The COVID-19 pandemic crisis and vulnerable firms. Evidence from Sweden.

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S V E R I G E S   R I K S B A N K

Summary

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In this paper, I study the incidence of financially vulnerable firms, and zombie firms in particular, among Swedish limited liability firms (AB) before and after the COVID-19 pandemic started. Since data for the year 2020 is not yet available, I employ a simulation exercise to estimate how vulnerable firms may have become during the toughest months of the pandemic. I also use data from the Swedish Credit Registry (KRITA) to study the exposure of the Swedish banking system to simulated vulnerable firms.

I document three main findings:

a) even though firms may have become more vulnerable, the total number of vulnerable firms should not have dramatically increased during the pandemic with respect to 2019;
b) nevertheless, the number of zombie firms is expected to have increased with respect to previous years;
c) between February 2020 and June 2021, the total amount borrowed by the vulnerable firms (including zombie firms) in my sample has been quite stable, yet it is substantial: around SEK 530 (250) billion out of a total of circa SEK 1,400 billion lent to all the limited liability firms in the sample. In June 2021, around SEK 100 billion went to large vulnerable firms with a higher one-year-ahead probability of default than in February 2020.

Since the economy is still recovering, my simulations could be simply picking up a temporary worsening of firms' financial health due to the hard times recently experienced. Nevertheless, there is still uncertainty surrounding the long-term effects of the pandemic and therefore it is important not to let down our guard and to continue monitoring the exposure of the financial system to potential vulnerabilities.

Sammanfattning på svenska

Denna studie undersöker hur många finansiellt sårbara aktiebolag som finns i Sverige, specifikt zombie-företag, innan och efter coronapandemin började. Eftersom data fortfarande inte är tillgänglig för 2020 gör jag en simuleringsövning för att uppskatta hur sårbarheten bland företagen förändrades under de mest kritiska månaderna av pandemin. Jag använder också data från den svenska kreditdatabasen KRITA för att undersöka i vilken utsträckning det svenska banksystemets är exponerat mot de simulerade finansiellt sårbara företagen.

Resultaten kan summeras i tre huvudsakliga slutsatser:

a) även om vissa företag har blivit mer finansiellt sårbara, uppskattas det totala antalet sådana företag inte ha ökat i någon större utsträckning under pandemin jämfört med 2019,
b) antalet företag som klassificeras som zombie-företag väntas ha ökat jämfört med tidigare år,
c) mellan februari 2020 och juni 2021 har utlåningen till sårbara företag (inklusive zombie-företag) varit relativt oförändrad. Samtidigt är volymen stor och uppgår till ungefär 530 (250) miljarder av de cirka 1 400 miljarderna som lånas ut till aktiebolag i den svenska företagssektorn. I juni 2021 lånades ungefär 100 miljarder ut till stora sårbara företag vars uppskattade konkurssannolikhet ett år in i framtiden var högre än i februari 2020.

Eftersom den ekonomiska återhämtningen fortfarande pågår, kan resultaten av simuleringen spegla en tillfällig försämring av företagens finansiella ställning orsakad av krisen. Men eftersom det fortfarande finns en osäkerhet kring de långsiktiga effekterna av pandemin är det viktigt att inte sänka garden, utan att fortsätta att analysera hur exponerat det finansiella systemets är för potentiella sårbarheter.

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1 Introduction

This memo studies financially vulnerable firms, and in particular zombie firms, in the universe of Swedish non-financial limited liability firms (aktiebolag) before and after the COVID-19 pandemic struck.

Building on existing work on financial vulnerabilities and weak firms (International Monetary Fund 2019, McGowan et al. 2017a, 2017b and 2018 and Cella 2020a, 2020b, and 2021a among others) and on the literature on distressed firms (Altman et al. 2019), this study starts by identifying firms that, in 2019, may have been particularly vulnerable to financial distress. In general, firms that cannot fully pay the interest on their debt (i.e. firms with an interest coverage ratio below or equal to 1) are considered among the most financially vulnerable. Because of their limited ability to service their debt, if these firms experience a negative shock to their revenues (even a small one depending on how levered they are), they may end up defaulting on their debt. Therefore, the natural question is: to what extent has the economic crisis caused by the pandemic affected financial vulnerabilities in Sweden?

To address this question, since data for the year 2020 is not yet available, I simulate the possible impact of the economic crisis on firms' revenues using the results of the extra bi-weekly economic tendency survey conducted by the Swedish National Institute of Economic Research (Konjunkturinstitutet, KI) over the period May 2020-June 2021.

My simulation exercise suggests that the total number of vulnerable firms in the sample may have only slightly increased during the pandemic. Yet, it also shows a clear effect of the crisis: firms may have become more vulnerable in most industries, not only in those industries that have been more directly affected by the measures taken to contain the spread of the virus (for example, the hotel and restaurant industry and the transportation industry). In particular, if we focus on the firms that can be identified as zombie firms (firms that are at least ten years old and have had three consecutive years of interest coverage ratio below 1), my simulation suggests an increase in their total number to around 6% in 2020 compared to 3.5% in 2019.[1]

To better assess how important a possible increase in firms' vulnerabilities may be for financial stability, using credit registry data (KRITA), I study how much of the lending portfolio of the largest Swedish monetary financial institutions (MFIs) was allocated to vulnerable firms, and to zombie firms in particular, in February 2020 and June 2021.

The analyses suggest that in June 2021, simulated vulnerable firms borrowed almost 39% of the total amount of money lent by the MFIs surveyed in KRITA to the limited liability firms in the sample (about SEK 1,400 billion), around SEK 530 billion. If we focus on firms that were classified as vulnerable using the original data for 2019, they would have borrowed a total of circa SEK 500 billion in June 2021. Therefore, independent of the data employed, the total amount borrowed by vulnerable firms is quite similar. This is the case because the simulation predicts that the total number of

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[1] See Cella 2020a for a discussion of zombie firms in Sweden over the period 2002-2016 and Appendix A in this memo for results for the period 2017-2019.

vulnerable firms may have not increased dramatically. However, within vulnerable firms, the simulation also suggests a substantial increase in the number of zombie firms. In fact, if we focus on zombie firms only, the simulated sub-sample received, in June 2021, a total of around SEK 250 billion while the sub-sample identified with data in 2019 would have received around SEK 200 billion. Importantly, in June 2021, almost SEK 100 billion went to simulated vulnerable firms that the MFIs themselves expect to be more at risk of distress in the coming year.

These results suggest that vulnerable firms represent an important part of the lending portfolios of banks and therefore monitoring their evolution (and better understanding what makes these firms vulnerable) becomes a key issue for the stability of the Swedish financial system. Yet, while most of the literature focuses on zombie firms, the results in this study clearly illustrate that the definition of zombie firms can induce significant biases in the identification of vulnerabilities and could further lead to underestimating (or even overestimating) the actual vulnerabilities that are building up in the system.

The rest of this study is organized as follows. Section 2 focuses on firms' financial vulnerabilities before the pandemic started. Section 3 focuses on the results of the simulation exercise. Section 4 describes how exposed the largest Swedish banks are to vulnerable firms identified at different points in time. Section 5 concludes.

2 Vulnerable firms before the pandemic struck

2.1 How vulnerable were firms before the pandemic struck?

2.1.1. Data description

In this study, the main source of data is the Serrano database provided by Bisnode in November 2020. The Serrano database contains detailed financial statement information for all Swedish limited liability companies (aktiebolag) that reported to the Swedish Companies Registration Office (Bolagsverket) in 2019.[2]

To be able to have a robust analysis, ensure data quality and build the final dataset, I follow the same methodology employed in Cella (2020a) Section 4.[3] After all data quality screenings have been applied and after dropping all firms (23,068) in the financial and insurance activities industry (SNI07 64110-66309), I am left with a total of 466,960 firms in 2019.[4] For each firm in the sample, I calculate variables that capture the firm's ability to service its debt, its leverage and performance among other characteristics. A description of the methodology employed and a discussion of the main results are presented in the following sections.

2.1.2. Financially vulnerable firms in 2019, definitions and main results

Following my previous work on financial vulnerabilities, (Cella 2020a and 2020b) and building on the existing literature (see for example, International Monetary Fund 2019 and Altman et al. 2019), I use financial statement information for the entire universe of limited liability firms in Serrano in 2019 to identify firms that may be more exposed to the risk of financial distress (i.e. financially vulnerable firms).[5] In particular, I try to

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[2] Besides all main accounting variables, I also know from Serrano whether a firm belongs to a group or not. Yet, because of limited access to consolidated data, I consider all firms as independent firms (also referred to as stand-alone firms), even if they belong to a group. By considering all firms as stand-alone, the total amount of vulnerabilities in the sample may be overestimated. This is because firms that belong to a group may appear to be more vulnerable when considered as independent since group-level synergies and the fact that these firms have access to the internal capital market of the group are not taken into consideration.

[3] The Serrano database used in this paper is a richer version than the (unidentified) version employed in Cella (2020a). Importantly, I also want to point out that there are two differences in the methodology employed here with respect to the work done in Cella (2020a). First, in this paper I drop all firms that are identified as inactive (as defined in the Serrano database documentation in Section 1.9.8). Second, I also keep in the sample firms that have reported less than 12 months of accounting data and for which data has been processed and imputed by Bisnode. Including these firms allows for a richer and more complete analysis. In fact, by removing firms that have reported less than 12 months of accounting data from the analysis, the sample would shrink down to 325,576, yet the proportions of vulnerable firms in each industry will stay very similar to that calculated in the largest sample.

[4] Consistent with the most common practices, I winsorize all of the relevant variables at the 5%-level by year and sector.

[5] Financial distress usually precedes bankruptcy, however the definition of financial distress is less rigorous than the definition of bankruptcy. For example, the International Monetary Fund (2019) defines firms with ICR below 1 as firms at imminent risk of distress since these firms are technically insolvent (they are unable to pay the interest on their debt). However, the literature does not only use this definition to identify firms

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capture as many potentially vulnerable firms as possible by employing a broad defini-tion based on leverage, return on assets (ROA) and interest coverage ratio.[6] Using these variables, I sort all of the firms in the sample in 2019 into the following sub-sets:

1. **ICR (interest coverage ratio) <=1**: This category includes all firms that in 2019 had an ICR below or equal to 1. I also include in the group firms that had filed for bankruptcy or restructuring in either 2019 or 2020 but for which the bank-ruptcy process was not yet concluded by October 2020.
2. **High leverage-poor performance**: This category contains firms with leverage above the median in their industry-size category and profitability (ROA) be-low the median in their industry-size category.
3. **High leverage-good performance**: This group contains all firms with leverage and profitability (ROA) above the median in their industry-size category.
4. **Other firms**: This category contains all firms that could not be otherwise clas-sified.

The group of firms with ICR<=1 also contains so-called "zombie firms"[7] which are firms older than 10 years that in 2019 had recorded an ICR below 1 for at least three consecutive years (2019, 2018 and 2017). However, there is also a substantial number of firms, about 9,400, that in 2019 were already older than 10 years and for two con-secutive years (2018 and 2019) had had an ICR largely below 1 (a median ICR of -10 in 2019). These firms are "technically" not classifiable as zombie firms in 2019 since they have registered an ICR<1 only for two consecutive years. Yet, unless their ability to re-pay the interest on their debt has improved dramatically in 2020, there is a good chance that these firms could be classified as zombie firms in 2020. I refer to these firms as "almost-zombie" firms.

Table 1 reports descriptive statistics for the main variables of interest for each of the sub-sets described above and also specifically for the sub-set of zombie and almost zombie firms contained in the firms with ICR<=1 group.[8]

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at risk of distress. See Platt et al. (2006) for a discussion of the differences between financial distress and bankruptcy. For more information about the Swedish legal system for bankruptcies and re-organization, see Cella (2020b).

[6] A firm's leverage is calculated as the ratio between its debt and the sum of its debt and equity. A firm's debt is calculated as the sum of long-term debt (excluding "other non-current liabilities" for example, lease liabilities and convertible loans) and short-term debt. A firm's performance is calculated by its return on as-sets (ROA) obtained as the ratio between its earnings before interest and taxes (EBIT) and its total assets. A firm's ICR is obtained as the ratio between a firm's earnings before interest and taxes (EBIT), and (the abso-lute value) of its interest expenses.

[7] Cella 2020a and Cella 2021a for a discussion about shortcomings in the definitions of zombie firms and vulnerable firms, respectively.

[8] Importantly, for a total of almost half a million firms in 2019, the data contains 208,833 firms for which the ICR is missing because it cannot be calculated. A missing ICR is due to interest payment either being zero or missing in a given year. Firms with missing ICR are included in the analysis and contribute to every group of firms. In the group of firms with ICR<=1, the ICR is missing for 175 firms (out of a total of 907 firms) that filed for bankruptcy or restructuring in 2019 and 500 (out of a total of 2,689 firms) that filed in 2020. In the group of high leverage-poor performance firms, these firms amount to 41,799. Hence, a substantial number of high leverage-good performance firms with poor performance report either zero interest pay-ments on their debt or this information is missing for these firms. A total of 39,857 firms with missing ICR are in the group of high leverage-good performance firms, and 126,502 are classified as other firms. In the

Table 1 Descriptive statistics

	(1)	(2)	(3)	(4)	(5)	(6)
			Average			Median
	No of Firms	Total Assets	Age	Leverage	ROA	ICR
All firms	466,960	40,043	13	48%	8%	5.27
Firms with ICR<=1	91,032	75,190	14	61%	-13%	-7.00
- Of which Zombie firms	16,696	186,479	25	55%	-12%	-7.26
- Of which Almost zombie firms	9,419	74,173	24	58%	-13%	-10.00
- Of which Other firms with ICR<=1	64,917	46,715	9.20	63%	-14%	-6.38
High leverage-poor performance	68,683	33,869	11.38	75%	-6%	3.99
High leverage-good performance	106,889	37,984	10.93	68%	23%	22.83
Other firms	200,356	27,289	13.89	23%	15%	64.33

Note: Table 1 shows descriptive statistics for selected variables. Table 1 starts by reporting statistics for all of the firms in the sample, then these firms are split in 4 groups: Firms with ICR<=1, high leverage-poor performance firms, high leverage-good performance firms and other firms. For the group of firms with ICR<=1, Table 1 also reports specific statistics for the sub-set of zombie firms, almost zombie firms and other firms with ICR<=1, separately. Column (1) shows the total number of firms in each category. Columns 2-5 show averages while column 6 reports the median. Column (2) reports the firms' total assets (in SEK thousand) while column (3) shows the average firm age. Firm age is the number of years from each firm's registration. Column (4) shows results for the firms' leverage. All variables are calculated using data for 2019. Details about the classification of firms and variable descriptions can be found in Section 2.1.1.

Source: Bisnode.

To allow comparisons, Table 1 starts by showing descriptive statistics for the representative firm in the sample in 2019. In fact, when the data is broken down in sub-samples based on the firms' characteristics described in Section 2.1.2, significant (both economically and statistically) differences arise between the firms in these sub-sets and the representative firm in the overall sample.

In 2019, the average firm classified as a zombie firm, with total assets of about SEK 186 million, was almost five times larger than the representative firm in the sample. The average zombie firm is also much older (25 years from registration), more levered (55%) and much worse in terms of performance (-12%) that the average firm in the overall sample. Interestingly, zombie firms have a median ICR of -7.26, which is very similar to the median in the group of firms with ICR<=1 and statistically and economically much worse than the median in the overall sample. The median ICR in 2019 suggests that the median firm in the overall sample could have repaid the interest on its debt more than 5 times over just by using its earnings before interest and taxes, while the median zombie firm was making a loss equal to more than 7 times the interest that it should have repaid.[9]

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interest of space, I do not specifically single out firms with missing ICRs, but I want to stress that it is not clear whether or not these firms may present a risk for financial stability.

[9] These results could be driven by different organization structures and tax optimization, please see Cella (2020a) for a discussion.

Similar to zombie firms, the average almost zombie firm is also larger (about SEK 74 million in total assets), older (24 years) and worse performing (ROA of -13%) than the average firm in the sample. Moreover, the median ICR for this group (-10) is worse than that of firms with ICR<=1 (-7) and zombie firms (-7.26) suggesting that this group of firms is faced with significant difficulties in repaying the interest on its debt. Finally, the rest of the firms with ICR<=1 also have quite a poor median ICR (-6.38) and, on average, perform substantially worse (-14) and are more levered than the average firm in the sample, still they tend to be smaller and younger than the other vulnerable firms. These simple descriptive statistics again suggest that firms with ICR<=1 may indeed be more vulnerable to changes in economic and financial conditions that may further worsen their financial health.

The rest of Table 1 suggests that, if compared to firms with an ICR<=1, the other firms in the sample are on average younger, smaller and have quite good ICRs and therefore could be less sensitive to financial distress, although many are quite levered and perform poorly. Therefore, in the rest of the study, unless otherwise specified, I refer to firms with ICR<=1 as "vulnerable firms" and I use the terms "firms with ICR<=1" and "vulnerable firms" interchangeably. However, in the rest of the paper, I further decompose the group of vulnerable firms and show results for the following three groups of firms: Zombie firms, almost zombie firms and other firms with ICR<=1.

Next, to better understand the importance of vulnerable firms for financial stability, I look at how these firms are distributed by firm size. I focus on firm size for several reasons. To begin with, in the descriptive statistics above, I show that vulnerable firms tend to be on average larger (and older) than the representative firm in the sample. Then, in Cella (2020b) I document that Swedish firms' leverage increases with size, which means that larger firms use more leverage, consistent with the fact that large firms may be less financially constrained.[10] Moreover, during the worse months of the pandemic, credit conditions seemed favourable for large firms,[11] so it is likely that many large firms may eventually emerge from this crisis with more leverage than they had before the pandemic started.
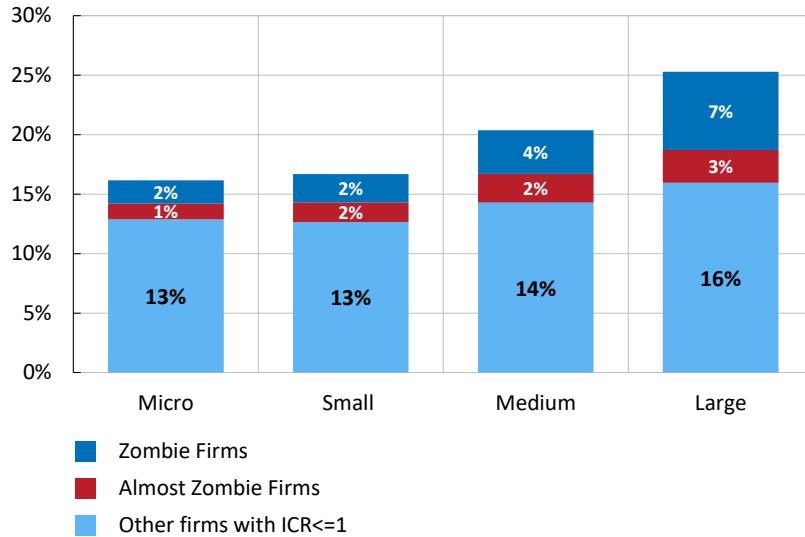
Finally, the default (or distress) of even a few very large firms could affect banks' lending to them. Importantly, in untabulated results, I find that, in contrast with smaller firms, large and medium-sized firms, on average, not only borrow larger amounts but also have relationships with more than one bank. This suggests that potential distress among large firms may even affect several banks at once and, therefore, it is important to understand where vulnerabilities are nested. I present relevant results for this discussion in Figure 1.

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[10] Angelini and Generale (2008), using a survey of Italian firms, show that firms that say they are constrained are on average smaller than those that do not. The authors also show that young firms also tend to be more constrained. Similar evidence is also found by Cabral and Mata (2003).

[11] The Riksbank's Business Survey September 2020 (Sveriges Riksbank, October 2020) reported that the major Swedish firms had not experienced difficulties to obtain funding since the spring. These firms reported good access to liquidity and perceived that funding terms were favourable. Also see Frohm et al. (2020).

Figure 1. Distribution of vulnerable firms by firm size

Per cent, quartiles of total assets

Note: Figure 1 shows the percentage of firms with ICR<=1 in the sub-sample of firms based on firm size. Micro (Large) firms belong to the bottom (top) quartile of the total asset distribution in their industry. Small (medium) firms are classified in the second (third) quartile of total assets distribution. The sub-sets of micro and small firms in the graphs contain a total of about 20,000 firms. The sub-sets of medium and large firms contain around 23,000 and 27,000 firms, respectively. For each group, the total amount of firms with ICR<=1 is reported and further split into 3 groups: Zombie firms (dark blue), almost zombie firms (red), rest of the firms with ICR<=1 (light blue). All variables are described in detail in Section 2.1.1.

Source: Bisnode.

In Figure 1, using firms' total assets, I group all firms into four size quartiles (micro, small, medium and large)[12] and I show what percentage of the firms in each quartile are zombie firms, almost zombie firms and other firms with ICR<=1.

Figure 1 shows that the total amount of firms with an ICR<=1 increases with size, therefore there are significantly more firms with ICR<=1 in the group of large firms than in the group of micro and small firms, a total of 25% versus circa 17-19%. Interestingly, consistent with what I already documented in Cella (2020a) for the year 2016, Figure 1 confirms that zombie firms are more common among large firms.

Out of the total amount of large firms, about 7% can be classified as zombie firms (dark blue) and 3% can be classified as almost zombie firms (red). If we instead look at firms in the medium-sized group, there is a smaller number of firms with ICR<=1 compared with the group of large firms and a substantially smaller number of zombie firms (4%).

In unreported descriptive statistics, I find that among large vulnerable firms, firms belonging to a corporate group (i.e. are either a Swedish parent company or a subsidiary in a group) represent almost 70% of the total of about 27,000 firms. However, if we

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[12] The average firm in the group of micro firms has total assets of about SEK 272 thousand. The average small and medium firm have total assets of about SEK 1,016 and SEK 3,385 thousand, respectively, while the average firm in the group of large firms reports about SEK 165 million in total assets.

look at the medium-sized firms, almost 62% of this subset comprises stand-alone firms that have no connection to a corporate group. I also find that despite having the largest number of zombie and almost zombie firms, the subset of medium and large firms with ICR<=1 in 2019 had, on average, the same amount of leverage as small firms (approximately 60%) and less than micro firms (which have an average of 66%). Most importantly, their ICR is substantially better. These latter results suggest that more work should be done to understand why, in Sweden at least, large firms classified as vulnerable often belong to corporate groups. While this type of investigation is outside the scope of this specific project, the results just described suggest that because of characteristics that are not considered in the definition of firms' vulnerabilities, firms may be misclassified as financially vulnerable firm, and vice-versa. Therefore, caution should be employed when interpreting the results.

In addition to the analyses presented above, I also combine firm size with market power (calculated as shares of total industry sales at the 5-digit SNI07 code level). These statistics suggest that large zombie firms (almost zombie firms) represent about 2.6% (1.4%) of firms with the largest shares of sales, on average. Hence, zombie firms, because of their size and market power, could represent a real entry barrier for other (more innovative) firms and crowd-out resources that could have been allocated to more productive and innovative firms. These potential distortions are particularly relevant given the large amount of government support that many industries have received during the crisis. See Appendix C for a discussion about zombie firms' (potential) access to government support and its consequences.

To conclude, the results in Section 2 show how vulnerabilities have been identified using firm's accounting data and describe the characteristics, in 2019, of the firms in each sub-sample. Building on these results, in the next section, I study how firms existing vulnerabilities might have been exacerbated by the economic crisis triggered by the restrictions introduced to reduce the spread of the COVID-19 virus.

3 Vulnerable firms after the pandemic

3.1 Simulation exercise: How the economic consequences of the COVID-19 pandemic may have exacerbated firms' financial vulnerabilities in 2020-2021

3.1.1 Data and methodology

Building on the analysis discussed in Section 2, this section will address the question of how the COVID-19 pandemic may have worsen firms' financial vulnerabilities. To study this question and since official accounting data for the year 2020 are not yet available, I use the analysis in 2019 as a starting point and follow a simulation methodology similar in spirit to the one employed by Banerjee, Illes, Kharroubi, and Garralda (2020).

Banerjee et al. study how the economic crisis caused by the pandemic might have affected firms' cash buffer and their ability to service their debt obligations. To do so, they assume that all firms in their data have experienced a 25% drop in their 2020 revenues relative to 2019. Moreover, they adjust the firms' costs using a cost-revenue elasticity of 0.6. Using these assumptions, they project how much firms should have borrowed to meet operating losses. Inspired by this exercise, I try to understand how Swedish non-financial limited liability firms may have been affected by the crisis using a simulation exercise based on survey data collected by KI.

In this study, to understand a firm's ability to meet the interest payments on its debt, I use the firm ICR which employs the firm EBIT in the numerator. Therefore, in my simulation I shock directly each firm's EBIT in 2019 to obtain the simulated EBIT in June 2021. This exercise implies that both the revenues and the operating costs of the firm are affected in the same way by the shock and it also assumes that, besides revenues and operating costs changing, everything else stays the same as reported by the firm in 2019.

In my simulation, I begin by summarizing the answers collected by KI over the period 11-13 May 2020 to 7-9 June 2021.[13] From the KI survey it appears that over the period May-December 2020, most of the respondent firms experienced a large drop in their revenues. As expected, this drop was particularly felt in the hotel and restaurant industry where the respondents reported a drop in revenues of between approximately -40% and -70%. Importantly, it also appears from the survey that firms within the same industry were not affected in the same way. In the wholesale and retail industry, for example, some firms have reported a drop in revenues of about -20%, while

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[13] Even though KI reports the results of the survey up to 9-11 August 2021, for my simulation I use data up to the 7-9 June 2021for consistency with the KRITA data that, at the time I started this memo, where available up to June 2021. . However, including the available responses up to August does not really change any of the simulation results.

firms in the sub-industry category of grocery stores have reported almost a 10% increase in revenues.

Importantly, the results of the survey clearly show that most of the industries have recovered some ground in the first five months of 2021. Yet, the recovery has been quite heterogeneous. For example, while the hotel and restaurant industry has recovered substantially (an average of 5 percentage points), it still has a long way to go before it is back to more "normal" levels, according to the interviewed firms. However, firms surveyed in industries such as transportation equipment, vehicles and machinery production report that they have almost fully recovered their losses.

The statistics reported above reinforce the idea that utilizing industry (and within industry) variation is much superior to assuming that all firms were affected equally by the crisis. Then, using the fine industry definition employed by KI, I adjust the EBIT of each firm in each of the 46 industries surveyed as illustrated in equation 1.[14]

(1) $$EBIT_{simulated} = EBIT_{2019} \cdot \left(1 + avrage\ industry\ reply_{May20-June21}\right)$$

A firm's EBIT is calculated as operating revenues minus operating costs. Operating costs are the sum of labour costs, depreciation and amortization expenses and other operating expenses (for example, marketing expenses, rent and utilities, etc.).Therefore, by adjusting a firm's EBIT, I am assuming that both operating revenues and operating costs will be adjusted by the same amount. In other words, that operating costs decrease (increase) one to one with the fall (rise) in operating revenues. While this assumption may seem extreme given that one could reasonably expect the operating revenues - operating costs sensitivity to vary considerably across industries and most likely not to be one, I estimate this relationship in each of the 46 industries in the KI survey and find that assuming an operating revenue-operating costs sensitivity of 1 is not so unreasonable.

For each of the 46 industries interviewed by KI, using data for the period 1998-2019, I estimate the relationship between operating costs and operating revenues. This analysis shows that the revenues-cost sensitivity varies substantially among industries but in 34 out of 46 industries, the operating costs to operating revenues sensitivity is above 90%. Over the period 1998-2019, the average sensitivity is around 90% (70% in the industry with the minimum sensitivity (Real Estate Activities (SNI codes 68310-68320)) and 98% in the industry with the largest sensitivity (Retail (SNI codes 45110-45400 and 47111-47999)).[15]

Given the discussion above and to keep things simple, I do not directly adjust each firm's operating costs using its specific industry sensitivity but simply adjust both the operating revenues and operating costs by the same amount. While using the estimated revenue-cost sensitivity would make the analysis richer, since for most of the industries the assumption that the sensitivity is not too different from the estimated

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[14] I simulate the EBIT of firms in industries with missing SNI07 codes using the overall sample average reported in the survey.

[15] The panel regressions include firm- and year-fixed effects and robust standard errors clustered at the firm level. Results are unreported for the sake of brevity but are available from the author upon request.

coefficient results should not be affected too much. Nevertheless, I acknowledge that assuming that firms can adjust their operating costs in full overestimates the ability of these firms to scale down when a shock hits. Therefore, even if the fall in revenues captured by the KI's survey may be very close to the one actually experienced by the firms during the pandemic, the firms' real EBIT is still likely to be smaller than the one estimated by my simulations since firms may not have been able to fully adjust the costs of their operations.

Another important issue is that many firms have benefited of the support of the government during the months of the pandemic and therefore, at least for these firms, depending on the type of support that they have received, the simulated results may be very far from what the firms may have actually experienced. Unfortunately, I cannot identify which firms have received which form of government support and therefore I cannot really assess the impact of this support on the firms in the sample.

However, my simulation assumes that the firms in the sample have not received any support and therefore all firms were forced to adjust operating costs as revenues fell. Therefore, my exercise could be interpreted as a potential "counterfactual exercise" for those firms that have received support and did not need to cut their costs to survive. While I cannot enrich the analysis employing firm level data on government support, in Appendix C, I try to discuss the possibility that even vulnerable firms may have had access to government support and what the consequences of this may be.
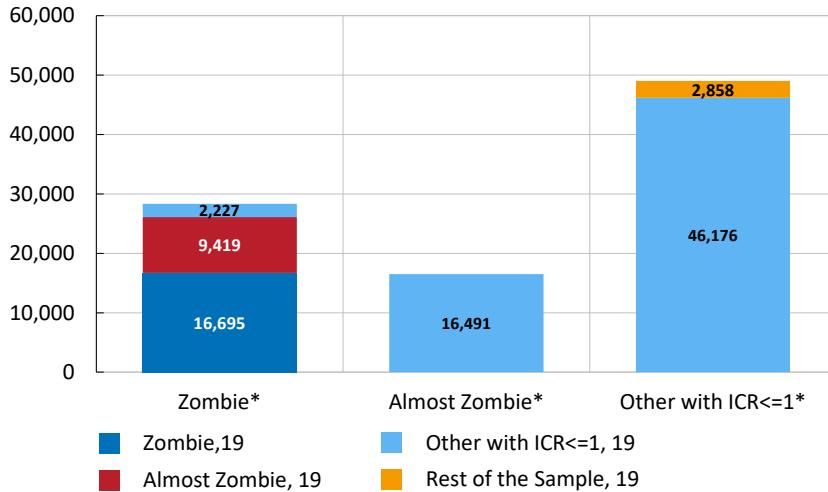
3.1.2 Main results

3.1.2.1 How were the firms reallocated by the simulation?

Using the methodology in Section 3.1.1, I simulate what each firm's ICR and ROA may have looked like in June 2021 using 2019 data as a starting point. Using the results of this simulation, I then re-organize all firms in sub-samples based on the vulnerabilities identified by using the newly calculated variables as described in Section 3.1.1.

Following the discussion in Section 2.1.2, I focus mostly on firms with ICR<=1 and further decompose this group in zombie firms*, almost zombie firms* and other firms with ICR<=1*. Figure 2 below shows how firms in the sample in 2019 were re-classified in 2020 using the data simulated as described above. Descriptive statistics can be found in Table 1.B in Appendix B while Figure 1.A in Appendix A shows the percentage number of simulated zombie firms.

Figure 2. Transition matrix: from original sub-samples to simulated sub-samples

Number of firms

Note: Figure 2 shows how many firms have been reclassified using the simulated EBIT results for 2021. Each column represents the simulated sample of zombie firms, almost zombie firms and other firms with ICR<=1. Each of the column is then decomposed to illustrate what type of firm (in 2019) contributed to each simulated group: zombie firms (blue), almost zombie firms (red), other firms with ICR<=1 (light blue) and rest of the sample (yellow). All variables are described in detail in Section 2.1.1 while the data and methodology employed for the simulation are described in Section 3.1.1.

Source: Bisnode.

Figure 2 shows how each group of vulnerable firms identified in 2019 contributed to the simulated groups of vulnerable firms and therefore gives us a sense of how vulnerabilities may have changed during the pandemic.

Looking at Figure 2, it appears that the amount of zombie firms predicted by the simulation is almost twice as large as the one calculated for 2019: 6.07% compared with 3.58%. The figure shows a clear increase also in the number of almost zombie firms: 3.53% compared with 2.02%.

Figure 2 suggests that the sharp increase in the number of zombie firms is driven by the fact that while existing zombie firms remain classified as zombies (i.e. over the period under consideration, they are predicted not to have regained the ability to fully service their debt and thus exit their zombie state), a large number of firms from other sub-samples of vulnerable firms are now re-classified as zombie firms.[16]

To begin with, I observe what could be defined as an ICR effect: all firms that were classified as almost zombie firms in 2019 were automatically reclassified as zombie firms. This is the case because these latter firms had at least 10 years from registration and only 2 consecutive years of ICR<1 already in 2019, therefore, unless their EBIT substantially improved, they were most likely to be classified as zombie firms in

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[16] Unreported industry level simulations predict an industry level increase in the amount of large zombie firms of between 0.5 and 8 percentage points.

2020/2021. This is exactly what my simulation predicts: all almost zombie firms identified in 2019 are not expected to have improved their ICR at all or significantly enough to be out of the zombie zone and therefore they were all mechanically reallocated into the sub-sample of zombie firms.

The group of other firms with ICR<=1 also makes a large contribution to the simulated group of zombie firms. This contribution is driven by an aging effect. In fact, the set of about 2,000 firms that joins the sub-sample of zombie firms had already had an ICR<1 for at least 2 consecutive years in 2019 but they were younger than 10 years and thus where not yet classified as almost zombie firms. Importantly, this sub-sample of firms had a quiet poor median ICR (-8.5) in 2019 and therefore, even though they are classified as zombie firms just because of their aging, they rightly belong to the group of potentially vulnerable firms.

Next, while all firms originally identified as almost zombie firms move to the simulated group of zombie firms, a large set of firms move from the original group of firms with ICR<=1 to the simulated group of almost zombie firms. This result is driven by the fact that while these firms had only 1 year of ICR<1 in 2019, they are now expected to have 2 consecutive years of ICR<1 and therefore are at risk of being classified as zombie firms in the near future. Importantly, though, these firms (a total 16,491) already showed a very poor median ICR (-8) in 2019 and unless their ICR improves substantially in the coming years, these firms are quite vulnerable from a financial stability perspective.

Interestingly, my simulation shows that of all the firms that were not classified as vulnerable (i.e. firms with an ICR>1), only a small group is re-classified as such and enters the simulated group of other firms with ICR<=1. These firms (a total of 2,858) are mostly large firms that, on average, in 2019, were about 9 years old. Yet, around 1,600 of these firms had high leverage and poor performance in 2019 and, after simulation, their median (and mean) ICR becomes a little less than 1. Therefore, although they may still perform poorly, as the economic recovery continues, these firms may be able to easily move out of a potentially vulnerable state.

Finally, even though the sub-set of other firms with an ICR<=1 is quite substantial, I would like to point out that the simulated sample is less financially vulnerable than the group identified using 2019 data. This is the case not only because it contains a smaller number of firms but also because the simulation reallocates the most vulnerable firms within this group to either the group of zombie firms or almost zombie firms and thus, on average, the firms in this group appear to be financially healthier than in the past. This can be seen clearly when comparing the descriptive statistics for the simulated sub-samples reported Table 1.B in Appendix B with those for sub-samples based on 2019 data in Table 1 in Section2.
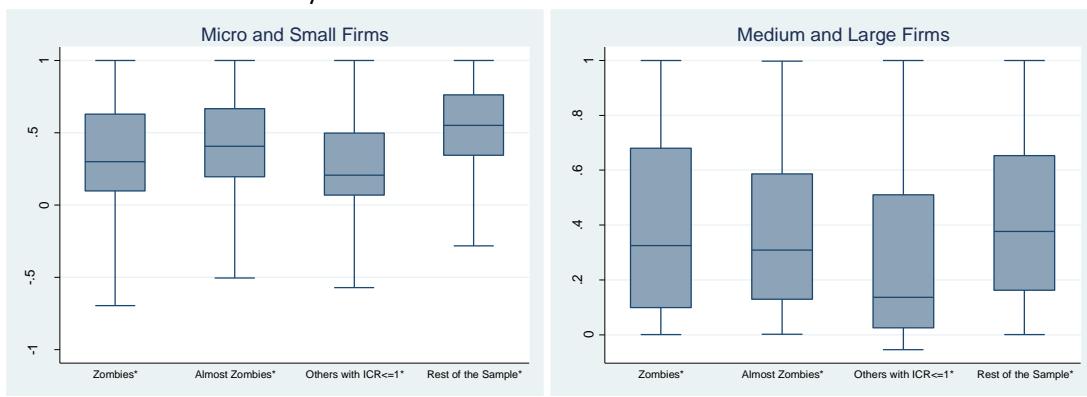
Next, to fully understand how exposed firms may have been to bankruptcy during the pandemic, I study how well capitalized firms in different size categories were in 2019 and how their capitalization could have been affected by the economic effects of the social restrictions. Results are reported in the next sub-section.

3.1.2.2 How much equity was held by simulated vulnerable firms before the pandemic hit?

In this section, inspired by the work of Carletti et al. (2020),[17] I try to understand how well capitalized firms were in the different sub-sets based on simulated vulnerabilities when the pandemic struck. I then discuss how the large losses that they may have faced during the period March 2020-June 2021 could have made them undercapitalized or even distressed. For this analysis, in Figure 3, I present a box plot of the firms' equity ratios calculated as the book value of equity divided by the book value of total assets. Results are show for sub-sets of firms classified by type of vulnerabilities and size.

Figure 3. Firms' capitalization in 2019

Simulated firms sorted by size in 2019

Panel A. Micro and small firms   Panel B. Medium and large firms

Note: Figure 3 shows a box plot of firms' equity ratios in 2019 by sub-samples based on simulated data: zombie firms*, almost zombie firms*, other firms with ICR<=1* and rest of the sample*. Firms are further categorized in quartiles of size (total assets). The graph on the left shows results for micro and small firms, while the graph of the right show results for medium and large firms. The box plot displays the distribution of data. From the bottom to the top, for each sub-set, the graph shows: the minimum, the first quartile (Q1), the median, the third quartile (Q3), and the maximum of the distribution. Firms that have filed for bankruptcy in 2019 and 2020 are excluded. Firms with an equity ratio smaller than the 1st and 99th decile of the distribution (-0.45 and 0.99) are excluded so that results are not driven by outliers. All variables are described in detail in Section 2.1.1 while the data and methodology employed for the simulation are described in Section 3.1.1.

Source: Bisnode.

To create Figure 3, I start by sorting all firms into quartiles of total assets using data from 2019 (the last available observation). The figure then presents two panels. Figure 3 Panel A shows results for the firms in the first and second quartile of the distribution of total assets (micro and small firms). Figure 3 Panel B shows results for the firms in the third and fourth quartile of the distribution of total assets (medium and

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large firms). Each panel shows results for a total of about 200,000 firms further divided in sub-samples based on simulated vulnerabilities: zombie firms*, almost zombie firms*, other firms with ICR<=1* and, for comparability, rest of the sample*.

Figure 3 Panel A shows the box plot graph for small and micro firms in the sample. In 2019, these firms had on average (median) a capital ratio (equity over total assets) around 48% (51%), however, if we look at the different sub-sample based on simulated vulnerabilities, there is large variation. In particular, the sub-samples of simulated zombie firms and other firms with an ICR<=1 show a mean (median) equity ratio substantially poorer than that shown by simulated almost zombie firms. On the other hand, firms in the rest of the sample appear to be better capitalized than the rest of the small and micro firms.

Next, Figure 3 Panel B shows results for the medium and large firms in the sample. Although, it is hard to see it directly from the graph itself because of scaling issues, these firms entered the pandemic slightly worse capitalized than the small and micro firms. The average (median) medium/large firm had an equity ratio of about 40% (35%) in 2019. These results are mostly driven by other firms with ICR<=1 followed by zombie firms.

Interestingly, if we look at zombie firms and other firms with an ICR<=1, regardless of size, their equity ratio distribution appears to be skewed toward zero (right-skewed). These means that, if we plotted a histogram of the equity ratio distribution for these firms, a larger number of them would be on the right side of the median, in this case closer to zero. Hence, a large number of firms may have been at risk of distress if they suffered losses during the pandemic.

Importantly, I also find that a meaningful set of vulnerable firms (especially zombie firms and other firms with ICR<=1) in the small and micro size category already had an equity ratio below or equal to zero in 2019. Many of them were in some of the industries most affected by the crisis.

The negative equity ratio of these firms could be explained by several factors.[18] For example, the firms may have accumulated losses in the past or may have borrowed excessively to cover these losses. For many of the vulnerable firms, this latter possibility is consistent with one or more consecutive years of negative EBIT and losses larger than the interest on their debt (ICR<1). A negative equity ratio could be also explained by an aggressive pay-out policy that has led to a smaller accumulation of retained earnings. Whatever the reason behind a negative equity ratio is, these statistics shows that many micro and small firms already needed to be recapitalized before the pandemic.

On the other hand, just a handful of medium and large firms already had an equity ratio below or equal to zero in 2019. However, Figure 3.B in Appendix B shows that a

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[18] From a legal perspective, firms with negative equity ratio could be forced into liquidation (Bolagsverket 2019). However, exceptions apply so that firms, under strict supervision, may temporarily have negative equity. For details, see Bolagsverket (2020) and Aktiebolagslag (2005:551).

substantial amount of firms in both sub-samples based on size had an equity ratio close to zero in 2019. Since my simulations suggest that most firms in the dataset have experienced significant losses during the period May 2020-June 2020, especially in the industries most affected by the restrictions, it is possible that many firms, even non-weak firms, may have become undercapitalized or even distressed and, until the recovery is completed, they may still be in jeopardy.

The results above may seem at odds with the fact that bankruptcies and reorganization filings have been subdued over the pandemic (FSR 2021:1). Yet, they are not. In fact, although firms may already have been weak and/or poorly capitalized in 2019, they did not necessarily have to go bankrupt as long as they had access to liquidity (for example, they could draw on their credit line, obtain additional bank credit or issue bonds) or could restructure[19] their liabilities or raise new equity. These alternatives were also available to most firms during the COVID-19 pandemic, which for almost all firms in the economy has caused a severe liquidity crisis.

To survive the crisis, many firms have operated within their existing financial contracts and, for example, have drawn as much as they could from their existing lines of credit. Those that were eligible to apply have benefited directly from government support programs. Other firms could get access to additional debt financing because of interest rates kept low by the Riksbank. And, finally, many firms may have been able to restructure by raising new debt to meet their liquidity needs.

Finally, while I calculate the firms' equity ratio using book value of equity and assets, market values could deviate from the book values. Therefore, a firm's net worth could be zero or negative on a book basis and yet the firm may appear to be viable in terms of market values (and the opposite is also possible). Then, since the strong government response to help firms deal with the shock has boosted market expectations, it has also provided additional, indirect support to firms.

The options described above together with the quick recovery that started when restrictions around the world were lifted may have enabled many firms to survive despite entering the pandemic on a weak footing and quite levered. However, it is important to keep in mind that while the effect of the crisis for some firms may have been just temporary, for other firms the effects could be more long term. This means that we need to keep monitoring firms, and debt accumulation by weak firms in particular, because bankruptcy risk could still materialize.

Overall, Section 3 shows that, if the average drop in revenues reported by the firms answering the KI survey resembles reality for most firms in the sample,[20] the overall number of vulnerable firms may have only slightly increased during the pandemic yet

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[19] In my analysis of firms' equity ratios, I exclude firms that filed for bankruptcy or restructuring in 2019 and over the period January-October 2020 (the last observation I have). Therefore, none of the firms I observe had filed for bankruptcy or reconstruction up until October 2020. Nevertheless, it is still possible that many of them have recapitalized or renegotiated their contracts with financial stakeholders out of court. An overview of the possible out-of-court (and in-court) restructuring tools can be found in Harmon (2020).

[20] Since some firms could have done much better than the average firm responding to the survey, I am exacerbating the losses for those firms. On the other hand, for those firms that have done better than the average firm, losses will be simulated as smaller than what they may have actually experienced.

vulnerabilities may become more acute especially within the sub-sample of zombie firms. Many firms also seem to have already entered the pandemic with quite small net worth. In particular, I find that the firms simulated as vulnerable, despite their size, entered the crisis much less capitalized than the "healthier" firms in the sample (rest of the sample). If these firms have accumulated further losses (and/or borrowed more to survive) during the pandemic then many of them may face an equity shortfall and even the risk of distress and will soon need to restructure. This is important from a financial stability perspective since, depending on banks' exposure to vulnerable firms, a sudden increase in the number of bankruptcies could potentially affect the health of the Swedish banking system. I further study this issue in the next section.

4 Banks' exposure to vulnerable firms in June 2021

To study banks' lending to non-financial firms, I match the data from the Serrano database with data reported in the Swedish Credit Registry (henceforth, KRITA) using each firm's corporate registration number. KRITA is a survey run by Statistic Sweden on behalf of the Riksbank to collect information on loans to companies and to the public sector.[21] Eighteen monetary financial institutions are surveyed to compile the data collected in KRITA. The data covers about 95% of all loans to sectors other than households.

In June 2021, KRITA reported information for a total of about 126,562 firms that matched with the Serrano database (out of a total of 466,960) and for which data on the total amount lent is available in the credit registry for the months of February 2020 and June 2021.[22] The data covers about 36% of the zombie firms, 41% of almost zombie firms and 30% of the sub-set of other firms with ICR<=1, all identified in 2019. These percentages are also similar after the simulation exercise.

Using the sub-sets of firms classified using data for 2019 (i.e. assuming that the economic crisis during the pandemic has left vulnerabilities unchanged), in Table 2, I present descriptive statistics for the main variables of interest: total amount borrowed, interest rate and the one-year-ahead probability of default (henceforth PD).[23] Results are shown for the months of February 2020 and June 2021, respectively, and firms are divided in sub-samples based on vulnerabilities calculated using data in 2019.

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[21] KRITA is a rather new dataset and work is still ongoing to improve and insure data quality so results using KRITA data must be interpreted with some caution. The results in this paper are based on a data extraction conducted on 14 September 2021.

[22] The interest rate paid in June 2021 and February 2020 is available for about 120,000 firms while for about 100,000 firms information about the one-year-ahead probability of default is also available. For about 97,000 firms, data on total amount borrowed, interest paid and one-year-ahead probability of default is all available.

[23] The PDs reported to KRITA are the counterparty's probability of default over one year. They are calculated internally by the MFI in accordance with the articles 160, 163, 179 and 180 of the Regulation (EU) No 575/2013 ("the CRR") if the MFI employs the internal ratings-based (IRB) approach for credit risk. If the MFI does not use the IRB approach, currently, it can choose to voluntary report the PDs. In this case, the PDs are calculated using an alternative model approved by the Swedish Financial Supervisory Authority (FI).

Table 2 Descriptive statistics of KRITA data
Original classification using data reported in 2019

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Total			**Average**			
	No of Firms	**Amount Borrowed**		**Interest Rate**		**On-year-ahead PD**	
		Feb-20	**Jun-21**	**Feb-20**	**Jun-21**	**Feb-20**	**Jun-21**
Zombie Firms	6,004	224	207	2.88%	2.85%	3.78%	4.49%*
Almost Zombie Firms	3,836	33	34	3.07%*	3.03%	3.39%	4.27%*
Other firms with ICR<=1	19,509	252	260	3.10%*	3.02%	3.27%	4.26%*
Rest of the Sample	97,213	861	869	2.35%*	2.23%	1.78%	2.27%*

Note: Table 2 shows descriptive statistics for selected variables for the month of February 2020 and June 2021, respectively. Table 3 reports results for 4 groups of firms classified using data for 2019: zombie firms, almost zombie firms, other firms with ICR<=1 and the rest of the sample, separately. Column (1) shows the amount of firms in each sub-sample for which data about the total amount borrowed is available. Columns (2) and (3) shows the total amount borrowed by the firms (calculated as the sum of the nominal value of each loan reported in KRITA at each given time) in SEK billion. Columns (4) and (5) report the simple sample average of each firm's value-weighted interest rate. Columns (6) and (7) report the simple sample average of each firm's value-weighted one-year-ahead probability of default. Amount borrowed, interest rate and probability of default are reported by the credit institutions surveyed by KRITA. The * shows that a test on the mean confirms that the averages are statistically different. For columns (2) and (3) tests are run on disaggregated data. Sub-samples are created using data for 2019. Details about the classification of firms and additional variable descriptions can be found in Section 2.1.1.

Sources: Bisnode and KRITA.

Table 2 shows that the firms in the sample borrowed a total of about SEK 1,400 billion both in February 2020 and June 2021, hence the total amount of credit lent to the limited liability firms in both KRITA and Serrano has stayed stable during the months of the pandemic. If we look at the sub-samples based on vulnerabilities, 2019 zombie firms, which are dominated by large firms belonging to Swedish corporate groups, in total borrowed about 15% of the total in June 2021 (16% in February 2020). Almost zombie firms in total (and on average) borrowed significantly smaller amounts and so did (on average) the rest of the firms with ICR<=1 even though the total is similar to the one for zombie firms because the significantly larger number of firms (almost 20,000 compared with 6,173). Importantly, the total amount lent in June 2021 is very similar (and statistically indifferent on average) to the total nominal amount lent in February 2020 for each sub-sample.

Table 2 also shows that, on average, all sub-samples paid a slightly larger (amount value-weighted average) interest rate on their loans in February 2020 than they did in June 2021, suggesting that, by and large, the cost of borrowing from banks has not changed much over the period. Together with the results above, this suggests that firms' borrowing has been quite stable over the period of the pandemic for each subset of firms and that firms' average borrowing costs have slightly decreased over the period.[24]

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[24] Please notice that Table 2 reports amount-weighted averages. However, adjusting for firm size (quartiles of total assets), the averages would be almost half in each sub-sample (1.43%, 1.19%, 1.61% and 1.75% in June 2021, respectively). In the overall sample, the total assets-weighted average interest rate was around 1.85% in February 2020 and 1.63% in June 2021. Notice that with respect to official statistics that usually

Concerning the one-year-ahead probability of default, Table 2 shows that all sub-samples in June 2021 were considered at higher risk of defaulting within a year than they were in February 2020. Interestingly, Table 2 also shows that, both in February 2020 and June 2021, zombie firms had the highest average one-year-ahead probability of default, consistent with the fact that these are among the most vulnerable firms. However, if we look at the change in the average PDs between June 2021 and February 2021, this has increased the most in the sub-samples of other firms with an ICR<=1, consistent with the idea that the crisis have exacerbated existing vulnerabilities. Table 2.B in Appendix B shows similar results for the sub-samples of firms classified using simulated data.
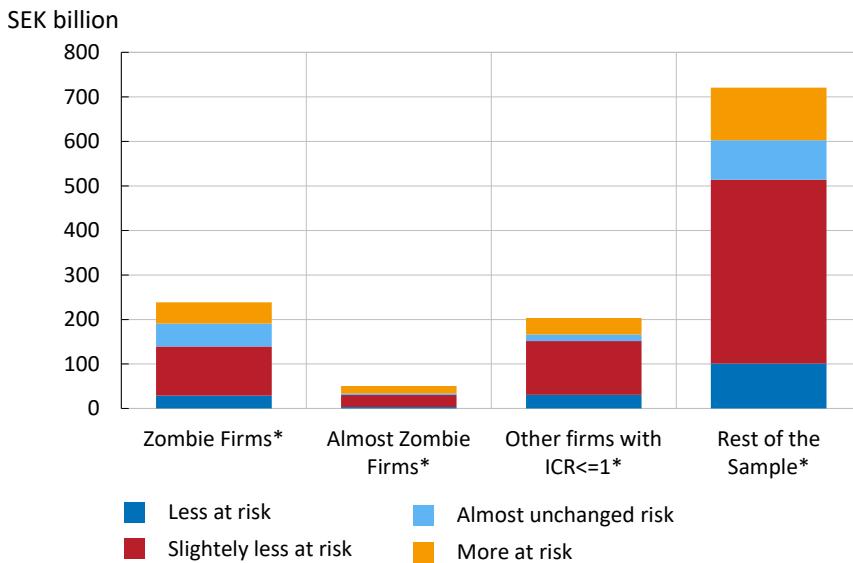
Next, in addition to the variables that go into my firms' classification and simulations, I also want to take into account the richer set of information that banks use when calculating firms' one-year-ahead probabilities of default that they report to KRITA. In particular, to capture how the pandemic may have affected firms' financial health, I want to capture what banks believe is the firms' risk of default within a year in June 2021 compared to what they expected in February 2020. To do so, for each firm in the dataset for which data is available, I calculate the difference between the amount-weighted average one-year-ahead probability of default reported in June 2021 and February 2020 (henceforth PD change) and divide all firms into quartiles based on these differences.[25]

The first quartile of the PD change distribution contains all firms for which the average probability of default in June 2021 is lower than February 2020. These are firms that are expected to be less at risk of default than before. Instead, the fourth quartile contains all the firms with the largest average increase in the one-year-head probability of default between February 2020 and June 2021. These are firms that are expected to be more at risk of default within one year than they were before the pandemic started.

Importantly, in unreported analyses, I also find that more than 90% of the amount lent by the credit institutions reporting to KRITA to the firms that match with Serrano went to large firms both in February 2020 and June 2021. Therefore, I further refine my focus and base the rest of the analyses on the largest firms in the Serrano database (the fourth quartile of total assets in 2019). For each sub-sample of large firms and quartile of the PD change, Figure 4 reports the total amount borrowed in June 2021. Results are based on a total of about 43,000 large firms.

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employ EU standards (2003/361/EC), the definition of size in this memo is based on quartiles of total assets calculated over the entire universe of firms in the Serrano database at the end of 2019.

[25] The majority of the firms in the sample have borrowed very similar amounts in June 2021 and February 2020, so it is unlikely that the difference in the amount borrowed largely affects the difference in the amount-weighted probability of default. However, to address this issue further, I also calculate amount weighted averages only using as weights the amount borrowed in February 2020. Firms' classification into quartiles stays stable. I also employ different methodologies to check the robustness of my classification and I establish that all firms are classified in the same quartile of PD change regardless of the methodology used. I find that in the quartiles of firms with almost unchanged PDs and slightly less at risk firms (the 2nd and 3th quartiles of the distribution), some firms are assigned to different quartiles depending on the methodology I employ. However, in the quartiles of less at risk and more at risk firms, almost all firms are classified in the same quartile regardless of the methodology used to calculate the weighted average probability of default.

Figure 4. Total amount borrowed by large firms

SEK billion

Note: Figure 4 shows the total amount borrowed by large firms in different sub-samples based on simulated data: zombie firms*, almost zombie firms*, other firms with ICR<=1* and rest of the sample*. Each bar is then further divided into sub-sets based on quartiles of change in the firms' one-year-ahead probability of default between June 2021 and February 2020: less at risk (dark blue), slightly less at risk (red), almost unchanged risk (light blue) and substantially more at risk (yellow). The graph is based on large firms for which information on the probability of default is available. All variables are described in detail in Section 2.1.1 while the data and methodology employed for the simulation are described in Section 3.1.1.

Sources: Bisnode and KRITA.

To begin with, Figure 4 shows that across all sub-sets of firms, the large majority of credit went in June 2021 to firms that are expected to be equally or less at risk of distress within a year than before (the dark blue, red portion and light blue portions of the bars). This is also the case among zombie firms. These results suggest that, despite the problems created by the pandemic, most firms, even firms already vulnerable before the pandemic started, are expected by their lenders to have become less vulnerable to financial distress. This in turn suggests that the recovery is indeed expected to be strong and that many firms, according to their average lender, may have suffered only temporarily from the liquidity shock. However, of the total of almost SEK 1,200 billion borrowed by the large firms in the sample, almost SEK 220 billion still went to firms that were expected to be more at risk of distress within a year than before the pandemic. Although bankruptcy risk can also materialize in the other sub-samples, these are the firms that, according to the average bank lending to them, pose the largest risk of losses. These are therefore the firms I focus on next. Descriptive statistics for these firms are reported in Table 3.

Table 3 Descriptive statistics of KRITA data
Simulated data, large firms with the largest (average) increase in PDs

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		Total				Average			Median
	No of Firms	Amount Borrowed		Interest Rate		On-year-ahead PD		Total Assets	Equity Ratio
		Feb-20	Jun-21	Feb-20	Jun-21	Feb-20	Jun-21		
Zombie Firms	1,333	35	48*	2.35%	2.39%	2.35%	8.84%*	264	23%
Almost Zombie Firms	1,040	21	17	2.43%	2.48%	1.35%	5.70%*	245	21%
Other firms with ICR<=1	1,264	34	37	2.40%	2.48%*	1.98%	6.56%*	129	9%
Rest of the Sample	7,514	121	118	2.07%	2.09%	0.95%	5.29%*	120	24%

Note: Table 3 shows descriptive statistics for selected variables for February 2020 and June 2021, respectively. Table 3 reports results for large firms with the largest increase in the reported probability of default and divided in 4 different sub-sets: zombie firms, almost zombie firms, other firms with ICR<=1 and the rest of the sample, separately. Column (1) shows the number of firms in each sub-sample. Columns (2) and (3) shows the total amount borrowed by the firms (calculated as the sum of the nominal value of each loan reported in KRITA at each given time) in SEK billion. Columns (4) and (5) report the simple sample average of each firm's value-weighted interest rate. Columns (6) and (7) report the simple sample average of each firm's value-weighted one-year-ahead probability of default. Column (8) reports the average amount of total assets (in SEK million) and column (9) reports the firms' median equity ratio. The latter variables are calculated using data for 2019. Amount borrowed, interest rate and probability of default are reported by the credit institutions surveyed by KRITA. The * shows that a test on the mean confirms that the averages are statistically different. Sub-samples are created using simulated data. Details about the classification of firms and additional variable descriptions can be found in Section 2.1.1 and Section 3.1.1.

Sources: Bisnode and KRITA.

Table 3 shows that a total of 11,151 firms (out of approximately 43,000 for which information on PDs is available) in the sample were large and were considered more at risk in June 2021 than in February 2020. In particular, if we focus on zombie firms (almost zombie firms and other firms with ICR<=1), these type of firms represent 13% (15% and 9%) of the total number of simulated zombie firms (almost zombie firms and other firms with ICR<=1). Interestingly, 779 firms were already classified as zombie firms in 2019.[26]

Although limited in number, the zombie firms described above borrowed more than SEK 48 billion (an average loan size of SEK 36 million per firm) in June 2021. This accounts for little more than 3.5% of the total lent to all firms (circa SEK 1,400 billion) and 19% of the total amount lent to all simulated zombie firms (circa SEK 250 billion), even though, on average their (amount-weighted) probability of default has increased

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[26] Importantly, when interpreting the results above a few caveats apply. While the majority of the firms in the sample borrow from one bank only, a number of firms have relationships with more than one bank. For some of the latter firms, sometimes banks report diverging PDs (for instance, one bank would report a higher PD in June 2021 than in February 2020, while another would report a smaller one). In these cases, the weighted average gives a larger weight to the banks with which the firm has the biggest commitment when the averages are calculated. Moreover, most of the MFI reporting PDs in KRITA employ the internal ratings-based (IRB) approach, however those that do not use this approach can report PDs calculated using a different model that has been approved by the Swedish FSA. Therefore, if a firm borrows both from a bank that employs the IRB credit model and from a bank that does not but still reports, then some difference in the PDs could also arise.

from 2.35% to more than 8% over the period under consideration. Interestingly, in total, these firms have also borrowed more than they did right before the crisis (SEK 48 compared to SEK 35 billion) but, all in all, their weighted average interest rate has remained (statistically) unchanged. So the increase in the PDs reported by the banks does not seem to be reflected either in the amount of loans taken by the firms or the cost of these loans. I also obtain the same result if I focus only on the firms already classified as zombie firms in 2019. I find similar results for both the firms in the sub-sample of almost zombie firms.

Table 3 also shows that, despite being more at risk of distress, the median equity ratio in each sub-sample was around 21% in 2019 with the exception of the subsample of firms with an ICR<=1 whose median equity ratio was around 9%. These results are consistent with the patterns shown in Figure 3, Panel B, and suggest that, if compared with the median firm in the other sub-samples, the median firm in the sub-sample of other firms with ICR<=1 was already "more at risk" of distress in 2019. This is particularly the case for those firms with an equity ratio below the median. If these firms have faced losses during the pandemic, then, as reflected also in the PDs, they may have become more at risk of distress. This is also consistent with the fact that this set of firms is the only one for which I find (on average) a slightly higher interest rate in June 2021 compared to February 2020.

To conclude, results in Section 4 show that, in June 2021, a total of around SEK 530 billion was borrowed by simulated vulnerable firms. While this amount is similar to what these firms borrowed in February 2020, almost SEK 100 billion went to vulnerable firms that the MFIs themselves expect to be more at risk of distress in the coming year. These same firms already borrowed circa SEK 90 billion in February 2020. Hopefully, consistent with good risk management practices, credit institutions have already correctly provisioned for the potential losses they may incur.

5   Conclusions

The COVID-19 pandemic has caused one of the worst health and economic crises of all time. Finally, thanks to vaccination programs, many people have been able to return to a less restricted life and the economic recovery has started. Yet, because of its peculiar nature, there is still uncertainty about the possible long-term effects of this crisis on firms.

In autumn 2020 (Cella 2020b), I studied the characteristics of the firms that had filed for bankruptcies and re-organization in the months immediately after the COVID-19 pandemic crisis began. In that study, I found that the crisis may have contributed to the exit of some firms that, already in 2018, showed quite weak financial ratios and poor profitability. I also documented that firms that filed for bankruptcy in March-June 2020 had a higher probability of default (reported in KRITA) than their competitors in different periods preceding the COVID-pandemic and were statistically similar to firms that had filed for bankruptcy in the fourteen months before the pandemic started.

In the months after my study time period (March-June 2020), statistics show that bankruptcies and re-organizations have remained low with respect to the period before the crisis and many have suggested that, at least in part, this outcome could have been driven by the government support offered to firms (Sveriges Riksbank FSR 2021:1). Nevertheless, despite the fact that some level of bankruptcy is normal (and healthy), the question remains of whether bankruptcies may spike up once the economy returns to more normal levels and government support is withdrawn.

This study tries to contribute to this debate by investigating how the crisis may have affected firms' financial health. I start by illustrating how vulnerable Swedish firms were before the COVID-19 outbreak. Then, since data for 2020 is still not available, I employ a simulation exercise to illustrate how the economic crisis, brought about by the restrictions to minimize the spread of the coronavirus, may have exacerbated existing vulnerabilities.

My exercise suggests that the *total number of vulnerable firms* in the sample may have only slightly increased during the pandemic. Yet, it also shows a clear effect of the crisis: firms may have become *more vulnerable* in most industries, not only in those industries that have been, and still are, most affected by the measures taken to contain the spread of the virus (for example the hotel and restaurant industry).

Using data from the KRITA, I also document that in June 2021, simulated vulnerable firms borrowed almost 39% of total amount of money lent by the MFIs surveyed in KRITA to the limited liability firms in the sample (circa SEK 1,400 billion). A total of around SEK 250 billion was lent to firms classified as zombie firms by the simulation. Finally, vulnerable firms for which the reporting MFIs attached a higher probability of default in June 2021 than in February 2020 received almost SEK 100 billion in credit.

These results corroborate my previous findings that vulnerable firms represent an important part of the lending portfolios of banks and therefore monitoring their evolution is crucial to insure the stability of the Swedish financial system.

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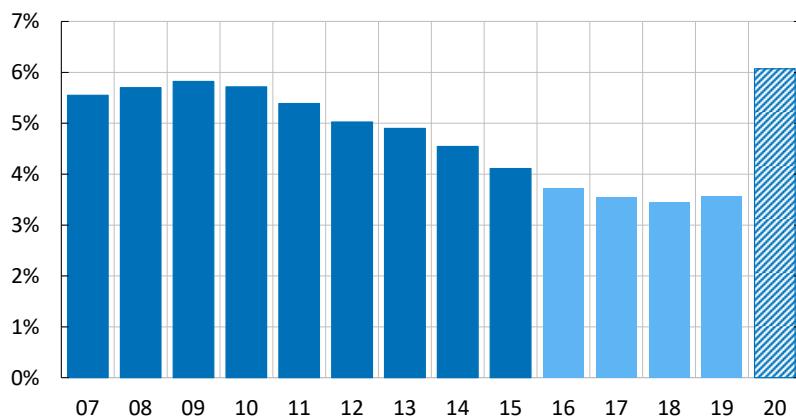
APPENDIX A. Evolution of zombie firms over the period 2016- 2019 and simulated data for 2020.

This appendix presents an update of the Figure 2a in Cella (2020a) employing the latest data delivery for each year from 2007 to 2019.

Figure 2a in Cella (2020a) provides information about the percentage of zombie firms among limited liability firms in Sweden for each year over the period 2002-2016. Calculations for Figure 2.a were done using an unidentified version of the Serrano database. Figure 1.A in this paper, uses the Serrano database delivered in November 2020 and covers data up to 2019. Moreover, using the simulation exercise described in Section 2.2, I am also able to show the simulated amount of zombie firms for 2020.

Figure 1.A Zombie firms evolution 2007- 2019 and simulated data for 2020
Per cent

Note: Figure 1.A shows how many firms have been classified as zombie firms using the definition illustrated in Section 2.1.2 each year between 2007 and 2020. The year 2020 shows results obtained using simulated data. Zombie firms are firms older than 10 years that have at least three consecutive years of ICR below 1. The blue bars represent the percentage of zombie firms for 2007-2015, the light blue bars report results for 2016-2019, while the patterned bar reports the simulated amount of zombie firms for 2020. The main variables are described in detail in Section 2.1.1 while the data and methodology employed for the simulation are described in Section 3.1.1.

Source: Bisnode.

Figure 1.A shows that the percentage of zombie firms in Sweden has been stable at around 3.6% over the period 2016-2019. If we focus on large firms only (not reported), the percentage of zombie firms has been stable at around 6.5% over the same period.

Importantly, firms that belong to a corporate group (either as parent companies or subsidiaries) make up a substantial number of zombie firms in the Swedish economy.

In 2019, 1.8% of all of the firms classified as zombie firms belonged to a corporate group, this number reached almost 5% if I focus on large firms alone. For the simulated results, I find that 2.75% of all of the firms in the universe of limited liability firms are large zombie firms. This percentage goes up to 7.22% if one only focuses on the sample of large firms.

Importantly, I know whether a firm belongs to a corporate group or not but I have no access to consolidated data, therefore I may overestimate the amount of zombie firms (and vulnerable firms) among firms belonging to corporate groups. Yet, even though I am aware of potential biases (which I discuss in detail in Appendix B), I prefer to include all firms in the study, even those that belong to corporate groups, since the goal of this paper is to map as comprehensively as possible potential vulnerabilities that may be harmful for Sweden's financial stability. Nevertheless, whenever possible, I describe results separately for firms belonging to a corporate group.

Appendix B: Additional material for simulated data

Table 1.B Descriptive statistics

Descriptive statistics simulated data

	(1)	(2)	(3)	(4)	(5)	(6)
	Firms	Total Assets	Age	Leverage	ROA	ICR
Simulated sub-sets:						
Zombie firms*	28,341	140,108	23.71	57%	-11%	-7.10
Almost zombie firms*	16,491	44,220	22.56	55%	-8%	-7.34
Other firms with ICR<=1*	49,034	46,397	4.96	66%	-12%	-3.63
Rest of the Sample*	373,094	31,422	12.58	45%	13%	27.72

Note: Table 1.B shows descriptive statistics for selected variables. Table 1.B starts by reporting statistics for all of the firms in the sample, then these firms are split in 3 groups using simulated data: zombie firms, almost zombie firms and other firms with ICR<=1, separately. Column (1) shows the total number of firms in each category. Columns 2-4 show averages while column 6 reports the median. Column (2) reports the firms' total assets (in SEK thousand) while column (3) shows the average firm age. Firm age is the number of years from the firm's registration. Column (4) shows results for the firm's leverage. All variables are calculated using simulated data for 2020. The main variables are described in detail in Section 2.1.1 while the data and methodology employed for the simulation are described in Section 3.1.1.

Source: Bisnode.

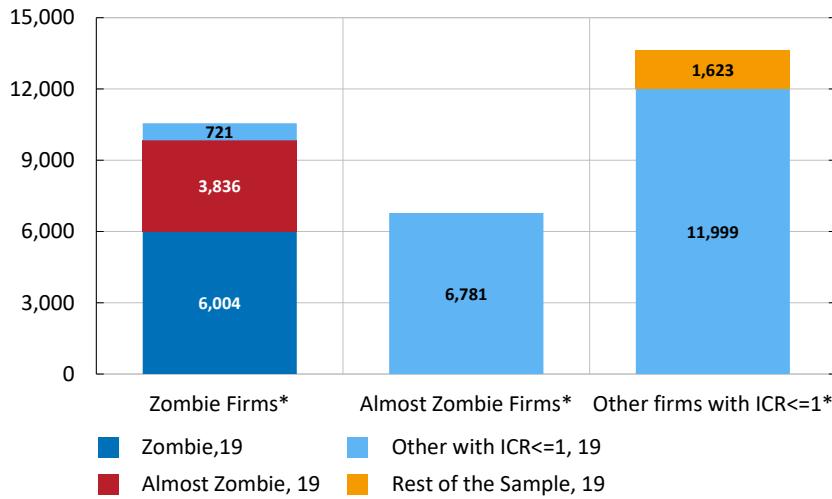## Table 2.B Descriptive statistics of KRITA data

Simulated data

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	No of Firms	Total Amount Borrowed		Average Interest Rate		Average One-year-ahead PD	
		Feb-20	Jun-21	Feb-20	Jun-21	Feb-20	Jun-21
Zombie Firms*	10,561	273	256	2.99%	3.10%	3.70%	4.49%
Almost Zombie Firms*	6,781	65	58	2.99%	3.03%	2.38%	3.56%
Other firms with ICR<=1*	13,622	206	219	3.11%	3.15%	3.62%	4.40%
Rest of the Sample*	95,598	827	836	2.34%	2.34%	1.76%	2.26%

Note: Table 2.B shows descriptive statistics for selected variables for February 2020 and June 2021, respectively. Table 2.B reports results for 4 groups of firms classified using simulated data: zombie firms, almost zombie firms, other firms with ICR<=1 and the rest of the sample, separately. Column (1) shows the amount of firms in each sub-sample for which data about the total amount borrowed is available. Columns (2) and (3) show the total amount borrowed by the firms (calculated as the sum of the nominal value of each loan reported in KRITA at each given time) in SEK billion. Columns (4) and (5) report the simple sample average of each firm's value-weighted interest rate. Columns (6) and (7) report the simple sample average of each firm's value-weighted one-year-ahead probability of default. Amount borrowed, interest rate and probability of default are reported by the credit institutions surveyed by KRITA. Finally, column (7) shows the number of firms in each sub-sample. Sub-samples are created using simulated data. The main variables are described in detail in Section 2.1.1 while the data and methodology employed for the simulation are described in Section 3.1.1.

Sources: Bisnode and KRITA.

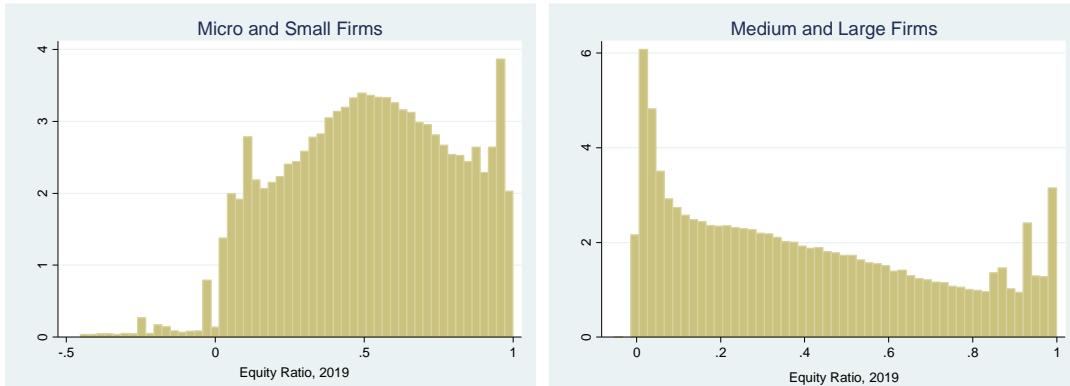**Figure 2.B Transition matrix from 2019 to 2021**

Number of firms

Note: Figure 2.B shows how many firms have been reclassified using the simulated EBIT results for 2021. Each column represents the simulated sample of zombie firms, almost zombie firms and other firms with ICR<=1. Each of the column is then decomposed to illustrate what type of firm (in 2019) contributes to each simulated group: zombie firms (dark blue), almost zombie firms (red), other firms with ICR<=1 (light blue) and rest of the sample (yellow). Only firms that were present in KRITA in both February 2020 and June 2021 are presneted. The main variables are described in detail in Section 2.1.1 while the data and methodology employed for the simulation are described in Section 3.1.1.

Source: Bisnode.

Figure 3.B Firms' capitalization in 2019, Histogram

Simulated firms, by size

Note: Figure 3.B shows the histogram of firms' equity ratios in 2019 by quartiles of size (total assets). The graph on the left shows results for micro and small firms, while the graph of the right show results for medium and large firms. Firms that have filed for bankruptcy in 2019 and 2020 are excluded. Firms with an equity ratio smaller than the 1st and 99th decile of the distribution (-0.45 and 0.99) are excluded so that results are not driven by outliers. All variables are described in detail in Section 2.1.1 while the data and methodology employed for the simulation are described in Section 3.1.1.

Source: Bisnode.

Appendix C: Government support and vulnerable firms

To counter the spread of the coronavirus, governments around the globe started imposing lock-downs, social distancing, and travel restrictions in early March 2020. In Sweden, the Public Health Agency (Folkhälsomyndigheten) recommended people to stay at home as much as possible: to work from home and avoid public transportation. Limits on the number of people that could gather at close quarters were also imposed.

These measures had an immediate effect on the movement of people (and goods) and caused a substantial slowdown in economic activity throughout the country. Moreover, as a small, open economy, Sweden has also been affected by the demand and supply shocks that resulted from restrictions imposed around the world.

To counterbalance the effects of the restrictions, the Swedish government, like many other governments, has employed an array of programs to support non-financial firms.[27] Among those, Sweden (like most Euro area countries) employed public loan guarantee programmes, tax deferrals and tax relief schemes, but has never adopted a credit moratoria like the one introduced in Germany, for example.[28]

These programmes have provided important support to the non-financial sector (Sveriges Riksbank, FSR 2021:1). However, the large decrease in the number of bankruptcies in Sweden, and in many countries around the world, also suggests that these programmes may have introduced some distortions in the economic system (see Cella 2020b). One worry is that part of the money provided to the non-financial system was allocated to vulnerable firms, and zombie firms in particular (ECB Financial Stability Report, May 2021).

Most of the programmes run in Sweden required firms to show that they had suffered temporary, serious financial difficulties caused by circumstances beyond their control.[29] This "condition" should imply that the firm's financial difficulties had not already started in 2019. Yet, given that I have no access to the information that was submitted by the firms and I have no information about the approval process either, I cannot exclude the possibility that vulnerable firms had in some way access to the support. Importantly, this is true for any industry not only those that received the most support.

In fact, I find no direct link between the amount of vulnerable firms (zombie firms) present in an industry in 2019 and the total amount of government support (short-term permits and tax deferrals support) the industry has received from when the programme

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[27] Policymakers around the word acted quickly and employed a variety of measures such as tax cuts and deferrals and credit guarantees. Central banks lowered policy rates, expanded asset purchase programmes, and, in some cases, even started financing companies directly. Capital and liquidity buffers were relaxed. Debt service moratoriums and prohibitions on evictions were suggested or mandated. More details can be found here: Sveriges Riksbank (May 2020) and ESRB (2020) and ECB (2020).

[28] Debt moratoria allowed firms affected (or expecting to be affected) by the COVID-19 shock to suspend the payment of their obligations for the duration of the moratorium period. Public loans guarantees schemes helped firms (with no financial difficulties at the end of 2019) to access financing by transferring some of the credit risk and potential credit losses from banks to governments. Tax deferrals and tax relief programmes vary between countries but they usually involve a deferral in the payment of VAT taxes or temporary reduction or deferral of payroll tax obligations or employees' social security contributions.

[29] More information can be found on this link: (https://tillvaxtverket.se/english/short-time-work-allowance-2021/apply-for-financial-support-2021.html).

was initiated to the present day. For example, I find that some of the industries particularly affected by the economic crisis (the arts, hotels and restaurants, transportation and wholesale and retail) entered 2020 with a substantial number of large firms with ICR<=1 of which a significant number were zombies. These latter industries are also among those that have received some of the largest support (Sveriges Riksbank, FSR 2021:1). It would then be easy to speculate that it is likely that vulnerable firms (and zombie firms) may have had direct access to at least some of the money provided to support the economy or have indirectly benefited from these programmes because of the additional funds they may have freed up at the industry level.

Nevertheless, while it is not clear that this is the case and firm level data is not available to me for further investigation, it is hard to conclude that this necessarily may have been detrimental to the economy or the financial system, even if vulnerable firms (and zombie firms) may have had access to the money provided to the economy by government agencies. For instance, even though zombie firms may create entry barriers for other competitors, in normal times, they tend to regain some efficiency and, at least in Sweden, they do not seem to impact the productivity of other firms in the same industry (see Cella 2020a).

Moreover, as discussed previously, it is difficult to gauge how weak so-called zombie firms really are since their identification is mostly based on accounting variables. For example, in Sweden many zombie firms belong to corporate groups and therefore have access to the group internal financial market which makes it difficult to assess how vulnerable these firms really are. Therefore, even if vulnerable firms have had access to some government programmes, it is not clear that they largely benefited from them and that this was detrimental to either the real economy or financial stability.

Finally, Brunnermeier and Krishnamurthy (2020) argue that if there is a return to pre-COVID-19 conditions soon, then the concern about providing credit support to zombie firms during the recession should be less acute than during a normal recession because in this case there will be less need to reallocate assets across sectors or firms than in a typical recession. Now that the restrictions have been lifted and the economy is recovering, we may find out if this is the case.