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Article

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On the identification of zombie firms

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A survey of the most prominent definitions of zombie firms, together with their replication on a common dataset for euro area firms spanning the years 2004-2019, shows limited overlap and low comparability in the sets of firms identified by several prominent studies. Such low comparability raises the concern that these definitions are less capturing true zombie firms but rather financially vulnerable ones, and that the policy discourse may be misguided by statements on effectively distinct groups of firms. Thus, a formalization of the classifications of zombie firms is introduced which helps to make order in the growing number of variations and identification methodologies. Such formalization allows the concept of binary identification to be extended to that of fuzzy zombie identification, which allows quantification of a certain degree of "zombieness". A general procedure to turn arbitrary binary classifications into fuzzy ones is also presented and is shown to successfully increase consistency between zombie definitions.

Key words: zombie firms, vulnerable firms
JEL codes: L25, D22, D24, C55, O40

1 Introduction

The Japanese economic stagnation that started in the early 1990s brought about the notion of "zombie firms" in reference to companies that would normally exit functioning markets but manage nonetheless to survive, typically relying on subsidized credit (Caballero et al., 2008). Concerns around the potential "zombification" of euro area corporates has again become prominent in recent years, motivated by the extended accommodative credit environment, first in the wake of the European sovereign debt crisis in the 2010s and more recently following the extensive support measures put in place in response to the COVID-19 pandemic.

Despite the growing interest in the effects of accommodative financing conditions, and the risks to economic growth and productivity associated with a rise in zombie firms, the literature seems to lack a general agreement on how zombie firms should be identified. This is due to the fact that the defining feature of zombie firms (i.e., receiving subsidized credit) is usually not observable and identification methodologies have to rely on proxies instead. On the one hand, authors then employ ad hoc methodologies for identifying such non-viable firms, which might select different subsets of firms. On the other, the proliferation of

1 Mingarelli and Wendelborn work at the European Central Bank; Shakir was at the European Central Bank until April 2023. The views expressed are those of the authors and not necessarily those of the institutions they are affiliated with.

studies has made the concept of zombie companies more evanescent – especially in the public debate – blurring the boundary between zombies and vulnerable firms.

In this article, we seek to reaffirm the distinction between the two, establishing conceptual order and providing a comparison and consistency assessment of some of the most prominent zombie identification methodologies. Such work is particularly important in the current context of post-pandemic recovery, where distinguishing between the notion of subsidized zombie firms and vulnerable, but fundamentally viable, firms is vital in order to understand the real effects and policy implications of the zombie phenomenon.

The remainder of this article is organized as follows. First, we provide a practical motivation for distinguishing between zombie firms and vulnerable firms. We do this by recalling a recent policy scenario in which an accurate determination of which firms should be labelled as non-viable could have made a substantial difference to the degree of credit and public resources being efficiently allocated in Europe. Then, we present a comparison of the three most popular zombie identification methodologies. We discuss the strengths and weaknesses of each methodology, and provide some insights into the factors that contribute to the comparability of different identification results. In the penultimate section, we discuss the benefits of turning identification "fuzzy", moving beyond dichotomous ones. We argue that fuzzy identification can provide a more nuanced understanding of the degree to which a firm is a zombie, and that it can be used to improve the comparability of different identification results. Finally, we provide policy-relevant conclusions discussing the implications of our findings for economic policy.

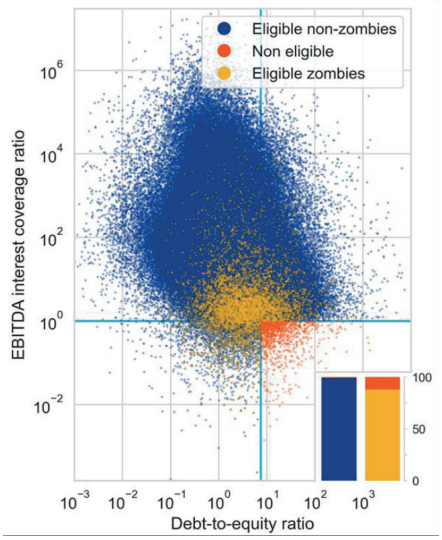
2 A policy case scenario: Credit allocation during the COVID-19 pandemic

Early in the pandemic, the European Commission put forward guidelines for determining which firms should have access to loan guarantee schemes. These guidelines required firms to have reported EBITDA interest coverage (EBITDA IC) ratios greater than unity, and debt-to-equity ratios below 7.5 for both of the two most recent reporting years. Each country eventually put in place its own criteria, although these have by and large been in line with these Commission's guidelines.

Comparing the European Commission's criterion with the zombie identification of Storz et al. (2017) on euro area firms shows that, while very few of the firms

labelled as viable (healthy) were excluded from the schemes (about 1%), policy measures intended to help viable companies bridge liquidity needs arising during the pandemic and lockdowns may also have been accessed by over 90% of firms labelled as zombies (see Figure 1).[2]

Figure 1: European Commission criterion for accessing loan guarantees schemes compared with the zombie identification proposed by Storz et al. (2017)



	Healthy	Zombie
EBITDA IC < 1	8%	66%
DE ratio > 7.5	12%	17%
Both	1%	10%

Note: Each dot represents an individual firm.

This raises the question of whether the European Commission's criterion is an effective way of excluding zombie firms. The criterion is based on two financial ratios that are commonly used to assess a firm's financial health. However, these ratios do not take into account other factors that may be important in determining whether a firm is a zombie, such as its profitability, its investment activity, and its debt structure.

This critique may also be applied to many of the identification methodologies employed in the literature and policy space, and the Commission's criterion can be considered in and of itself a measure of firm viability. Because the status of zombie is not directly observable, the design of diverse methodologies, each with its pros and cons, aims at constructing proxies that are often driven by data

2 Clearly, eligibility does not mean such firms necessarily accessed financial schemes, although evidence exists at the country-sector level of correlations between high fractions of non-viable firms and pick-ups in loan guarantees and moratoria (Helmersson et al., 2021).

availability and may emphasize different factors. The natural question arising is whether these proxies are consistent among each other, that is, whether they identify the same phenomenon and type of firms.

3 Zombie identifications: A new framework and consistency assessment

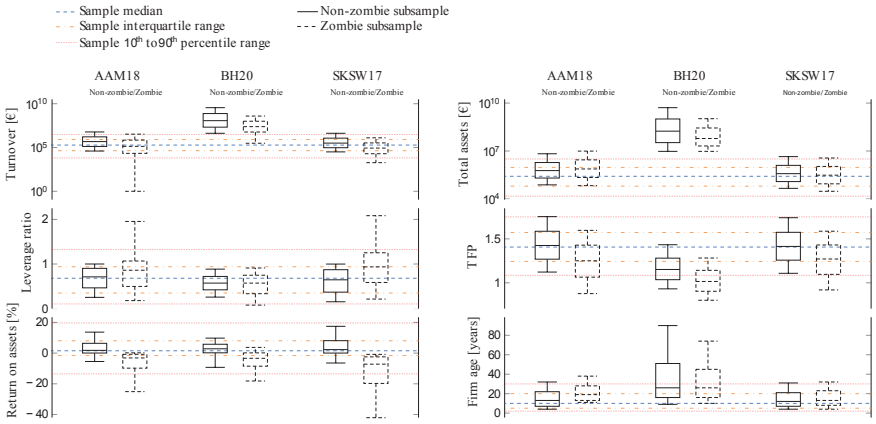
While the literature on zombie firms is rich in coexisting identification methodologies, it remains challenging to reconcile results and recommendations into a unified framework. Aside from the conceptual differences distinguishing different approaches, due to data limitations analyses are often conducted on different subsets of the economy, in specific geographies and sectors.

Although the methodologies each have clear advantages and disadvantages in depicting different aspects of zombieness, their heterogeneity in terms of time, sector, and country coverage, but also different underlying frameworks, makes it hard to perform a direct comparison, leaving the conceptual debate on the size, real effects, and policy implications of the zombie phenomenon open to misinterpretation. We attempt to bridge this gap by providing a generalized framework and replicating the main identifications on a common dataset of euro area countries over the period 2004–2019. We use firm-level data from Orbis, augmented with other data sources as needed, such as Bloomberg and the Centralized Securities Database (CSDB) for Tobin's Q calculation. In addition, as each methodology naturally restricts the sample to a specific subset of firms, we introduce the concept of *largest identifiable subset* (LIS), that is, the subset of firms on which a given identification (or set of identifications) can be applied.

We compare three of the most prominent identification methodologies introduced in recent years, namely, those by Adalet McGowan et al. (2018), Banerjee and Hofmann (2020), and Storz et al. (2017).[3] While our cross-identification comparison shows some consistency in trends and levels of zombie firms in the economy, we take a step further to determine whether such methodologies actually identify the same subset of unviable firms. We start our analysis by first looking at a set of main firm characteristics for zombies/non-zombies for the identifications mentioned above (Figure 2).

3 For a more ample discussion and for more details, please see Mingarelli et al. (2022). The identification criteria are as follows: for Adalet McGowan et al. (2018), an interest coverage ratio less than one for at least three consecutive years and an age of at least ten years; for Banerjee and Hofmann (2020), an interest coverage ratio below unity and Tobin's q below sector median for at least two consecutive years; for Storz et al. (2017) negative returns on assets, negative net investments, and debt servicing capacity below five percent, for at least two consecutive years.

Figure 2: Boxplots for selected firms' characteristics for the non-zombie and zombie subsamples



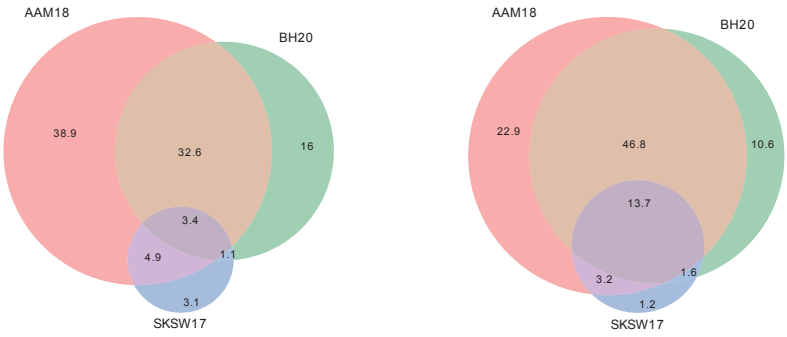
Note: Whiskers denote the 10th and 90th percentiles. Dashed lines show the distributions for the entire sample of firms. AAM18: Adalet McGowan et al. (2018), BH20: Banerjee and Hofmann (2020), SKSW17: Storz et al. (2017).

The distributions depicted in Figure 1 show a number of commonalities, but also important difference between methodologies, explained by the different criteria used by each. Across all methods, zombies tend to have (i) lower turnover, (ii) lower productivity, but also (iii) lower and often negative returns on assets than their non-zombie peers. Negative return on assets is hardwired into the identification put forward by Storz et al. (2017), but lower ratios are also observed for the other two identifications. The LIS associated to the identification of Banerjee and Hofmann (2020) is structurally different than the other two methods as it can be applied to listed firms only. As expected, these listed firms are larger in terms of total asset and have higher turnover, but lower total factor productivity (TFP). They have similar median returns on assets, and not such large differences in leverage between zombies and non-zombies compared to other identifications.

Secondly, we look at how firm-level identifiers overlap across zombie identifications (Figure 3). For this analysis, we make results comparable by selecting a common sample of firms corresponding to the joint LIS of all three methods. Figure 3a shows that firms jointly identified as zombies by different methods are relatively few. These results leave open the question of the ability of different methodologies, on one hand, to generalize their empirical findings, and on the other to establish with certainty the overall level of zombie firms in the economy. Moreover, these results raise the concern of whether these methods

actually capture zombie characteristics in firms (i.e., whether the firms receive subsidized credit) or simply detect financially weak and less profitable firms.

Figure 3: Venn diagrams representing the overlaps between a selection of three zombie identifications



(a) Binary (b) Fuzzy

Note: AAM18 = Adalet McGowan et al. (2018); BH20 = Banerjee and Hofmann (2020); SKSW17 = Storz et al. (2017). Identification is performed over a common set of firms. Numbers labelling each area refer to the share of firms (in percentage) with respect to all firms identified as zombie by any of the three methods. Left: overlap of zombie firms identified using binary classification, i.e., a firm is either a zombie or non-zombie. Right: overlap of fuzzy identified groups , i.e.,, a firm is a zombie to a certain degree.

4 From a binary classification to a generalized *fuzzy* approach

An improvement can be made by moving away from the dichotomic, *crisp* classification of zombie firms and recognising that the very concept of zombies is not clear-cut, but rather can be associated with a certain degree of zombieness. For example, using a binary identification when analysing firms exiting zombie status might suggest that these have fully recovered, while their performance might simply have improved just slightly by the amount necessary to exceed the zombie threshold. In fact, our analysis shows that recent declines in the share of zombies have not always been met with a similar decline in quasi-zombies. The introduction of a *fuzzy*, non-binary identification proves to be more robust to misclassification and allows us to describe the degree of a firm's viability, improving the inevitable arbitrariness of the identification thresholds used in the literature. As such, we draw on the work of Caballero et al. (2008) and provide a generalized framework which allows us to turn each existing binary identification into a fuzzy one, with the two-fold advantage of not requiring any extra data and adding only minimal computational complexity.

We perform a similar comparison to the one presented in the previous section and find that introducing fuzziness increases consistency across different definitions (Figure 3). While fuzzy identifications have the drawback of being less conservative, with the risk of potentially including firms that are not actual zombies, this concern is mitigated by associating decreasing importance to such first-kind errors. On the other hand, reducing the likelihood of missing out firms that are potentially unviable increases consistency across identifications, allowing for a better comparison and generalization of results. Figure 3b shows that the overlap between the three identification methods increases when compared to the binary example (Figure 3a).

In addition to ensuring consistency and comparability, a fuzzy analysis allows for an assessment of how firms evolve from their current status to another status of zombie, quasi-zombie and non-zombie. Using the definition provided by Storz et al. (2017), we started an analysis of the probabilities of transitioning from one status to another for the period 2014–2015 and find that most recovering zombies or quasi-zombies gradually attain healthy status, while those that did not experience an improvement progressed towards a deeper level of zombieness. Moreover, firms with a high fuzzy score were more likely to remain in their (quasi-)zombie status, while firms with lower scores had a higher probability of recovering.

5 Conclusion

With the introduction of a general framework formalising the concept of binary zombie-identifications, we compare the main methodologies and highlight their heterogeneity both at a conceptual and quantitative level. Although the shares and trends of zombies are somewhat consistent between methods, we find that they are identified using different subsets of the population of firms.

Consistency improves when using a generalized fuzzy-theoretic approach, which has the advantage of providing a more granular measure of zombieness, decreasing the arbitrariness in choosing thresholds, and informing on the evolution in the shares and trends of zombies, quasi-zombies, and non-zombies. In turn, such an approach allows for a better comparison between different identifications, but does not rule out a mismatch between the conceptual notion of a zombie and the different methodologies for their actual identification. As such, generalizations of findings as well as the design of targeted policy responses should be conducted with caution.

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