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# Zombie firms and a low-interest environment

*An empirical analysis of ultra-low interest rates in relation to the surviving of inefficient firms in the nordic region*

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# Abstract

This paper examines the relationship between ultra-low interest rates and the amount of zombie firms using panel data for Sweden, Norway, Denmark and Finland over the period 2007-2020 in a multivariable regression model. Specifically, the questions addressed are: is there a relationship between the interest rate and the amount of zombie firms? Could it be concluded that the amount of zombie firms increases during periods of low interest rates? This study documents a statistically significant relationship between ultra low interest rates, i.e interest rates below the inflation target of 2%, and the increase in the amount of zombie firms. However, it can not be concluded that a further decrease in ultra low interest rates affects the amount of zombie firms. Two more variable used in the regression, GDP output gap and inflation, does also show a significant relationship with zombie firms which leads us to conclude that further research on this topic would be beneficial.

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# 1. Introduction

The term zombie firm was first mentioned when discussing Japan's "Lost Decade" describing companies under the 1990's, following the burst of the country's asset price bubble. Zombie firms are firms that typically would not survive in a competitive market and have to exit or be forced to restructure. These firms have therefore been named "zombie firms" due to their inability to keep up their operation with their own revenue (Goto & Wilbur, 2019). Research from BIS (Banerjee & Hofmann, 2018) suggests that lower interest rates can cause high leverage firms to survive longer in an otherwise efficient market. Greater risk-taking due to lower financial costs results in weak firms taking on more debt during low interest periods.

The amount of zombie firms have risen since the 2008 financial crisis. Zombies pose a threat towards the economy due to the crowding out effect these inefficient firms have on healthy firms, meaning that invested capital is being allocated away from efficient firms disrupting the creative destruction process. Interest rates have declined since 2008, making capital cheaper and increasing risk aversion which may be a contributing factor to the rise in zombie firms.

Several studies have picked up the term and investigated the causes and effects on the economy. Some have found relationships between low interest rates and others have not been able to conclude a relationship. We have yet to find a study which assesses the relationship during a long time period including recent years and several other explanatory variables other than interest rate and bank health. We want to further research the cause of zombie firms where we suggest low interest rates could be one of great importance.

This study intends to explore the relation between low interest rates and the amount of zombie firms on the chosen markets. We intend to answer the main questions: is there a relationship between the interest rate and the amount of zombie firms? Could it be concluded that the amount of zombie firms increases during periods of low interest rates?

Through data from four nordic countries: Sweden, Norway, Denmark, and Finland, which all have had similar interest rate development, we will construct a multivariable regression from the collected data over a 14-year period and determine whether there is a significant relationship between interest rate and zombie firms. Collecting data through S&P Capital IQ and OECD we run a regression in Gretl with multiple variables including interest rate, output gap, inflation rate and low interest rate regime. The low interest rate regime-variable is a dummy variable

separating the two time periods, before and after the financial crisis of 2008, in order to capture a low interest rate environment.

Our regression shows a significant relationship between the rise in zombie firms during periods of ultra low interest rates ie. periods with interests below the inflation target of 2%. However, we find no statistically significance between the specific level of low interest rates and the amount of zombie firms.

We will present and motivate our chosen definition of zombie firms as well as present some up to date information on the interest rate development and central bank policy for each country. We will also further discuss and examine the possible problem with zombie firms. Chapter 2 will review relevant literature which can be useful in explaining why this is a relevant topic to study. In chapter 3 and 4 we will then present our data and describe more in detail through which method we got our results as well as discussing potential error sources. This will be followed by a longer general discussion on the topic in chapter 5 and we will then finally reach our conclusion in chapter 6.

# 2. Background

## 2.1 Definitions

Zombie firms are a relatively new finding within research. These firms survive through financial help from their creditors which gives an explanation to the term “zombie firms”, indicating that they survive despite being dead in a financial sense (Caballero et al. 2008). In order to research this phenomena we need to specify a few characteristics which can describe the concept of surviving despite not being efficient.

Different studies on this topic characterizes zombie firms somewhat similar. An early study on this, constructed by the Bank of Korea, suggests that a characteristic to be used should be three consecutive years of insufficient operating income covering interest expenses.

To characterize zombie firms, EBIT (earnings before interest and tax) is being used to determine the firm's earnings in relation to its interest expenses. The ratio we will use to capture inefficient firms is for that reason the interest coverage ratio (ICR) which is EBIT over interest expenses. The ICR should be below 100%, that is when EBIT is at lower levels than interest expenses, for three consecutive years in order for it to count as a zombie firm. This in order to capture companies not able to cover its debt cost with its revenue during a longer period of time (Andrews & Petroulakis, 2019).

Some of the more recent studies build upon the ICR- criteria. It usually takes several years for a newly founded company to be profitable. To avoid classifying start-ups and newly founded companies as zombie firms, an additional useful criteria is age. The OECD has produced zombie literature in which a criteria of age has been added, requiring firms to be older than ten years (McGowan et al. 2017).

Other definitions include net investments and its return on assets being negative as well as a debt-servicing capacity being lower than 5% for two consecutive years, however for the simplicity of finding data on this, we will not add it to our definition (Storz et al. 2017).

This paper will apply the ICR criteria (ICR < 1 for three consecutive years) based on the study from the Bank of Korea as well as the applied age criteria (firms older than 10 years) suggested in the OECD paper in order to identify zombie firms.

## 2.2 Zombie firms as a threat to the economy

Zombie firms are a threat to the economy mainly through two channels. Zombie firms prevent more productive firms from gaining market shares and they, on a micro-level, exhibit low or negative rates of firm-level productivity growth. The creative destruction-process, that market forces should compel poorly performing firms to restructure or cease operations, is fundamental for an efficient economy. Firms need to operate in an environment where they constantly try new ideas and are exposed to competition. Through that process, only the most efficient firms survive and capital is efficiently distributed. However, zombie firms disrupt this process leading to an inefficient asset allocation where more productive firms receive too little capital. (Ahearne & Shinada, 2005).

Empirical evidence from China shows that these low productive firms tie up abundant financial capital and accordingly have a significant crowding out effect on efficient firms, the non-zombie firms. Zombie firms worsens the market distortion and hampers the development of efficient industries (Wang & Zhu, 2021). In practice, zombie firms affect the aggregate productivity negatively. They reduce the returns on potential investment projects making expansion less attractive as wages are being inflated and prices depress. As zombie firms continue to exist, barriers to enter as a new market actor are being created (McGowan et al. 2017b).

Previous research has mainly focused on zombie firms in relation to bank health and insolvency regimes. The inability of insolvency regimes to facilitate the exit or downsizing of inefficient firms is one explanation for the increase in zombie firms. One other explanation for the capital misallocation is weak banks that need to maximize their lending in order to stay profitable by also taking on creditors with high risk and low earnings (Andrews & Petroulakis, 2019).

## 2.3 Monetary policy

In order to give a fair review of the different interest rates in our data set, a brief explanation of the central bank policy in each country and in the world overall, is beneficial for our analysis.

### 2.3.1 The studied countries monetary policies

Sweden's central bank, Riksbanken, has a monetary policy goal to maintain a fixed monetary value by keeping the inflation rate low and steady. Specifically, the goal is keeping the inflation rate at two percent on average. Riksbanken measures inflation by consumer price index (CPI) showing living costs in Sweden over time (Riksbanken, 2022a). The CPI of October 2022 was at 9,3% which is higher than the goal (Riksbanken, 2022b). This results in Riksbanken using monetary policy to lower the inflation rate. Norway's central bank, Norges bank, defines their monetary policy goal roughly the same as Riksbanken, by keeping the inflation rate low and steady with a goal of two percent with one of the reasons being that high inflation rates are costly for society (Norges Bank, 2021). Denmark's central bank, Danmarks nationalbank, presents the same objective of monetary policy as Sweden and Norway, keeping the inflation rate low. They add that through monetary policy, another goal is to keep the exchange rate stable against the euro. Denmark, unlike Norway and Sweden, has a fixed exchange rate (Danmarks Nationalbank, 2021). Finally, Finland differs from the rest of the studied countries since they are a part of the euro area. This means that Finland's central bank, Finlands bank, has tasks both relating to Finland and the euro system which share the same goal of price stability, inflation (Bank of Finland, n.d.).

All of the studied countries are part of the nordic region and so a part of the nordic cooperation. This explains the monetary policy similarities across our four studied countries. They share similarities and some differences but they are all small open economies, i.e economies that can not influence prices on the global market (Persson, 2019), which makes them convenient to study and compare (Valkonen et al. 2014). Large economies are usually considered large because of their power position on a specific market which means that land mass is not a part of the definition, only the size of economic power. Thus larger actors have an influence on the market and world prices by regulating policies, for example imposing tariffs. Small economies, however, do not impact the world market price by imposing any policies (Guerron-Quitana, 2013).

As stated in previous sections, the Nordic countries are rather small actors at the world market and are largely affected by other economic conditions and monetary policy from actors such as the European central bank and federal reserve. It is thus relevant to investigate the reasoning behind ECB and FEDs monetary policy decisions.

### 2.3.2 Unconventional monetary policy: the 2008-financial crisis

Interest rates started to decline as a consequence of the financial crisis in 2008. In the fourth quarter of 2008, ECB reduced interest rates by 175 basis points and further by 150 basis points between January and May 2009 to historically low levels of 1% on main refinancing operations, 0,25% on deposit facilities and 1,75% on marginal lending facilities. This in order to: "foster more supportive financing conditions and the flow of credit to households and corporations". The eurozone was in the beginning of a cyclical slowdown in 2007 which turned into a recession in the first half of 2008. The consequences of the recession were large and the eurozone faced record declines in business and consumer confidence leading to lowest levels of inflation recorded since 1999 of 0,3% right after inflation levels of 3,3% in 2008. Low levels of liquidity was recorded among a number of markets as a result of higher volatility in financial markets, resulting in a severe fall in trade volume and a significant drop in output. This indicated an increase in investors risk aversion (ECB, 2009).

The FED handled the financial crisis in a similar manner as the ECB. The US economy weakened markedly in the second half of 2008 as the uncertainty in financial markets intensified. Asset prices continued to drop and credit conditions tightened further. A majority of large sectors of the economy registered deep declines in activity and inflation pressure reduced. Like in the eurozone, investor confidence dropped and risk aversion increased. FED lowered the federal funds rate by 325 basis points and reassessed its target rate for federal funds rate to an interval between 0% and 0,25% (Federal Reserve, 2009).

## 2.4 Existing research

Research on zombie firms has become more relevant during later years, due to the current economic state. Studies on the topic have been released by larger organizations such as the central bank of Sweden, Bank of international settlements (BIS), Federal Reserve (FED) and

OECD. They differ in many ways, not least in the results presented, but can be helpful to look at in order to reach accuracy in this study.

Some theories motivating the research claim banks and low interest rates as factors to an increase in the amount of zombie firms. Lower short-term-interest rates from the central banks imply lower long-term interest rates, which are determined by the domestic banks. Evidence suggests that banks suffer from lower interest rates as they gain less profit from interest rates in that environment. This leads to less pressure on zombies to restructure, reduce debt or exit the market. The banks have a reduced pressure to clean up their balance sheet and evergreen loans[1]. Therefore, lenders instead cut funding costs of bad loans and increase expected recovery rates on loans. A low-interest-rate-environment also creates incentives for risk-taking. As zombie companies are considered risky debtors, lower risk aversion reduces financial pressure on zombie firms (Banerjee & Hofman, 2018).

The national bank of Sweden, Riksbanken (Cella, 2020), published a Staff memo in which the threat of zombie firms in Sweden is discussed. The study looks at the period 2002-2016 and has a shorter studied period compared to other available literature. A study from BIS looks at the relationships between zombie firms and low interest rates over a longer period, from 1980 to 2016. This study, however, also ended in 2016 and has not studied the relationship during the Covid-19 pandemic. A note published by the Federal Reserve (Favara et al. 2021) does study further than 2016 and include 2020 in their dataset. Their studied period differs between 1990 and 2021 but analyzes the period 2015-2020 deeper and most frequently. This shows a gap in the previous literature on this topic where studies having a longer time period does not include the recent pandemic. The ones that do include the pandemic, do not analyze zombie firms' existence further back than 2015.

Definitions of zombie firms also differ between studies. Riksbanken uses the definition by McGown et al. (2017b). Riksbankens study explains that low interest rates can both help all existing firms, not only zombies, by supporting demand for goods and services but it can also give incentive for some firms to increase their leverage. If this, however, is a concern for Sweden is being discussed using empiric data. The data suggested that the amount of zombie firms in Sweden decreased between the years 2010-2016 and decreased their exposure to financial institutions. In 2016 roughly three percent of existing firms were classified as zombie firms and

[1] Evergreen loans are loans where lenders do not need to reapply for a new loan whenever they need more money.

these absorbed less than five percent of the total amount lended by financial institutions. This research draws the conclusion that the phenomenon of zombie firms is not necessarily related to low interest rates and that this phenomenon does not pose a significant threat towards the Swedish economy nor financial stability.

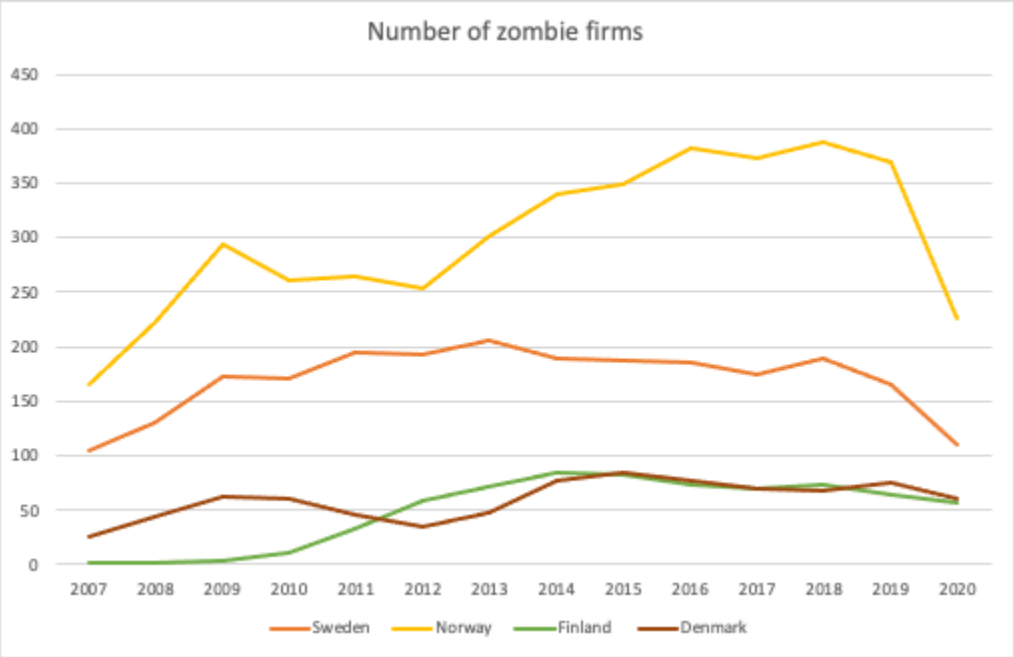
Zombie firms are discussed roughly with the same perspective of it being a prominent feature of the economy or not, like Riksbanken's Staff memo, by the FED (Favara et.al 2021). Their definition of a zombie firm is simplified compared to some of the other literature by not having the ten year criteria. They find that zombie firms are short-lived and usually exit the market within five years. An explanation given to this is simply that the firms go bankrupt. The study finds that zombie firms are not an important feature in the US economy so far and that these firms did not benefit disproportionately from improvements in the credit market. They, however, will not completely dismiss the concerns that the current economic environment breeds new zombie firms. This note can be viewed as less detailed and simplified compared to other literature on this topic which makes it harder to draw any conclusions.

Unlike the Riksbanken and FED report which only studied the domestic country in this matter, BIS looks at zombie firms from a wider range by collecting data from 14 advanced economies (Banerjee & Hofman, 2018).

# 3. Data

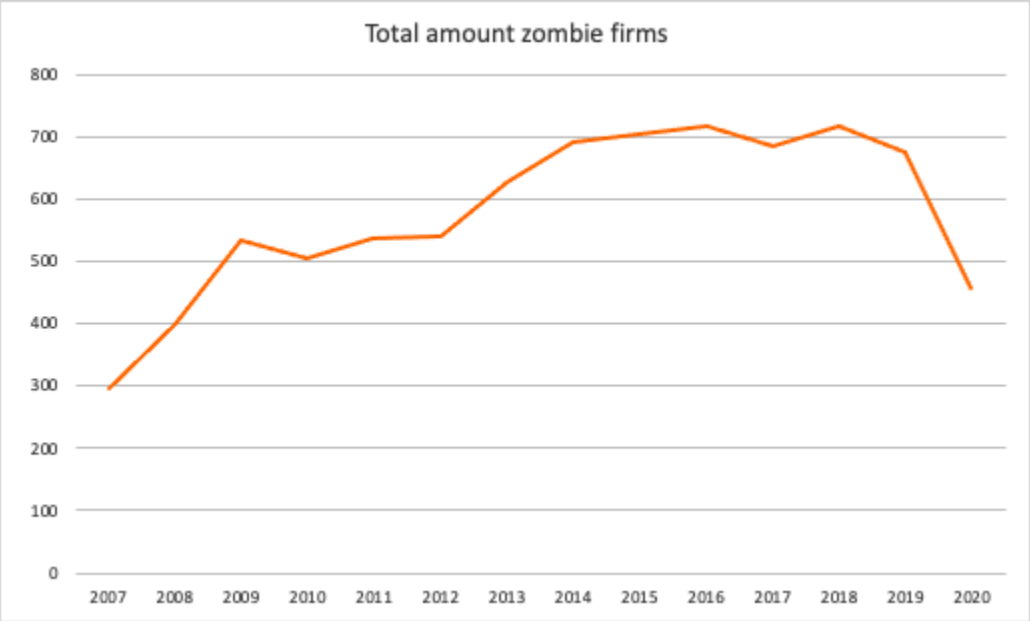
The main data variables collected in order to run the regression are the amount of zombie firms in each country and the interest rate development for each country over time. We have also used inflation and GDP output gap for each country as other possible factors that could explain the rise in zombie firms, to not exclude the possibility of endogeneity between the data points.

**Figure 1:** number of zombie firms year 2007-2020




*Source: S&P Capital IQ and own calculations*

**Figure 2:** Zombie firms for Sweden, Norway, Denmark and Finland aggregated




*Source: S&P Capital IQ and own calculations*

The number of zombies have varied throughout the years, as seen in figure 1. We have looked at domestic companies founded in Sweden, Norway, Denmark and Finland respectively. Collecting data from Capital IQ, we see that in 2020, the number of zombie firms was at a total of 455, all countries included, which is an increase of 154% since 2007, as seen in figure 2.

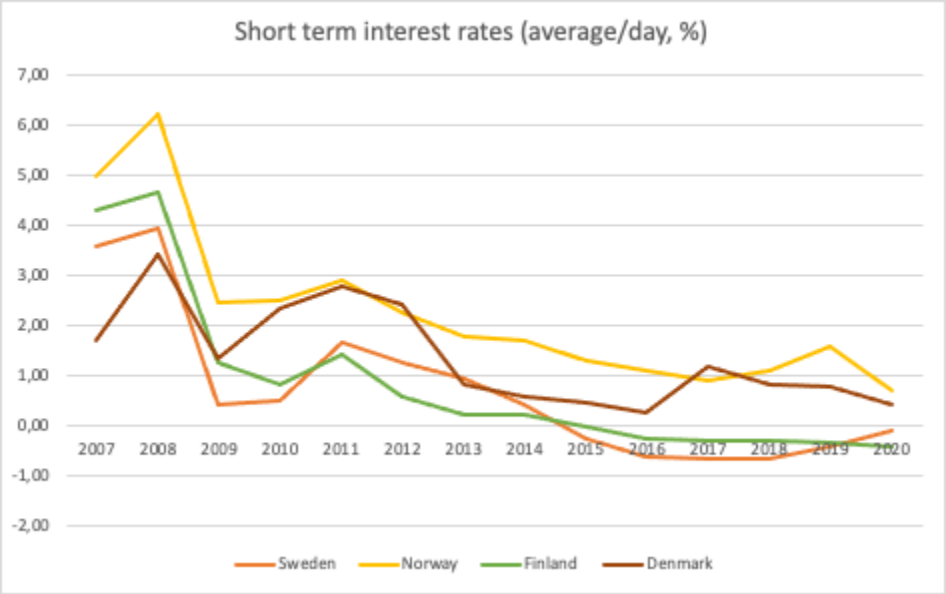
We made our search solely for companies founded in the Nordic region. However, companies with other origins that operate in these countries can also take advantage of cheap loans in the respective countries which means that low interest rates not only affects dometic companies. We use the ICR to determine if the firm is a zombie firm. The ICR measure is widely used but it can confuse the result due to lower interest rates also resulting in lower costs, to such an extent that firms receive subsidized credits.

We have used data on zombie firms as absolute values rather than as shares of total companies because this will be partially adjusted in our regression when using fixed effects.

The data on zombie firms have been collected from S&P Capital IQ. S&P capital IQ is a financial platform with information on both public and private companies globally (S&P global,

2022). For collecting the data we also looked at possibly using data from Orbis database but discovered that we would only be able to display data for a 10-year period. In Capital IQ, one can customize the search and create new formulas which we did with the help of S&P capital IQ staff. This made the search more accurate as we took help from professionals, but this may also be an error source as we did not have full control over how the search was done. The specific formula is being presented in chapter 4.

**Figure 3:** average short term interest rates



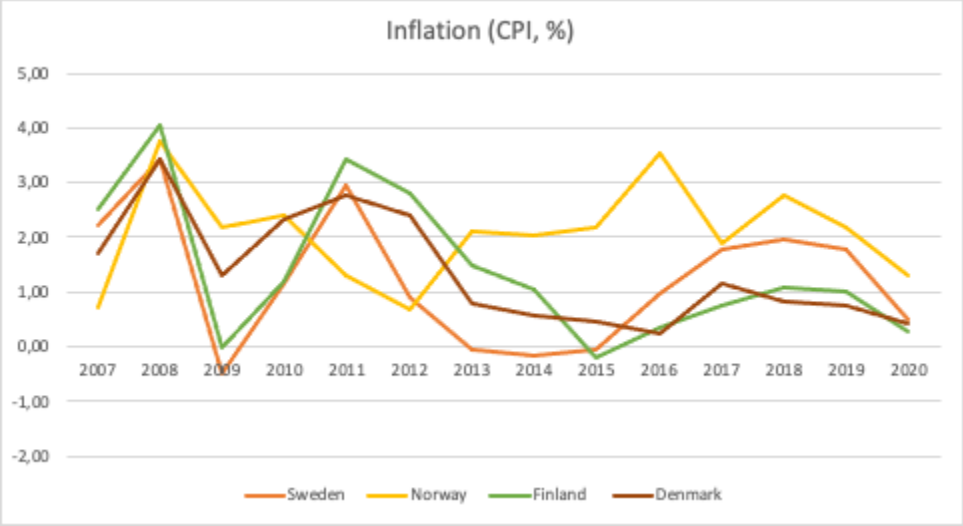

*Source: OECD*

We have collected the data on short term interest rates, i.e the overnight-rates set by the respective central banks, from the OECD database setting the time period to 2007-2020 and choosing Sweden, Norway, Denmark and Finland. The average of daily short term-rates are illustrated in figure 3. Interest rates have declined at a fast pace since the beginning of 2000. Overall, the studied countries have had a similar interest rate during the period, however, Norway has had a slightly higher interest rate on average. The mean short term interest rate year 2000-2020, including all countries, is at a rate of 1,92%. During the period 2015-2020, the interest rates have been at historically low levels and under 0% for all 5 years for Sweden and Finland. Norway and Denmark have both shown ultra low interest rates below 2%[2], and under

[2] We call these interest rates below the inflation target, i.e below 2%, for ultra low interest rates.

1% for several years during the same period. This can be compared to the country's mean interest rate which is in the interval [1.48, 3.03]. Pre financial crisis 2008, the overall mean interest rate was at 3.4%. In contrast, the mean interest rate for post financial crisis 2008 was at 0,81%. (OECD, 2022)

**Figure 4:** inflation (CPI) year 2000-2020




*Source: OECD*

Before a period of low interest rates, there was a period of higher interest rates. One reason for interest rates to increase was to prevent too high levels of inflation. This is what happened the years before the 2008-crisis. Inflation was higher in Sweden during this period (SCB, 2022). Looking at figure 3 and 4, inflation seems to have fluctuated more than the interest rates. (The world bank, 2022).

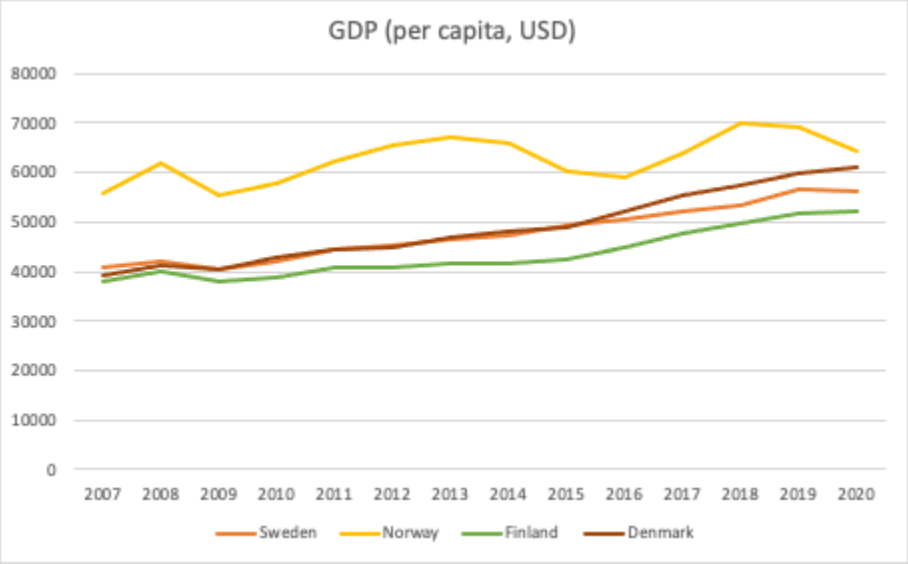
We added two more variables that may affect the amount of zombie firms: GDP measured as GDP output gap and inflation measured as CPI.

Inflation is an indicator on where in the business cycle the respective country lies and whether the country is in recession or in a boom. Higher inflation should indicate high activity in the economy and possibly that more firms survive as the purchasing power and the demand is at higher levels. Thus indicating more zombie firms surviving. The inflation has fluctuated a lot throughout the studied period but, as seen in figure 4, there are years with very low, respectively high, inflation rates.

The GDP output gap is an indicator in a similar manner, specifically periods of lower GDP should indicate less firms surviving and consequently more zombie firms should be forced to exit the market. The GDP output gap measures the gap between the actual GDP and the potential GDP where it is desirable, from a macroeconomic perspective, for the gap to be zero. A negative value of the output gap indicates that the economy does not perform to its full potential while a high positive gap could indicate an overheated economy with the risk of high inflation rates (OER Services, n.d.). We calculated the output gap for the years 2007-2020 using data collected from Nasdaq (2020) and equation 2. Y being actual GDP and Y* being potential GDP.

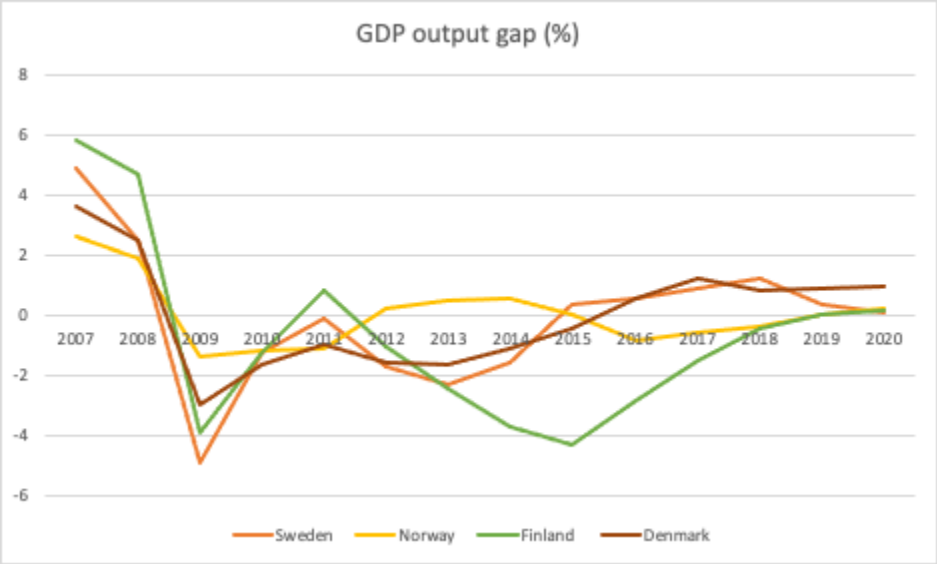
$$\frac{Y-Y^*}{Y^*} \quad \textbf{(2)}$$

**Figure 5:** GDP per capita in USD year 2007-2020




*Source: OECD*

**Figure 6:** GDP output gap in % year 2007-2020




*Source: Nasdaq data link*

The real GDP is one factor that has increased rather steadily over the last years with a decline past 2008-financial-crisis and past the covid pandemic 2020, as seen in figure 5. Looking at the GDP output gap in figure 6, we get a more accurate representation of the development as the data is stationary. The inflation rate has fluctuated during the same period with unusually low levels in 2008 and 2020 as a result of the same factors as for GDP.

The GDP was collected from the Nasdaq data link while interest and inflation- data were collected from the OECD database. There may be a downside in collecting the data from a general database rather than from the respective countries own databases. This due to the risk of measurement errors when collecting data from a big institution focusing on several countries rather than collecting it from an institution only focusing on one country.

Overall, there is a possibility for lagging effects of the interest rates impact on the company's balance sheet. Interest rates first started to be at ultra low levels around the year of 2010, which in context is a fairly short period of time the companies have lived in the current interest environment. This can cause error sources when studying zombie firms in low-interest-rate-environments. One other possible source of error is that the sample is relatively small as we only have access to 14 years since we look at the amount of zombie firms per year.

# 4. Method

Our decision, studying more countries than one, was motivated by having a broader database with significantly more firms than we would have if we only looked at one country. This will also decrease risk of error sources as the studied countries may have taken different monetary decisions due to their slightly different economic conditions, which can affect the results. These countries are, however, quite similar to each other in many ways and are all part of the Nordic cooperation. The similarities are reflected in their interest rate development, as shown before, which facilitates our analysis further.

We wanted to be able to study the correlation between interest rate and zombie firms with historical data to get a better view of the relationship year 2007-2020. In order to receive the desired data, we requested a formula in the data base for firms older than ten years, as mentioned before, this is to prevent start ups to wrongly classify as zombie firms. We also requested the formula to include the ICR criteria, in which we wanted to sort out firms that had an ICR of less than one for at least three consecutive years. We were then given a formula[3] which we could apply to our four chosen countries and transfer our results by downloading a dataset in excel.

From the formula, we received a dataset of companies over the time period 2000-2020. However, we excluded data from the first 6 years as the amount of companies were close to 0 for several years during that time period due to lack of data in the database. The companies were at least 10 years old from the respective year and have had an ICR <1 for three consecutive years for any time period during 2007-2020. For the respective companies and the respective years, we got a value of 0, 1, 2 or 3 for how many years that specific company had an ICR<1. We then created our own dataset by summing up the companies who had an ICR <1 for three consecutive years seen from the respective years., i.e for which years the company had a value of 3, to capture how many zombie firms there are per year and per country.

The regression is a fixed effects model of panel data. In Gretl we chose 14 time periods and 4 cross-sectional units to account for the 14 years and the four countries.

The regression was being done from 56 data points containing interest rates, GDP output gap, inflation and low interest rate regime.

[3] SUMIF(CIQ(IQ_EBIT_INT,IQ_LATESTK) < 1, 3Y, 1, 0)

The regression model was created as follows:

$$zombie\ firms_{it} = \alpha + \beta_1 interest\ rate_{it} + \beta_2 output\ gap_{it} + \beta_3 inflation_{it} + \gamma d_{it} + \varepsilon_{it} \quad \textbf{(1)}$$

$zombie\ firms_{it}$ is the dependent variable and describes the amount of zombie firms for each country, $i$, per year, $t$. We added the independent variables $output\ gap_{it}$ and $inflation_{it}$ in order to adjust for possible endogeneity. The dummy variable, $\gamma d_{it}$, describes a low interest rate regime[4].

The dummy is coded to d=0 for the period 2007-2011 and d=1 for the period 2012-2020. Rates are starting to be below 2% year of 2009, in order to capture that it takes three years of ICR<1 in to be considered a zombie company, the end-period for the d=0 is therefore set to three years from 2009 which is year of 2011. With the dummy, we investigate if we significantly can conclude a relationship between interest rate and zombie firms while put in two different conditions and to adjust for the large and persistent decrease in interest rates after the financial crisis. We defined the period before the financial crisis as ultra-low interest rates since the interests are below the country's inflation targets of 2%.[5]

Finally we tested our regression for autocorrelation, using the Wooldridge test, see table A.3, and the degree of autocorrelation using the Durbin Watson statistics, see table A.4. We also tested the regression for heteroskedasticity, using the free Wald test, see table A.5.

[4] See appendix B for further explanations on the interest rate regime-dummy.
[5] Using Gretl

# 5. Empirical results and discussion

## 5.1 Results

The following results derive from the linear regression model, see equation 1 in chapter 4, whether there is a significant relationship between our independent variables and the dependent variable. We are looking for a relationship between the variables and zombie firms through normal distribution with a null hypothesis and a significance level of 95%. This means that we will reject the null hypothesis for the variables if the p-value is $\leq 0.05$.

Testing for heteroskedasticity in the panel data, doing a Wald test, our null hypothesis is: the units have a common error variance. We received a p-value of 1.71675e-09 so we reject the null and can not show any heteroscedasticity in our regression. Testing for autocorrelation using a Wooldridge test with a null hypothesis: no first-order autocorrelation we get a p-value of 0.0102709 and can reject the null hypothesis and thus show that there most likely is autocorrelation in our regression. This result is not surprising as the economy over a time period naturally depends previous economic conditions. From the Durbin-Watsons test, we can conclude that there is positive autocorrelation meaning that the variables show similar values. See appendix A for further information on the tests.

**Table 1:** regression on amount of zombie firms in relation to interest

*Dependent variable: amount of zombie firms*

| Variable | Coefficient | P-value |
|---|---|---|
| Constant | 100.932 | 1.91e-07*** |
| Low interest rate regime | 39.435 | 0.0069*** |
| Interest rate | −6.80043 | 0.1679 |
| Inflation | 16.339 | 0.001*** |
| Output gap | -7.356 | 0.0061*** |

*LSDV R-squared: 0.934036*
*Within R-squared: 0.530775*

Our null hypothesis is: there is no form of relationship between the variables and the amount of zombie firms. From our regression using the four variables interest rate, inflation, output gap and low interest rate regime, we got the results shown in table 1. Looking at the p-values for the different variables we see that the low interest rate regime-variable is showing a value of $0.0069 < 0.05$, which means that we can reject the null hypothesis and suggest that the dummy does have a significant impact on the amount of zombie firms. This means that the low interest rate regime-variable can show us that the different time periods, before and after the 2008-crisis, does show a relationship with the amount of zombie firms. More specifically the coefficient for this variable, as shown in the table, is 39.435. We have, as described in chapter 4, put the period before 2012 as value d=0 and the period after as d=1 which means that 39.435 is the increase of zombie firms in the second period.

Our interest rate variable show a p-value of 0.1679 > 0.05 which tells us that we can not reject the null hypothesis. We can thus not conclude that there is a significant relationship between the interest rate and the amount of zombie firms when looking at the data points individually during a continuous time period. This result is in contrast to when we compare two different time periods, which the low interest rate regime-variable represents.

When looking at other potential explanatory variables we see that the p-value for inflation is 0.001 < 0.05, suggesting that we can reject the null hypothesis. We see that inflation may have a significant effect on the amount of zombie firms. We look at the variable output gap to see if this can be a factor in the amount of zombie firms. The p-value shows 0.0061 < 0.05 which means that we can reject the null hypothesis and suggest that GDP output gap and therefore business cycles does have a significant relationship with the amount of zombie firms. The coefficient for output gap is -7.356 meaning that for each unit output gap, the amount of zombie firms decrease by 7.356.

Furthermore, the regression displays a high R-squared of LSDV R-squared= *0.934036* and within R-squared=*0.530775* showing at approximately 93% fit between observed values and the regression line.

We can thus not conclude that the amount of zombie firms solely depends on solely one variable.

## 5.2 Discussion

The results from our calculation show us that utra-low interest rates do have a relationship with the amount of zombie firms. Our regression show a significant relationship between the low interest rate regime- variable and the amount of zombie firms, leading us to rejecting the null hypothesis. From this we can suggest that during the period of which the level of interest rate is below the inflation target, the amount of zombie firms increases. Although, this isn't completely clear. It could be that the amount of zombie firms rather are correlated with some other factor over time. We are not sure that the significance level on the dummy variables concludes that it is specifically the low interest rates that are the explanation for the increase in zombie firms in the period after 2008 compared to the period before.

The interest rate variable on its own tells us that we can not reject the null hypothesis and so conclude that there is not a significant relationship between this variable and the amount of

zombie firms. This leads us to concluding that periods of ultra low interest rates does have an impact on the amount of zombie firms but we can not determine that lower levels of ultra low interest rates increase the amount of zombie firms.

Comparing our result to some of the previously discussed literature we see that Riksbanken's staff memo concludes that zombie firms and low interest rates are not necessarily related and do not pose a significant threat to the Swedish economy (Cella, 2020). This somewhat resonates with our results in regard to not being able to show a statistically significant result between our variable interest rate and the amount of zombie firms. However, unlike their study, we used a dummy variable and defined a low interest rate regime where we could see that extreme values overall on interest rates do impact the amount of zombie firms. We do not use nearly as many observations as Riksbanken.

Our results align more so with the BIS study in which they perform Granger's causality test for interest rates on zombie firms and find a significant link between these (Banerjee & Hofman, 2018a). They also have a higher number of observations than us which makes their calculations more reliable. The study from BIS also considers bank health, defined as "price-to-book" ratio, as a potential variable but they do not find a significant relationship between this and the amount of zombie firms. This differs from our results where we find variables, other than interest rate, to have significant relationships with the amount of zombie firms.

The note from FED suggests that zombie firms did not benefit more than non zombie firms during the easing of financial conditions in 2020. They focus on comparing zombies with non zombies in their study which gives them a good perspective of the situation. However, they study a relatively short period, 2015-2020, which can affect their analysis due to very low interest rates and an unusual economic situation compared to periods further back. We study a 14-year period which allows us to investigate different economic situations and how the correlation between interest rate and zombie firms has acted during different conditions.

The differences in our research in relation to previous research is mainly due to the selected data. We investigate a longer time period, from the year of 2007 to the year of 2020, compared to research made by BIS, FED and Riksbanken. However, we do have a more limited dataset where we have less firms in our research due to the nature of our chosen database. We do not use zombie firms as a share of total existing firms which also differs from previous research.

The method used, multivariable regression, is roughly the same as previous studies but we use GDP measured as output gap and inflation as other explanatory variables to zombie firms which, to our knowledge, has not been used in previous research.

Looking at a historical context, we have only used a 14-year period in our regression, we therefore haven't captured the "normal" interest- and inflation rates. Interest rates have declined steadily since 1975 when the interest rates were at around 15%. In that context, our "high" interest rates for the investigated time period are fairly low at around 5%. We may therefore have received a different result if we were to investigate a longer period of time.

The monetary policy we have seen since the financial crisis in 2008 have been a policy of low interest rates and an intention to stimulate the economy to avoid a too low recession and increase consumer demand. Inflation rates have declined in order to stimulate the economy, in accordance with the central bank's monetary policy targets to keep the inflation at around 2%. Short term consequences may have been large if the economy wouldn't get stimulated resulting in possible long term consequences.

The GDP output gap clearly has an impact on the amount of zombie firms. An economy in boom naturally results in more firms surviving. However, this factor should also result in the companies restructuring and increasing their ICR. That may be an explanation to why we have seen a slight decrease in the amount of zombie firms from the year of 2018 through 2020. The firms have lived in a booming economy for a longer period of time and have invested enough capital to restructure and adapt to the current market conditions.

We find different explanations as to why zombie firms increase when interest rates are at ultra low levels. On a free market, market forces depend on risk aversion and a trade-off between risk and reward. With ultra-low interest rates, market forces may be artificially disrupted as the price of money gets too low. This leads to investors looking for high risk investments where the risk premium, as well as possible revenues, are higher leading to zombie firms surviving for a longer period of time as they receive capital even though they aren't really profitable and their products and services aren't really demanded by consumers. Firms that would typically be eaten up by the creative destruction process can stay on the market longer and keep up operations as they continue to receive capital from lenders. We are taught that due to the limited amount of capital, capital on a free market will be allocated towards the most efficient operations and towards operations where investors can earn revenue for a longer period of time. If capital is too

cheap and the risk is lower when doing overall investments, too risky investments will be taken on. Such as zombie firms which have operated for a longer period of time but are not able to cover its interest expenses with its EBIT over three consecutive years.

# 6. Conclusion

The topic of zombie firms has sparked an interest in recent research partly due to the covid-19 pandemic, which has made it more interesting researching this topic during other financial crises, such as the 2008 crisis. The aim of this research is to examine the relationship between interest rates and the amount of firms that can not cover its interest expenses with its revenue during a longer period of time, so called zombie firms. Specifically, the questions are: is there a relationship between the interest rate and the amount of zombie firms? Could it be concluded that the amount of zombie firms increases during periods of low interest rates?

Our data concludes that zombie firms in fact have risen during the period 2007-2020. There was an increase past the financial crisis 2008 that correlates with a drastic decrease in short term interest rates. Specifically, we can see a relation between the time period past 2008 and an increase in the amount of zombie firms. This indicates that interest rates at ultra low levels compared to higher interest levels have an impact on the amount of zombie firms. However, we can not conclude a relationship indicating that the lower the interest rates are, the higher the amount of zombie firms will be since we do not see a significant relationship between the variable interest rate and zombie firms.

When measuring the GDP output gap and inflation we found a significant relationship with the amount of zombie firms. Thus these variables also seems to have an effect on the survivorship of zombie firms.

Overall, this paper highlights that more research is needed that includes more observations and a longer time period to further determine a significant relationship between interest rates and zombie firms. It would also be beneficial to further study GDP and inflation in relation to zombie firms since we could show a significant relationship between these, as well as more countries.

The 56 datapoints we have in the dataset is a fairly small amount, so it is unclear what we can say about the relationship in general. However, our research gives an indication that there seems to be some kind of relationship between interest rates and the amount of zombie firms in the nordic region over the time period 2007-2020. This also makes intuitive sense as lower rates means cheaper loans and therefore that more market actors are able to take out loans.

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# Appendix A: regression output and tests

**Table A.1** full regression output

Model 1: Fixed-effects, using 56 observations
Included 4 cross-sectional units
Time-series length = 14
Dependent variable: amount of zombie firms

| Variable | Coefficient | std-error | T-ratio | P-value |
|---|---|---|---|---|
| **Constant** | 100.932 | 16.609 | 6.077 | 1.91e-07 |
| **Interest rate** | −6.8004 | 4.85652 | −1.400 | 0.1679 |
| **Inflation** | 16.339 | 4.669 | 3.500 | 0.001 *** |
| **Output gap** | -7.356 | 2.564 | -2.869 | 0.006 *** |
| **Interest rate regime** | 39.435 | 13.958 | 2.825 | 0.007 *** |

**Table A.2** Properties of the regression

| | |
|---|---|
| **rho** | 0.476849 |
| **Mean dependent variable** | 144.2143 |
| **S.D. dependent var** | 110.0654 |
| **Sum squared resid** | 43951.17 |
| **S.E. of regression** | 30.25970 |
| **LSDV R-squared** | 0.934036 |
| **Within R-squared** | 0.530775 |

**Table A.3** Wooldridge test for autocorrelation in panel data

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Null hypothesis: No first-order autocorrelation (rho = -0.5)

Test statistic: F(1, 3) = 33.4718

with p-value = P(F(1, 3) > 33.4718) = 0.0102709

---

**Table A.4** Durbin watson statistics

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Durbin-Watson statistic =0.926115

H1: positive autocorrelation

p-value = 7.16671e-05

H1: negative autocorrelation

p-value = 0.999928

---

**Table A.5** Distribution free Wald test for heteroscedasticity

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Null hypothesis: the units have a common error variance

Asymptotic test statistic: Chi-square(4) = 46.7529

with p-value = 1.71675e-09

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# Appendix B: the dummy variable on interest rate regime

More specifically, the dummy variable shows us whether it matters for the amount of zombie firms if it is before or after the year of 2008.

After the year of 2008, as mentioned in chapter 2, the interest rates have been at ultra low levels, below 2%. In practice, the dummy variable therefore intends to shows whether an interest rate below 2% has an impact on the amount of zombie firms. The difference between this variable and the "interest rate"-variable is that the lastly mentioned variable shows if the interest rate, in general, has an impact on the amount of zombie firms, not connected to specific time periods. Thus, this variable also takes into account if the amount of zombie firms changes with how low the interest rates are. The dummy only takes into account if an interest rate below 2% has an impact on the amount of zombie firms.

We have added three years after the ultra-low interest rates when coding the dummy in order to capture that the zombie firms first show up as zombie firms, according to our definition, when ICR has been below 1 for three consecutive years. With this, we capture all the firms that has been in the "higher" interest rate environment taking the ICR-measure into account.

If we were to reject the null on the dummy-variable, we wouldn't be able to conclude that there is any relation between interest rates below 2% and the amount of zombie firms. If both the dummy-variable and the interest-rate variable weren't to be rejected, we would have been able to see that there is both a relationship between low interest rates below 2% and amount of zombie firms as well as a relationship between the specific "low- level" of the interest rate and the amount of zombie firms.