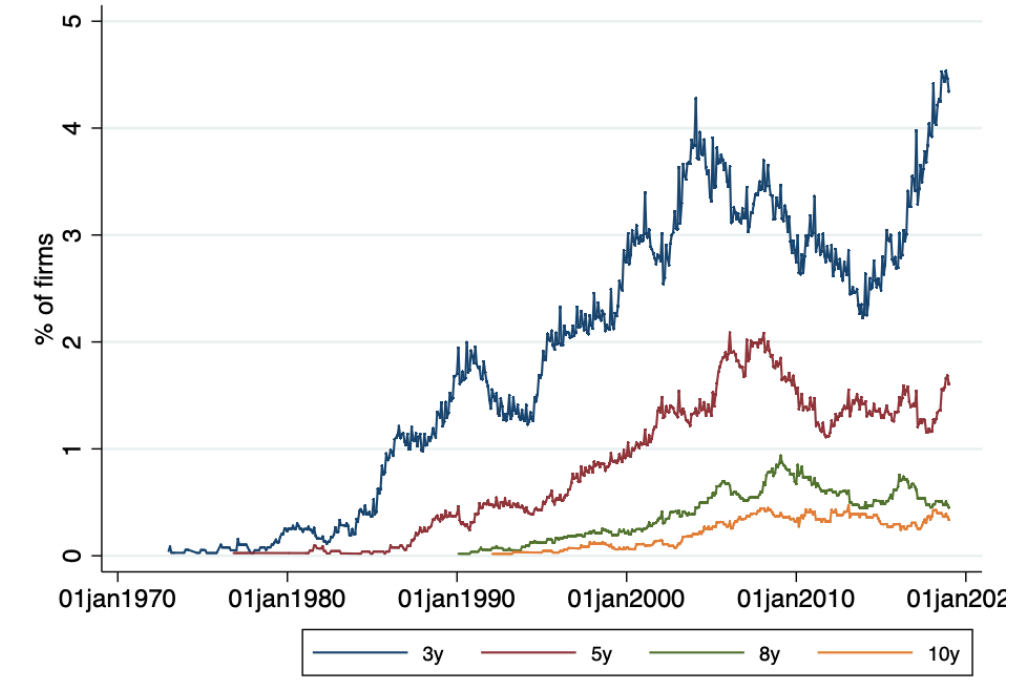
We combine the identification methods of McGowan et al (2017) and Andrews and Petroulakis (2017). The interest coverage ratio, calculated as earnings before interest and taxes (EBIT) divided by interest expense, is an assessment of the riskiness of lending capital to a company, since it measures the ability of that company to pay interest on its debts. It would be expected for banks to expand lending to firms with lower interest

coverage ratios due to the aforementioned risk-taking channel. The return on assets and investment further measures the profitability and productivity of a firm. The more productive a firm, the higher these return measures are expected to be. Zombie firms would be expected to exhibit persistent weak profitability and efficiency indicators. Therefore, we classify a firm as a zombie if it simultaneously exhibits ICR less than one, negative ROA, and negative ROI for at least three consecutive years. This will be the principal and most broad definition of a zombie firm. More stringent conditions that require five, eight, and ten consecutive years of weak financial indicators are also considered. The intuition being that firms who meet all the criteria for such extended period of time are more likely to be structurally unsound and closer to the precipice of insolvency.

To our knowledge, this combination of indicators has not yet been utilized in the literature to identify and measure zombie firms. This identification method confirms the previous evidence of a rising trend of zombie firms in the economy. By our main zombie definition, the United States saw a significant increase in the share of zombies in the post-financial crisis recovery period and reached its all-time high of 4.5 percent only in recent years. Though there was a decade long downward trend in their share since the early 2000s. All other zombie conditions also show significant increases since the 1980s. Notably, calculations show the existence of firms that meet even our most stringent criteria; meeting all conditions for eight and ten consecutive years. It was not until the 1990s that these firms appeared in the United States economy. This occurred a decade after the precipitous decline in interest rates that followed the federal reserve's struggle with inflation in the late 1970s. Though the share of these super zombies has yet to surpass the one percent pre-crisis maximum, their existence is a bit surprising. The ability for firms to exhibit poor

profitability and liquidity indicators for an entire decade and remain in the market in low-interest rate environments prima facie suggests the viability of the interest rate channel hypothesis.

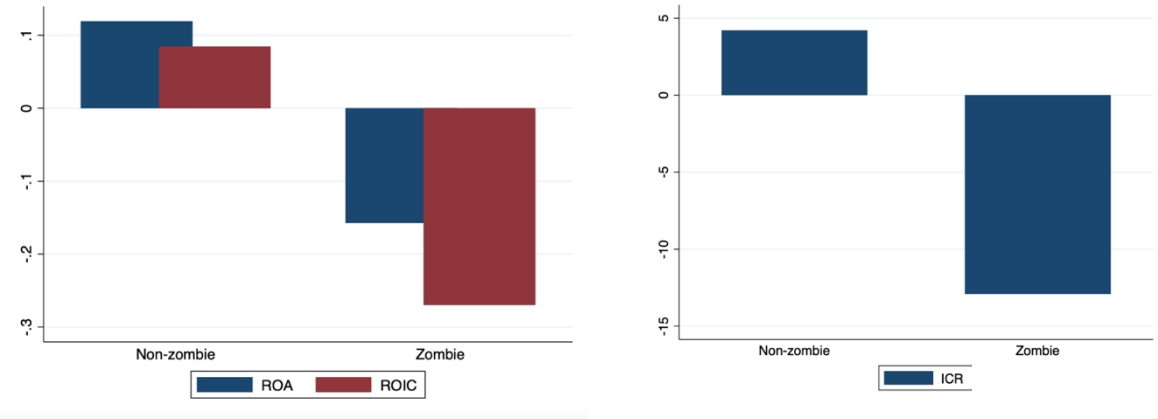
Figure 3.1: The Rise of Zombie Firms in the United States, 1970-2019 [1]



[1] Firms with an interest coverage ratio less than one, negative return on assets, and negative after-tax return on invested capital for 3,5,8, and 10 consecutive years. Zombie percent share calculated as proportion of those firms to total number of observed firms per month. [2] Based on universe of non-financial CRSP Common Stock and S&P 500 Index Constituents. Source: CRSP-Compustat-Capital IQ database, Wharton.

For non-zombie firms, the median return on assets is more than double that of zombie firms. While non-zombie return on investment is almost four times that of zombie firms. We also find that zombies have a median interest coverage ratio of around negative 13, and ten-year zombies have on average and median the lowest indicators across the board. Unless otherwise noted, zombie share refers to three-year zombie firms.

Figure 3.2: Median Return on Assets, Return on Invested Capital, and Interest Coverage Ratio[1]

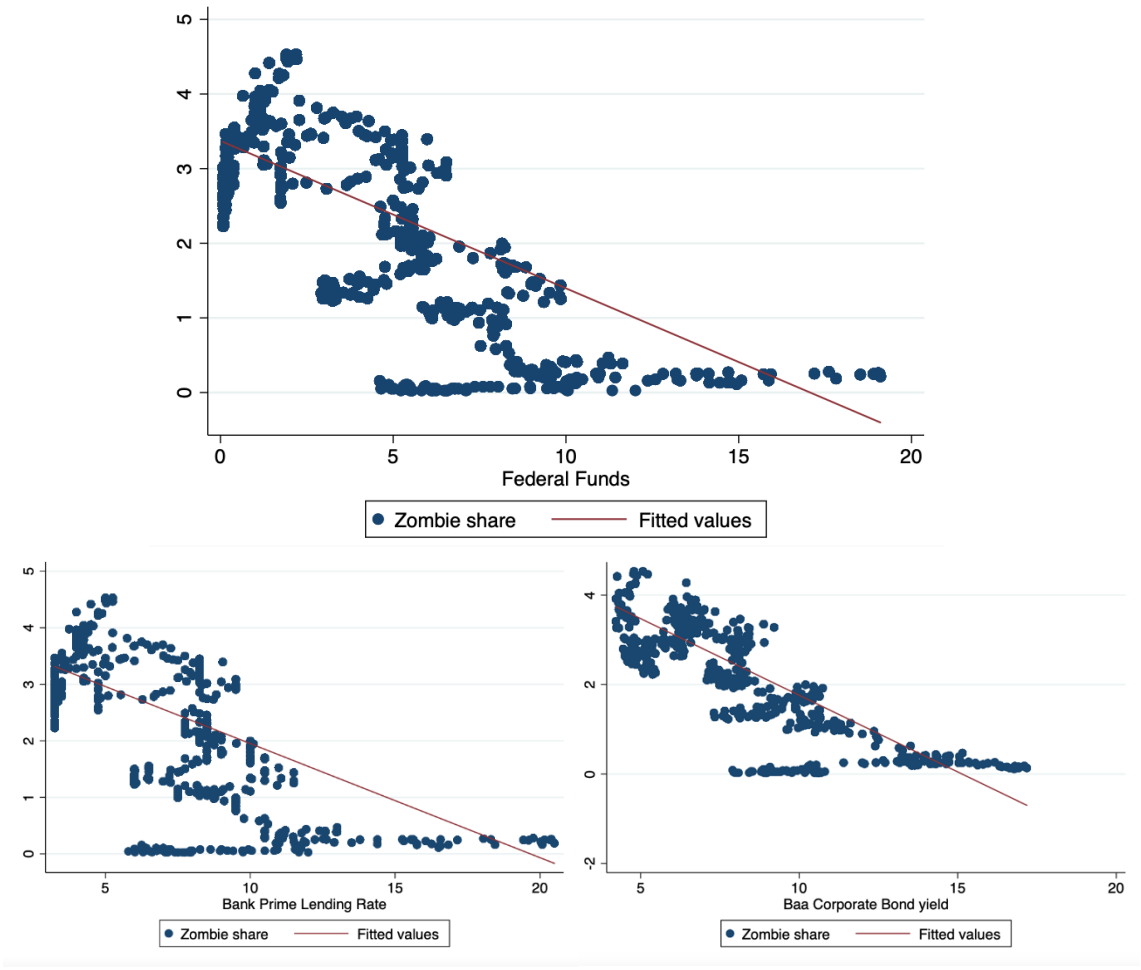


[1] Return on Assets = Operating Income Before Depreciation as a fraction of average Total Assets based on most recent two periods. After-tax return on invested capital = Net Income plus Interest Expenses as a fraction of Invested Capital. Interest coverage ratio = Multiple of Earnings Before Interest and Taxes to Interest and Related Expenses. Source: CRSP-Compustat-Capital IQ database, Wharton.

We examine the relationship between nominal interest rates and the proliferation of zombie firms by using firm-level panel data from the North American WRDS CRSP-Compustat-Capital IQ database. The unbalanced panel data details the monthly Interest coverage ratio (ICR), Return on Assets (ROA), and after-tax Return on Invested capital (ROIC) for non-financial CRSP Common Stock and S&P 500 index constituents. The unbalanced dataset fluctuates from 1953 observed firms to a maximum of 7229 per month. This could be explained by creative destruction and the competitive dynamics of the market, or simply as a shortcoming of the dataset. In order to account for the unbalanced nature of the data, the zombie share time series is calculated as the proportion of firms who fit the criteria to the total number of firms observed each month. The effective federal funds rate, 10-year treasury rate, Bank prime lending rate, and Moody's seasoned Aaa and Baa corporate bond rate were acquired from FRED. The benchmark lending and bond market rates were considered in order to capture the more direct short-

term effects that the federal funds rate may miss. An interpolated total firm asset variable is used as proxy for firm size. Firms are classified according to the current standard industry classification code (SIC), to possibly measure industry specific behavior and effects. Plentiful and accurate data on firm age is difficult to come by, therefore, to control for firm age, we use the number of years each firm is present in the dataset as proxy. Following Banerjee and Hofmann (2018), we use banking sector price-to-book ratio (Fama-French 49) to asses and control for bank industry health. This is done to better isolate the effects of the benchmark interest rates and control for variances stemming from the risk-taking channel and elsewhere.

Figure 3.3: Zombie Share and Federal Funds Rate, Bank Prime Lending Rate, and Baa Corporate bond



CHAPTER 4

METHODOLOGY

Following Banerjee and Hofmann (2018), we can estimate the baseline econometric specification through the following fixed- and random-effects panel regression framework.

$$Zombie_{st} = \beta_1 Interest\ rate_{t-1} + \beta_2 Bank\ Health_{t-1} + \alpha_f + \gamma_{s,t} + \varepsilon_{st}$$

Where the dependent variable, $Zombie_{st}$, is the share of firms that satisfy all zombie conditions for *n* consecutive years, in month *t*; $Interest\ Rate_{t-1}$ refers to the effective federal funds rate, 10-year treasury rate, bank prime lending rate, and Aaa and Baa corporate bond yields.. $Bank\ Health_{t-1}$ is measured by the banking sector's price-to-book ratio in year t – 1. Finally, α_f refers to firm-level controls and $\gamma_{s,t}$ to sector*year fixed/random effects, to control for unobserved time-varying year-sector specific shocks. Additional models with other interest rate benchmarks and zombie conditions will also be estimated.

Given that the main time series are demonstrably negatively correlated, to address spurious regression concerns (Granger and Newbold:1974, Mahdavi-Damghani:2012), all non-stationary time series are tested for unit roots and transformed into a covariant stationary process. The Eagle-Granger two-step method was applied to the stationary I (1) zombie share and interest rate series to test for cointegration (Eagle and Granger: 1987).

This would provide us with a more confident assessment of a long-term causal relationship, if there is one. As part of further causal testing procedures, the following VAR models will be estimated:

$$(1)\ Zombie_{st} = \sum_{i=1}^{n} \beta_i\, Interest\ rate_{t-i} + \sum_{j=1}^{m} \beta_j\, Zombie_{st-j} + \varepsilon_t$$

$$(2)\ \ Zombie_{st} = \sum_{i=1}^{n} \beta_i\, Interest\ rate_{t-i} + \sum_{j=1}^{m} \beta_j\, Zombie_{st-j} + \sum_{k=1}^{m} \beta_j Interest\ rate_{t+k} + \varepsilon_t$$

Where (1) and (2) represent the unrestricted models for the Granger and Sims Causality tests, respectively (Sims:1972, Spearot:2019). These simple prediction-based time series causality tests will help determine the effect of lagged and leading terms on our variable of interest.

To decide on the baseline specification framework, we employed the Breusch-Pagan Lagrange multiplier test for random effects or simple OLS, and the Hausman specification test (Hausman:1978) for random or fixed effects. The results of the former suggest random effects and the latter test suggests fixed-effects, at all reasonable significance levels, though the difference is minimal. Therefore, all three frameworks will be considered. Models use heteroskedasticity-robust standard errors, are Ramsey RESET tested for omitted-variable bias and specification, variance inflation factors for multicollinearity, and tested for normality through the Shapiro-Wilk test.

CHAPTER 5

RESULTS

Preliminary estimates suggest that the benchmark interest rates most inversely associated with zombie growth are Baa and Aaa corporate bonds. This is expected, considering that zombie firms are by definition financially unsound, therefore higher prevalence of zombies would be most associated with lower rated bonds. The bonds of a financially unsound company will be of lower grade relative to those of more stable institutions. Table A.2 (Appendix A) shows the estimation results for the OLS models for each zombie definition to movements in the federal funds rate. It indicates that there is statistically significant relationship between movements in interest rates and the share of zombie firms in the economy, at all reasonable significance levels. For our main zombie definition, a percent increase in the federal funds rate is associated with a 0.19 percent decrease in the share of zombies. Similarly, with the more stringent zombie definitions, although with a diminishing economically significant effect. These estimates also suggest that older firms are associated with a higher prevalence of zombies. At industry level, those with the highest estimated incidence of zombies are manufacturing, retail, and services. This is the case across all zombie definitions.

Tables A.3 and A.4 (Appendix A) detail the estimates of the fixed and random effects models, respectively. Both frameworks predict a statistically significant negative interaction between the federal funds rate and zombies. Though its prediction is not as

economically significant as the OLS models suggest. An increase in the policy rate is associated with a 0.04 percent decrease in zombie incidence under fixed effects, and a 0.5 percent decrease under random effects. However, unlike the OLS estimates, this effect is not the same across all zombie classifications. Interestingly, the inverse relationship disappears for the five- and ten-year zombie measures. Though this reversal is not as statistically robust as under other zombie measures. However, across all models, corporate bonds remain the most economically significant of all benchmark interest rates considered.

We also want to test for a long-term relationship between zombie firms and interest rates. The cointegration and causality tests suggest that the movement of interest rates and zombie share are not cointegrated at reasonable significance levels. Furthermore, we cannot confidently say that any of the benchmark interest rates Granger-cause zombies.

CHAPTER 6

CONCLUSION

In the course of the past several decades, there has been an evident rise in the number zombie firms in the United States. By identifying zombies as firms who simultaneously exhibit interest coverage ratio less than one, negative return on assets, and negative return on investment for at least three consecutive years and at most ten consecutive years, our findings support the previous literature on the increasing prevalence in zombie firms since the 1980s. We identify 4.5 percent of firms in the United States as zombies in 2018. The industries with highest incidence of zombies being manufacturing, retail, and services.

The interest rate channel hypothesis seems to be theoretically justified. There exists significant evidence on the interest rate and risk-taking channel in the transmission of monetary policy. While our baseline analysis does find statistically significant negative interaction among interest rates and the prevalence of zombie firms in the United States economy, cointegration and causality testing does not reveal a direct long-term temporal relation. The bivariate interaction indicates that we cannot confidently say that any of the benchmark interest rates Granger-cause zombie incidence. This result does not necessarily refute the findings of Banerjee and Hofmann (2018) or others. The uniqueness of our zombie identification conditions makes it so there will be some difference in the zombie time series. And these discrepancies can reasonably be significant enough to alter cointegration and causality analyses. The rise of zombie firms calls for greater

understanding of their role in the economy and highlights the higher order effects of monetary policy. The transmission of monetary policy is the transmission of incentives. Changes in the cost of capital significantly alter the incentives structures that dictate economic action. The central bank in the United States can theoretically be said to affect the creation of unproductive and insolvent borrowers through the manipulation of benchmark incentives. These zombie firms point to a possible blind spot in what is perhaps the most important transmission channel in monetary policy.

If the interest rate channel hypothesis is sound, we can expect the rising trend in zombie firms to continue as far as ultra-low interest rate environments continue. Given the evidence of their anemic effect on employment and total factor productivity, it will not be surprising for this depressing effect to be magnified as their prevalence in the economy is magnified. Giving credence to concerns of more persistent, sluggish growth, and secular stagnation (Summers:2014, Lo and Rogoff:2015, Eggertsson and Mehrotra:2014, Eichengreen:2015). Their existence and link to benchmark interest rates can impose challenges for traditional policy tools. We leave closer exploration of this linkage to future research. Robust literature does not yet exist for a phenomenon that, if established, could pose significant implications on monetary policy and the advanced economy in the twenty-first century.

APPENDIX A

REGRESSION TABLES

Table A.1: Preliminary OLS

	(1) Zombie 3Y	(2) Zombie 3Y	(3) Zombie3Y	(4) Zombie 3Y	(5) Zombie 3Y
Federal Funds	-0.198***				
	(0.00101)				
Prime Lending Rate		-0.202***			
		(0.00115)			
10Y Treasury			-0.309***		
			(0.00116)		
Aaa Corporate Bond				-0.361***	
				(0.00130)	
Baa Corporate Bond					-0.343***
					(0.00125)
_cons	3.373***	3.970***	4.221***	4.968***	5.188***
	(0.00471)	(0.00777)	(0.00718)	(0.00933)	(0.0100)
N	50265	50265	50265	50265	50265
R^2	0.377	0.323	0.562	0.587	0.557
adj. R^2	0.377	0.323	0.562	0.587	0.557
rmse	0.707	0.737	0.592	0.575	0.596

Table A.2: OLS

	(1) Zombie 3Y	(2) Zombie 5Y	(3) Zombie 8Y	(4) Zombie 10Y
Federal Funds	-0.185***	-0.0848***	-0.0431***	-0.00878***
	(0.00167)	(0.00191)	(0.00193)	(0.00252)
Firm Size	0.0000726***	0.000110***	0.0000409***	0.0000135
	(0.0000103)	(0.0000141)	(0.00000789)	(0.00000832)
Bank Health	0.700***	0.203***	-0.0953***	-0.0846***
	(0.0108)	(0.0123)	(0.00901)	(0.00856)
Firm Age	0.00668***	0.00671***	-0.000704	0.00168*
	(0.000762)	(0.000797)	(0.000620)	(0.000687)
SIC				
Mining	0.0214	0.113***	0.252***	0
	(0.0625)	(0.0314)	(0.0102)	(.)
Construction	0.158*	0.191***		
	(0.0784)	(0.0351)		
Manufacturing	0.409***	0.458***	0.389***	0.164***
	(0.0581)	(0.0284)	(0.00645)	(0.0110)
Trans, Com, Utility	0.326***	0.444***	0.377***	0.148***
	(0.0622)	(0.0412)	(0.0203)	(0.0172)
Wholesale	0.300***	0.558***	0.551***	
	(0.0726)	(0.0635)	(0.00494)	
Retail	0.417***	0.693***	0.481***	0.232***
	(0.0665)	(0.0545)	(0.0251)	(0.0118)
Finance	0.0101	0.0624	0.143***	-0.0863***
	(0.0649)	(0.0327)	(0.0208)	(0.0110)
Services	0.466***	0.432***	0.346***	0.125***
	(0.0592)	(0.0321)	(0.0151)	(0.0169)
Public Admin.	0.320***	0.421***	0.331***	0.209***
	(0.0673)	(0.0410)	(0.0177)	(0.0119)
_cons	1.863***	0.691***	0.363***	0.249***
	(0.0601)	(0.0326)	(0.0126)	(0.0154)
N	15806	6267	2030	1018

R^2	0.483	0.303	0.476	0.403
adj. R^2	0.482	0.301	0.473	0.397
rmse	0.611	0.393	0.150	0.0902

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.3: Federal Funds Fixed-Effects

	(1) Zombie 3Y	(2) Zombie 5Y	(3) Zombie 8Y	(4) Zombie 10Y
Federal Funds	-0.0411***	0.00317**	-0.0131***	0.0151***
	(0.00122)	(0.00112)	(0.000976)	(0.000824)
Bank Health	0.376***	0.0961***	-0.120***	-0.0678***
	(0.00641)	(0.00562)	(0.00431)	(0.00342)
Firm size	0.000127***	-0.0000112	-0.00000263	-0.00000592
	(0.00000713)	(0.00000735)	(0.0000110)	(0.00000705)
_cons	2.281***	1.113***	0.703***	0.358***
	(0.00965)	(0.00787)	(0.00590)	(0.00438)
N	50265	19591	6275	3149
R^2	0.085	0.019	0.176	0.138
adj. R^2	0.048	-0.014	0.153	0.110
rmse	0.382	0.211	0.0915	0.0478

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.4: Federal Funds Random-Effects GLS

	(1) Zombie 3Y	(2) Zombie 5Y	(3) Zombie 8Y	(4) Zombie 10Y
Federal Funds	-0.0548***	-0.00170	-0.0145***	0.0139***
	(0.00120)	(0.00111)	(0.000971)	(0.000830)
Bank Health	0.403***	0.105***	-0.120***	-0.0673***
	(0.00646)	(0.00564)	(0.00431)	(0.00346)
Firm size	0.000120***	-0.00000492	0.0000117	-0.00000360
	(0.00000666)	(0.00000721)	(0.00000942)	(0.00000706)
_cons	2.210***	1.053***	0.702***	0.353***
	(0.0165)	(0.0165)	(0.0123)	(0.0101)
N	50265	19591	6275	3149
R^2				
adj. R^2				
rmse	0.390	0.213	0.0922	0.0486

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.5: Non-Fed Funds Fixed-Effects

	(1) Zombie 3Y	(2) Zombie 3Y	(3) Zombie 3Y	(4) Zombie 3Y
Bank Health	0.373***	0.350***	0.251***	0.201***
	(0.00643)	(0.00613)	(0.00620)	(0.00668)
Firm Size	0.000129***	0.0000971***	0.0000895***	0.000103***
	(0.00000715)	(0.00000687)	(0.00000682)	(0.00000697)
Prime Lending rate	-0.0367***			
	(0.00128)			
10Y Treasury		-0.138***		
		(0.00193)		
Aaa Corporate Bond			-0.182***	
			(0.00232)	
Baa Corporate Bond				-0.138***
				(0.00228)
_cons	2.375***	2.869***	3.468***	3.394***
	(0.0116)	(0.0131)	(0.0187)	(0.0221)
N	50265	50265	50265	50265
R^2	0.079	0.153	0.169	0.130
adj. R^2	0.042	0.119	0.135	0.094
rmse	0.383	0.367	0.364	0.373

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.6: Non-Fed Funds Random-Effects GLS

	(1) Zombie 3Y	(2) Zombie 3Y	(3) Zombie 3Y	(4) Zombie 3Y
Bank Health	0.397***	0.369***	0.253***	0.185***
	(0.00648)	(0.00613)	(0.00619)	(0.00667)
Firm size	0.000123***	0.0000813***	0.0000747***	0.0000894***
	(0.00000672)	(0.00000619)	(0.00000614)	(0.00000636)
Prime Lending rate	-0.0485***			
	(0.00127)			
10Y Treasury		-0.169***		
		(0.00181)		
Aaa Corporate Bond			-0.215***	
			(0.00216)	
Baa Corporate Bond				-0.172***
				(0.00215)
_cons	2.327***	2.959***	3.646***	3.614***
	(0.0184)	(0.0170)	(0.0212)	(0.0245)
N	50265	50265	50265	50265
R^2				
adj. R^2				
rmse	0.390	0.374	0.369	0.379

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.7: Granger Causality Wald Tests

Equation	Excluded	chi2	df	Prob > chi2
zmb3ys	ff_o	.66136	4	0.956
zmb3ys	prime_na	2.9788	4	0.561
zmb3ys	tcmnom_y10	3.7138	4	0.446
zmb3ys	aaa	6.0907	4	0.192
zmb3ys	baa	4.4982	4	0.343
zmb3ys	ALL	17.015	20	0.652
ff_o	zmb3ys	1.7341	4	0.785
ff_o	prime_na	45.585	4	0.000
ff_o	tcmnom_y10	15.991	4	0.003
ff_o	aaa	22.437	4	0.000
ff_o	baa	6.8971	4	0.141
ff_o	ALL	135.04	20	0.000
prime_na	zmb3ys	2.634	4	0.621
prime_na	ff_o	232.91	4	0.000
prime_na	tcmnom_y10	6.3957	4	0.171
prime_na	aaa	23.686	4	0.000
prime_na	baa	10.247	4	0.036
prime_na	ALL	409.54	20	0.000
tcmnom_y10	zmb3ys	3.2579	4	0.516
tcmnom_y10	ff_o	30.831	4	0.000
tcmnom_y10	prime_na	34.185	4	0.000
tcmnom_y10	aaa	3.9335	4	0.415
tcmnom_y10	baa	9.1274	4	0.058
tcmnom_y10	ALL	75.426	20	0.000
aaa	zmb3ys	1.967	4	0.742
aaa	ff_o	22.674	4	0.000
aaa	prime_na	33.106	4	0.000
aaa	tcmnom_y10	12.509	4	0.014
aaa	baa	8.2717	4	0.082
aaa	ALL	79.9	20	0.000
baa	zmb3ys	2.0769	4	0.722
baa	ff_o	21.199	4	0.000
baa	prime_na	19.978	4	0.001
baa	tcmnom_y10	.96475	4	0.915
baa	aaa	5.4425	4	0.245
baa	ALL	68.157	20	0.000

APPENDIX B

OLS MODEL CHARACTERISTICS

Figure B.1: Correlation Matrix

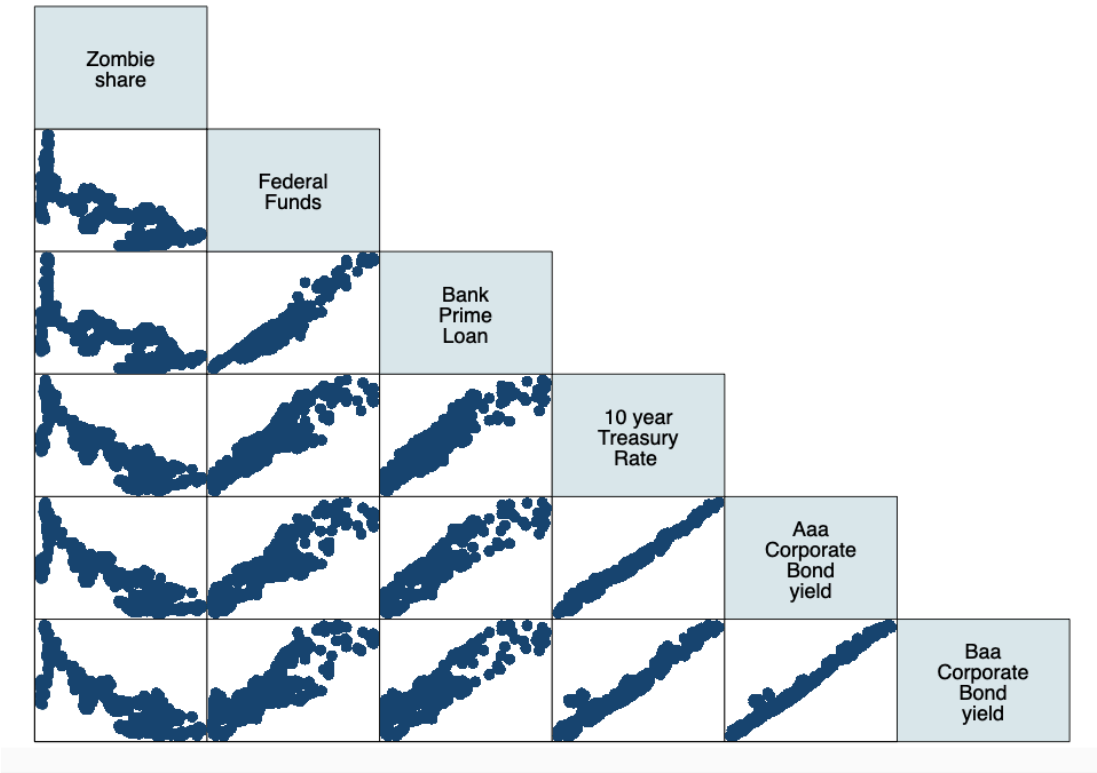


Figure B.2: Added-Variable Plots

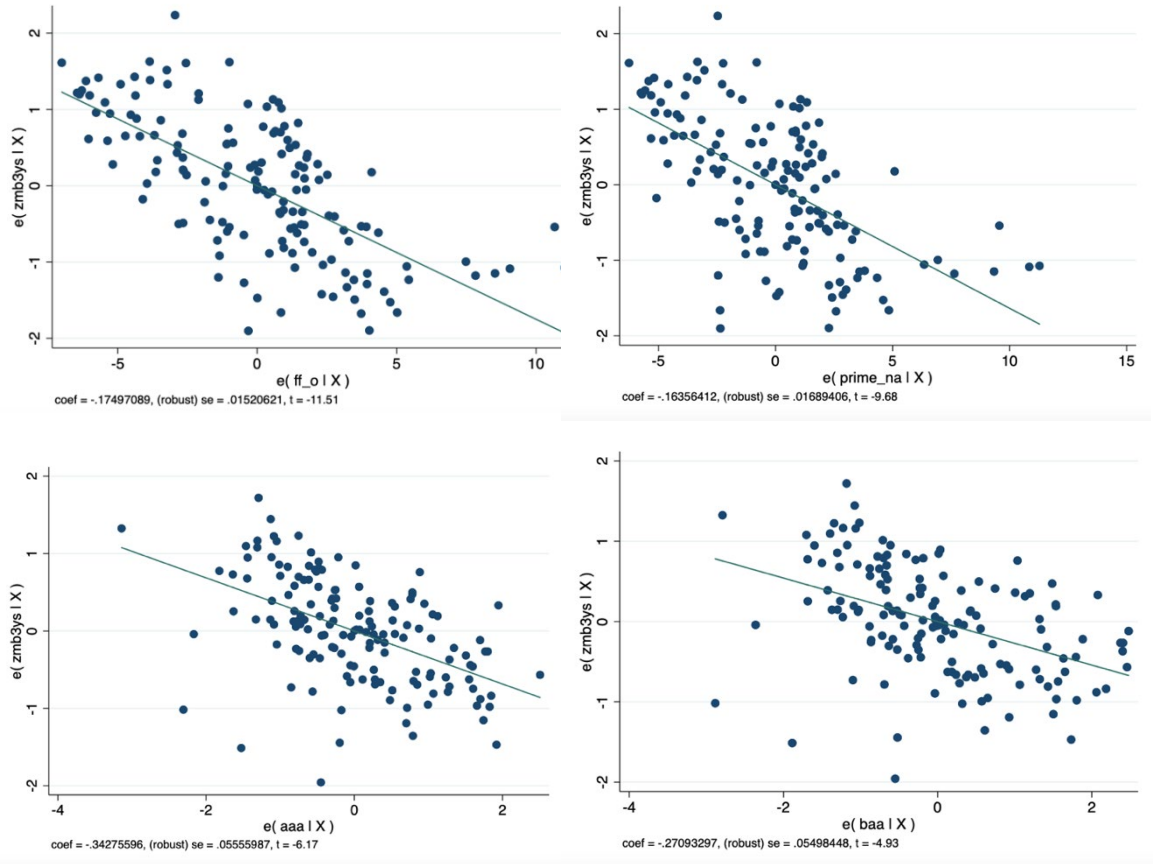
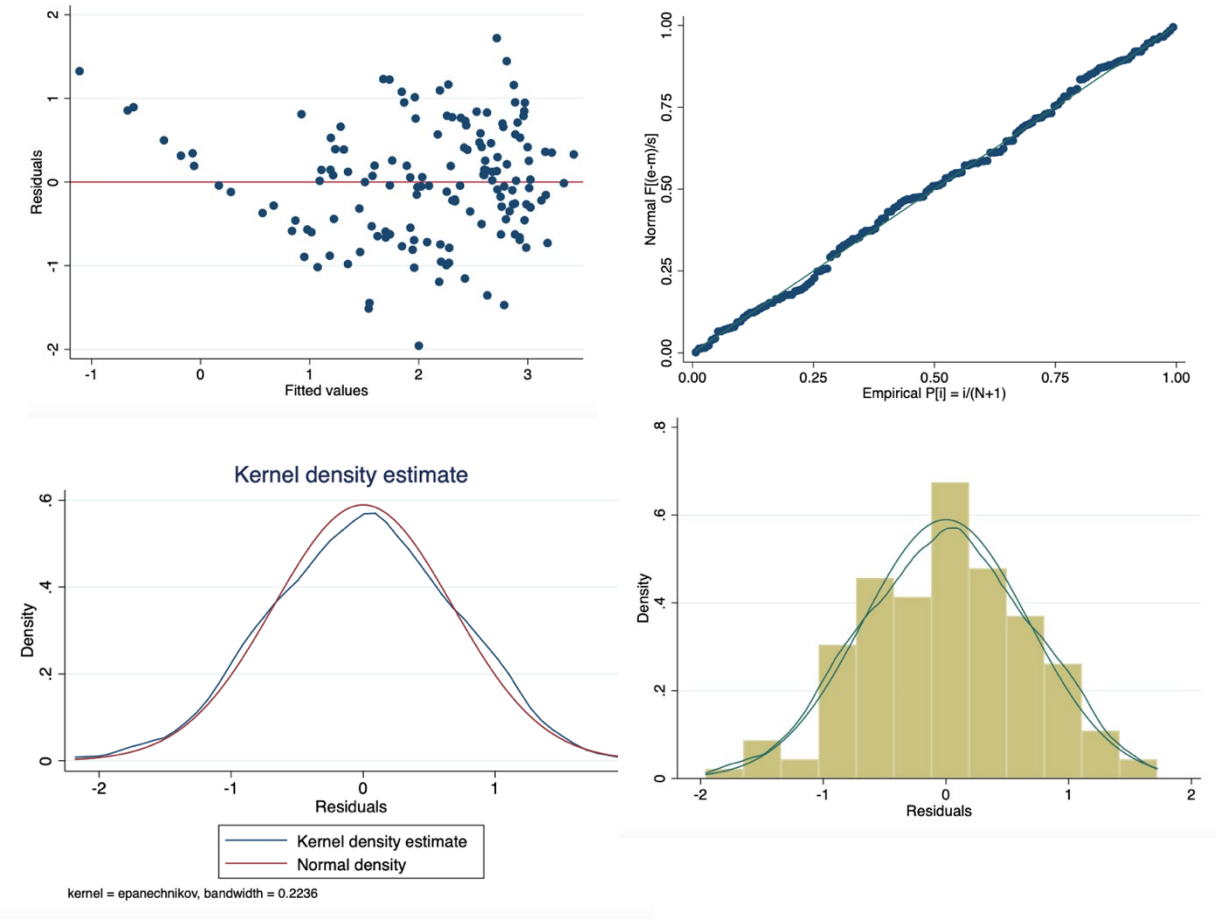


Figure B.3: OLS Residuals v. Fitted, Standardized Normal, Kernel Density, Histogram Plots



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Ismael was born and raised in Uriangato, Guanajuato, Mexico. He began his studies in Economics at UTA in the fall of 2017. His main interests lie in philosophy, economics, and history. He is a member of the International Honor society in both economics and philosophy, and winner of the Joan McCrea Memorial scholarship. He plans to join Federal Deposit Insurance Corporation (FDIC) as a Financial Institution Specialist, part of the Department of Risk Management Supervision.