

REVIEW

Fear the Walking Dead? Incidence and Effects of Zombie Firms in Europe

Issam Hallak¹⁺ Péter Harasztosi¹⁺ Sebastian Schich^{2*}

1. European Commission, Joint Research Centre (JRC), Ispra, 21027, Italy

2. Organisation for Economic Co-Operation and Development (OECD), Paris, 75016, France

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ABSTRACT

One explanation for the observed lack of economic dynamism in Europe is that so-called zombie firms are spreading and that they crowd out the growth of other, potentially more "lively", companies. Zombie firms are firms that apparently are unable to repay their debt and yet, they continue operating. The report describes estimates for 2010 and 2013 of the incidence of zombie firms across 19 European countries using firm-level data for more than one million companies. Importantly, it uses three alternative definitions of what constitutes a zombie firm to ensure robustness of estimates. The report finds that zombie firms are spreading in Europe, with the estimated incidence for 2013 being higher than for 2010. It also identifies considerable differences across countries. Zombie firm shares as of overall corporate capital are particularly high in Greece and Spain, but low in the Czech Republic and Slovakia. Distinguishing among firms in terms of size and age, the report finds that larger and older firms, as compared to relatively smaller and younger firms, are more likely to be zombie firms. The report also finds that the growth of zombie firms in terms of employment crowds out the growth of other, non-zombie firms, especially young ones. Thus, one policy implication is that, greater economic activity is achieved by allowing zombie firms to exit the market.

1. Introduction

Zombie firms tend to have detrimental effects on their healthy peers. In the corporate sector, zombie firms are firms that are not reporting any profits (net of interest paid) for an extensive period of time, and yet manage to continue operating. Such firms, if financial textbook suggestions were literally applied, would be considered "distressed" and candidates for liquidation. But in practice, they are rarely liquidated. Moreover, their continued existence may create some negative externali-

ties for the remaining healthy corporate sector in that the former crowd out the growth of other, non-zombie, firms.

The present report provides estimates of the incidence of zombie firms in Europe and analyses the potential effects of the presence of such zombie firms on other firms in the same country and sector. The report follows Adalet McGowan et al.^[1] and Bank of Korea^[2], although it goes beyond these studies in that it considers several alternative definitions of zombie firms to ensure robustness of estimation results. In particular, it considers three alternative

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definitions. First, firms with a coverage ratio (operational earnings, that is, earnings after depreciation over interest payments) below one during three consecutive years, regardless of the age of the firm. Second, mature firms, defined as firms ten years or older, with a coverage ratio below one during three consecutive years. Third, mature firms with a coverage ratio below one during five consecutive years. Young firms, defined as firms that are nine years old or younger, are excluded in the latter two definitions as the lack of profits might be a temporary (and natural) feature of such firms. In fact, firms often incur losses in the first years of their life for extended periods of time because they must invest until they reach sufficient operating capacities and customer bases, which then allows them to eventually report profits. All three definitions aim to capture indebted companies whose debt servicing eats up their profits during a considerable stretch of time and yet continue to operate; perhaps because the firm is being kept alive "artificially" by its lenders?

Our main empirical results are as follows:

a. The share of zombie firms is larger among larger and older firms, thus confirming the results by Adalet McGowan et al.^[1]. The latter authors consider the first of the three definitions considered here, according to which even young firms can be identified as zombie firms. Using that definition, we find that about 3% of 3 to 6-year-old firms are zombies, versus 7% in the case of firms that are between 21 and 40 years old. For large firms with more than 250 employees, the share is nearly 6%, while it is less than 4% for firms with 5-9-employee firms.

b. Zombie firms are spreading: There is an increase between 2010 and 2013 in the share of zombie firms in Europe and in particular in Greece, Spain, and Portugal. Ireland is characterised by a high share as well, although it is decreasing. Slovenia, Belgium and Sweden have comparatively lower shares of zombie companies and Hungary and Bulgaria have the lowest shares among the sample countries.

c. Zombie firms are crowding out the growth of non-zombie firms. To assess the potential interaction between zombies and non-zombies, we construct a measure for zombie congestion by calculating the share of sunk capital by country and sector. We find that the share of zombies affects non-zombies. In particular, the larger the share of zombie firms is, the less non-zombie firms are likely to grow, although they seem to become more productive to overcome the constraints they seem to be facing. Zombie firms thus create a "congestion". Focusing on young non-zombie firms, we find that they are more strongly affected by the "zombie congestion" than older non-zombies are. These findings are in line with Adalet

McGowan et al.^[1] and they suggest that greater incidence of zombie firms tends to hamper the growth of young and potentially fast-growing firms. As regards the future of zombie firms, we find that smaller and younger zombies stand a greater chance of becoming "alive" again and report positive operating profits compared to larger and older firms.

d. Zombie firms fairly rarely turn healthy again, especially when they are old. We find that close to 90% of zombie firms remain zombies or exit the market in the next two years after they were identified as zombies, by any of the three zombie definitions.

The report is organized as follows. The next section discusses selected previous studies and provides some theoretical background. Section 3 describes the data used for the empirical analysis. Section 4 reports the results of the analysis of the incidence of zombie firms distinguishing between countries, firm age and firm size. Section 5 reports the results from estimates of multivariate models assessing the effects of the existence of zombie on non-zombie firms. The final section concludes and raises questions that could be addressed in follow-up work.

2. Related Literature

Takeo Hoshi highlighted the issue of zombie firms in Japan in a series of contributions, including Hoshi^[3]. He observes that a large share of Japanese firms was under financial distress but could still continue to operate. His analysis focuses on the interest paid by Japanese firms in the 1990s at the level of the individual firm, which he then compares with an estimate of what should be the lowest payable rate – as derived from the term structure of (government bond) risk-free rates, taking into account the debt maturity structure of the firm under consideration. The analysis reveals that a large share of firms made interest payments that were lower than the minimum estimates. Also, those firms that made such "abnormally" low interest rate payments were firms that were performing rather poorly, which seems at odds with such low rates being charged. These observations can however be reconciled by assuming that banks were financially supporting these firms by lowering nominal interest rates to effectively provide a form of debt forgiveness. Hoshi^[3] argues banks were subsidizing firms. While such a strategy to refinance loans in the expectation to obtain repayment in the future might in principle be more profitable for the bank than plainly reducing the reported value of the loan through asset liquidation, such practises were concentrated in particularly weak corporate sectors with little upside risk. In fact, such practises were concentrated in sectors less subject to international competition such as services and construction. This observation casts doubts on the ultimate

rationale on the part of the banks for keeping the firms artificially further alive as an eventual improvement in the debtor situation appears unlikely.

Peek and Rosengren^[4] argue that banking regulation is part of the mechanics behind the zombie phenomenon. Using a sample of loans extended to Japanese listed firms during the Japanese 1990s recession, the authors find that banks with capital ratios close to regulatory thresholds were more likely to refinance loans to weakly performing companies at unusually low interest rates than were banks with stronger capital ratios. The authors refer to the phenomenon as bank forbearance, whereby banks rollover debt in order to avoid having to report losses, which in turn might trigger costly regulatory recapitalization. This phenomenon is often considered to be a main factor explaining the Japanese economic stagnation of the 1990's, i.e. the growing incidence of so-called zombie firms.

Caballero et al.^[5] go beyond the analysis of the incidence of zombie firms and investigate theoretically and empirically the effects of the incidence of zombie on non-zombie firms. Following Peek and Rosengren^[4], the former authors assume that banks, in order to maintain required regulatory capital ratios, opt to support existing borrowers in economic downturns. Unproductive zombie firms are therefore subsidised through abnormally low interest rates because banks are unwilling to book loan losses. Healthy and productive non-zombie firms must compete against zombie firms on loanable amounts. Banks' subsidies to zombies distort competition in credit markets in favour of the latter; this adds on financial constraints to healthy non-zombies and slows down their growth. Moreover, zombies are likely to distort prices in product and labour markets as a result of the subsidies, as zombies are likely to gamble for their survival. As a result of the fierce competition from zombies, incumbent healthy non-zombie firms must retrench from relatively less productive projects and instead renew or select more productive projects. As a result, the growth of non-zombie firms is adversely affected, while their measured productivity increases. The authors construct a measure of interest gap similar to Hoshi^[3], that is the difference between an estimate of the interest rate a firm does pay in practise and the estimated lowest possible market interest rate that it might secure in theory (if it managed to finance itself at the rates applicable to government borrowing). Negative values of that measure are taken as an indication that the firm is subsidised by the bank (zombie firm)^①. The authors show that the share of total assets held by zombie firms in Japan grew from about 2% in the early 1980s to about 12% in 2002. Zombie firms have hindered the growth of non-zombie firms. Among different sectors, construction

was most severely affected with a share of assets held by zombie firms that attained 30% in 2001.

Adalet McGowan et al.^[1] conduct a somewhat similar empirical analysis for selected OECD countries, although the latter authors consider an alternative definition of zombie firms. Their suggested definition is that zombie firms are ten years or older and are reporting coverage ratios below one in three consecutive years, where coverage ratio is the ratio of earnings before interest and tax payments but after depreciation (EBIT) to interest payments. The coverage ratio is a standard measure for assessing loan repayment capacity and is widely used by credit analysts. Repeated records of the coverage ratio falling below one are seen as indicating serious financial difficulties. The authors show that the share of zombie companies varies substantially across the 13 sample countries. They compute the share of total capital (fixed assets) held by zombie firms, which they call sunk capital. In their sample, sunk capital ranges in 2013 from 4% in Slovenia to 15% in Spain and almost 20% in Italy. This estimate suggests that the empirical relevance of the zombie firm phenomenon can be considerable in practise for countries other than Japan during the 1990s.

That the phenomenon of zombie firms can be practically relevant in Europe is also suggested by Acharya et al.^[6]. The authors study the effects of the Outright Monetary Transactions (OMT) program of the European Central Bank (ECB), which was launched in 2012. The program is interpreted by the authors as an indirect subsidisation of European banks that substantial amounts of sovereign bonds issued by European periphery countries. The authors find that banks that thus benefited from the program increased their overall loan supply, but that this supply was mostly targeted towards low-quality firms with pre-existing lending relationships with these banks. Loans to unproductive firms increased in the period shortly after the start of the OMT program in particular in Italy, Spain and Portugal. Following Caballero et al.^[5], the authors show that banks extended loans to borrowers at interest rates that were below those paid by the most creditworthy European sovereign borrowers. Moreover, non-zombie firms suffered from the presence of zombie firms. According to the authors, both investment and employment growth rates of non-zombie firms were significantly lower if the fraction of zombie firms in their respective industry sector increased compared to non-zombie firms that were active in sectors without a high incidence of zombie firms. This finding suggests that, in the presence of a considerable incidence of zombie firms, indirect subsidisation of banks can have undesired effects on employment and investment operating through a misallocation of loan supply.

Aggregate estimates for Europe can hide considerable cross-country differences. For example, Deutsche Bundesbank^[7] consider firm-level microdata from the Deutsche Bundesbank Financial Statement Data Pool for German firms and shows that zombie firms only make up a small percentage of all firms in Germany and that this share has not increased as of recently compared to the situation eight years before. That said, that result is based on the widely used zombie company definition of a firm with interest rate coverage not exceeding one for three years. Considering an alternative definition of zombie firms that classifies as a zombie firm one whose cash flow has been negative for three consecutive years, a slight increase in zombie firm incidence can be observed, although at much lower levels than considering the more widely used definition.

3. Data

We obtain micro-level firm data from Orbis, an electronic databank of corporate financial statements published by Moody's Bureau van Dijk. We extract unconsolidated accounts of all non-financial firms in both manufacturing and services sectors registered in European countries and retain firms with at least five employees and reporting assets in at least two years. Our sample includes 19 European Union countries for which we have sufficient information so to identify the incidence and share of zombie companies. The countries represented in our sample are Austria, Belgium, Bulgaria, Czech Republic, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Poland, Portugal, Romania, Slovenia, Slovakia, Spain, Sweden, and the United Kingdom.

Table 1 reports the number of sample firms by year and country. It illustrates that the number of firms covered varies over time and across countries. One issue in Orbis is a sudden increase (or drop) in the number of firms, which might just reflect that data from specific providers to Orbis is added or withdrawn. Fortunately, we do not observe such variations in our sample. As a general rule, the most recent years of data available from Orbis tends to contain fewer companies simply because firms may delay their reporting. To avoid this issue, we choose 2013 as the last year for our sample. The table shows that we have available data for only about 5,000 and a little more than 10,000 firms for Ireland and Slovenia, respectively, while we have data for more than 300,000 and 250,000 firms for Germany and Spain, respectively.

We consider three definitions for zombie firms and refer to the firms identified by them as zombie A, zombie B, and zombie C, respectively (see also Table A1 in Annex A).

a. The first definition is zombie A. It defines a firm as

a zombie firm, any firm – regardless of age – with a coverage ratio equal to one or less during three years, where the coverage ratio is defined as the ratio of operational earnings (EBIT, earnings net of depreciation) to interest payments.

b. Zombie B definition restricts zombie A definition to ten years or older firms (again, with coverage ratios equal to one or less during three years).

c. Zombie C definition further restricts zombie B definition to firms with a coverage ratio below one during five consecutive years – instead of three as in the other definitions.

Each of the three definitions of zombie firms requires that firms report at least three consecutive years of coverage ratio. This constraint limits the extent to which we are able to produce estimates for different points in time for the given sample. As regards zombie A and zombie B definitions, data for the three years from 2008 to 2010 are considered to obtain estimates of zombie firm incidence in 2010, although such data are not available for all sample countries. Data from 2011 to 2013 are used to identify incidence of zombie firms in 2013, and these data are available for all sample countries. As regards zombie C definition, estimates are produced for year 2013 only, and for a subset of countries. Orbis reports corporate profits unevenly across countries. Typically, only 20% of firms report profits in Germany, Austria, the Netherlands, and Belgium^[8,9], which accordingly reduces the number of firms available in our sample in the case of these countries.

4. Incidence of Zombie Firms

4.1 Share of Zombie Firms by Age and Size

This section reports estimates for 2013 of the share of zombies, by age and by size in number of employees, considering all three zombie definitions. The share of zombie firms increases with age, although also exhibiting a slight U-shape at the lower end, regardless of the zombie definition we consider (Figure 1). Considering zombie B definition, the share of zombie firms among 5-9 employee firms is about 5.2% and drops to about 3.8% for 10-19 employee firms, representing a drop of 26%. The number then gradually increases up to 6.45% for larger companies (250 employees or more); for example, the share of zombies is 56% higher among 250+ firms than among firms with 10-19 employees.

The relation between age and zombies is also monotonically increasing for the most part, although it slightly drops at the higher end, that is considering firms with 41 years or older. Considering zombie A definition, which does not restrict companies to be at least 10 years old

Table 1. Number of Observations by Country and Year

	2008	2009	2010	2011	2012	2013
Austria				36,611	37,203	37,253
Bulgaria	45,771	48,471	50,952	54,203	57,077	59,127
Belgium	38,643	39,557	40,608	41,481	41,667	41,769
Czech Republic	35,435	36,684	37,714	38,074	38,101	38,101
Finland	20,784	21,696	22,572	23,385	23,990	24,221
France	189,535	194,889	200,039	204,149	206,600	207,205
Germany				308,962	309,313	310,413
Greece	22,373	22,687	22,909	23,098	23,198	23,206
Hungary			44,917	48,139	50,324	52,311
Ireland			4,948	5,024	5,052	5,152
Italy	185,044	194,370	204,112	212,470	216,524	217,574
Poland		74,820	76,679	79,994	80,031	82,031
Portugal		77,256	79,581	81,929	84,137	86,037
Romania	78,236	81,617	85,656	89,957	94,176	97,692
Slovakia	20,042	20,891	21,756	22,555	22,998	23,041
Slovenia	10,846	11,060	11,287	11,501	11,662	11,729
Spain	234,837	239,484	244,115	248,119	251,562	252,951
Sweden	41,817	43,354	45,114	45,832	45,934	46,132
United Kingdom	40,071	41,017	41,886	42,641	43,227	43,415
TOTAL	963,434	1,147,853	1,234,845	1,618,124	1,642,776	1,654,760

Notes: Observations for firms in Orbis by country and year, for which data on total assets of firm is available.

unlike zombie B definition, young companies (2-5 years) display the lowest share of zombies (4.5%) while 21-40 years old firms display the largest share (nearly 7.7%); the latter is considerably higher than the former (70%). The share of zombies then drops to 7.2% among oldest companies (41+).

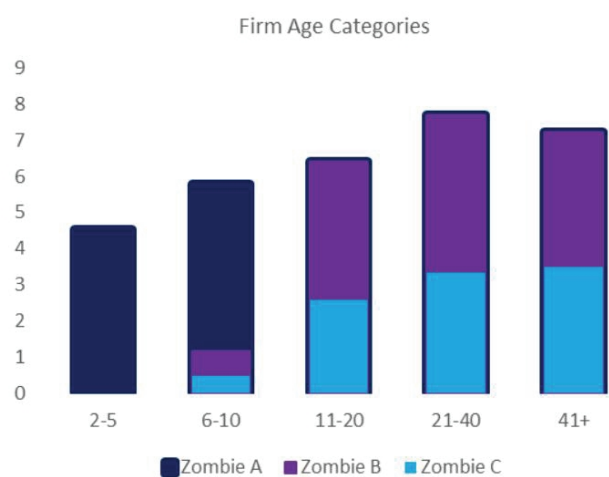


Figure 1. Zombie firms distribution by size and age category, 2013

Notes: The figures report the shares of zombie firms by category. The left-hand figure reports the share of zombie firms by size category; the right-hand figure reports the share of zombie firms by age category. We use three definitions of zombies.

The patterns of zombie incidence as a function of firm age and size described above are consistent with Hoshi (2006) and Adalet McGowan et al.^[1,3](Figure 4), although the latter estimates are higher in absolute values. For instance, Adalet McGowan et al.^[1] find that the highest share of zombie in age categories is 11.5% at the higher end (41+). In most categories, our estimates are within a +/- 0.5 percentage points range compared to the estimates by Adalet McGowan et al.^[1], but estimates for the oldest firms differ considerably. As regards size in terms of number of employees, the overall patterns of estimates are similar although our point estimates are about 2-4 percentage points smaller than those reported in Adalet McGowan et al.^[1].

Thus, our results confirm that the share of zombie firms increases with age and size. These patterns can be explained in various ways. First, larger and older firms are least opaque: they have longer track records, provide more reliable financial reports, and may have established longer term lending relationships with banks. Such firms may have built a reputation as regards their ability to cope with temporary spells of profitless years, which might justify refinancing viewed from the point of the bank. Moreover, the sunk costs of loan restructuring and potential need for additional capital tend to be higher for large firms. Young companies are less likely to benefit from such considerations.

4.2 Share of Zombie Firms by Country

This section reports estimates of the total share of zombie firms by country for 2010 and 2013. Two measures are considered. First, we calculate the share as the ratio of the number of zombie firms in a country to the total number of firms in this country in our sample. Then we compute the ratio of the total amount of fixed assets (capital stock) held by zombie firms to the total fixed assets in the same country in our sample. The latter measures the so-called sunk capital; sunk capital is the figure we will use for the analysis of the spill-overs of zombie firms on non-zombies.

The results for the first measure are shown in Figure 2. The share of zombie firms increases between 2011 and 2013, except in Great Britain and Ireland. The jump in the share of zombie firms is striking in Greece, Spain, Portugal, and Italy, which are countries that were particularly affected by the European sovereign debt crisis. Ireland, which was affected by the global financial crisis, but less so by the subsequent European sovereign debt crisis, experiences a decline from 2010 to 2013, although at high levels. By contrast, estimates for Bulgaria suggest a jump, although at a comparatively low level. The direction of

changes over time and the absolute numbers are broadly similar to Adalet McGowan et al.^[1], although the estimates in absolute numbers differ for Sweden. Our estimates are slightly lower than Adalet McGowan et al.^[1]; Slovenia (slightly higher); Belgium (much lower); France (much higher); and Italy (highest share of sunk capital in Adalet McGowan et al.^[1], but ranked only average here). Annex C reports more details on the differences between estimates; these could facilitate reconciliation of differences in results, although such reconciliation is beyond the scope of the present report.

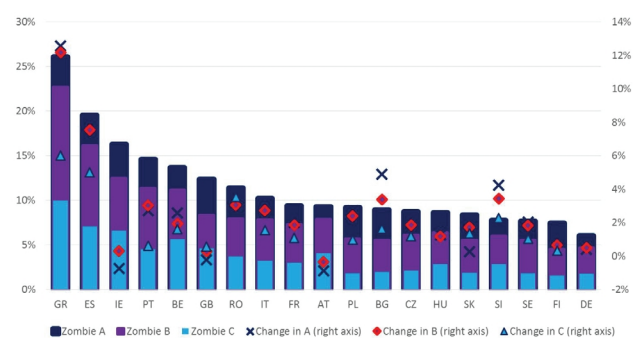


Figure 2. Zombie firms incidence by country -- Number of zombie firms as of total firms

Notes: The share of zombie firms by country in 2013, identified by bars and calculated as the number of zombie firms over total number of firms. Change in percentage points of zombie shares between 2010 and 2013 shown as crosses, diamonds and triangles, for zombie firms A, B and C, respectively. Note that data limitations do not allow us to show triangles for Germany and Ireland.

The results for the second measure are shown in Figure 3. As background, this measure is obtained as the total amount of funding allocated to zombie firms which thus cannot be allocated to other firms. Following Adalet McGowan et al.^[1], it is referred to as sunk capital and obtained by using the book value of fixed assets as reported in Orbis. Unlike Adalet McGowan et al.^[1] though, we did not calculate the real stock of capital.^② The figure highlights substantial discrepancies across countries. More than a fourth of Greek corporate capital is estimated to be held by zombie firms, while zombie firms in Slovakia, Czech Republic, and Finland hold less than 5% sunk capital. Countries that were most affected by the European crisis are not necessarily those displaying the largest share. For instance, Belgium, France and Great Britain have greater or similar shares of sunk capital as do Italy and Portugal. In general, new entrants to the European Union (e.g., Slovakia, Czech Republic, Hungary, Romania and Poland) are less affected by the issue of sunk capital than other EU members. While Belgium, Bulgaria and

Germany are estimated to have a low number of zombie firms, they rank less favourably in terms of the share of sunk capital. By contrast, the sunk capital share is low in Ireland, but the number of zombie firms relatively high. Comparing these estimates with Adalet McGowan et al.^[1], the overall magnitudes are fairly similar, with estimates ranging from somewhat less than 5% to 20%. Considering country-specific estimates, results are similar for Spain, Belgium and Portugal. Higher results are obtained here for Great Britain (about 12 instead of 7), France (13 instead of 8). Lower results are obtained for Italy (13 instead of 20), Austria (7 instead of 9) Finland (4 instead of 7).

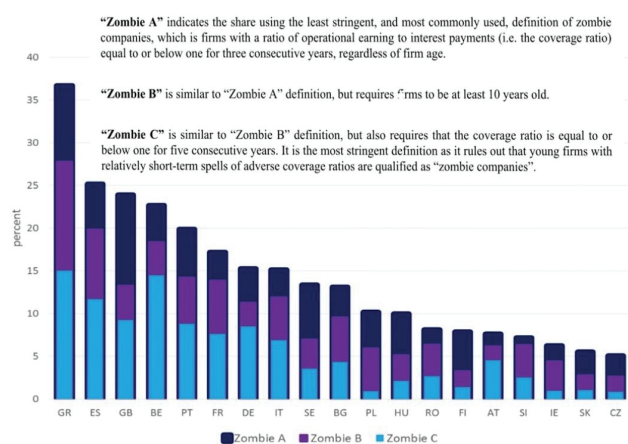


Figure 3. Zombie firms incidence by country – Ratio of fixed assets held by zombies to total assets.

Notes: Estimates of the share of sunk capital in 2013. Sunk capital is the share of capital held by zombie firms as of fixed assets held by all firms in the respective country.

4.3 Effects of Zombie Firms on Non-zombie Firms

The incidence of zombie firms, discussed in the previous section, may affect the development of non-zombie firms in the same economy or sector. At least three potential channels for such spill-overs can be distinguished. First, by "absorbing" bank capital at prices unfairly low given their riskiness, zombie firms add to pressures facing healthy non-zombie firms to obtain bank financing. Healthy non-zombies might be forced to contract loans at higher rates, and at one point the rates might be so high that the firms will decide to rely on internal financing (i.e., reduce dividends and reinvest earnings) as opposed to external financing, which might penalize overall investment and subsequently growth. Second, zombie firms compete with non-zombie firms on product markets. Given their low profitability and financially weak situation, zombie firms may increase risk in an attempt to gamble for redemption^[5]. Any financial subsidies that zombie firms receive from banks allows the former to exert such

product market competitive pressure on healthy firms for longer periods than would have otherwise been feasible. In a way, unhealthy zombie firms keep a share of products sales away from healthy non-zombie firms, which would need to reduce prices to recuperate "lost" product sales. Third, a similar mechanism might operate in labour markets – zombie firms increase salaries so as to retain workforce, and are thus "crowding out" the labour market for healthy zombie firms. As a result of the various types of competitive pressures, healthy non-zombie firms face a lower growth potential. In response to this situation, healthy non-zombie firms will renew only relative more productive incumbent projects, which will have the effect that the latter gradually increase their overall productivity. There is evidence that these various conceptual considerations are reflected in the data. For example, Caballero et al. (2008) and Adalet McGowan et al.^[1,5] find that the incidence of zombie firms penalizes the growth of non-zombie firms. In fact, they find that the share of assets (total assets or fixed assets) held by zombie firms in a sector affects the growth in employment and investment of healthy zombie firms in that sector. There is also evidence that non-zombie firms become more productive in response. To investigate the effects of the incidence of zombie firms on the performance of non-zombie firms, we estimate the following empirical model of firm performance:

$$Firm\ performance_{i,y} = non-zombie_{i,y} + non-zombie_{i,y} \times zombie\ share_{c,y} + Age_{i,y} + Size_{i,y} + Industry-year-country\ fixed\ effects \quad (1)$$

The firm performance model (1) is estimated using all firms in our sample, i.e. zombies and non-zombies, and its specification follows Adalet McGowan et al.^[1]. The dependent variable is one of four indicators capturing the performance of firm *i* in year *y*.

a. The first performance indicator is $\ln(I/K)_{i,y}$, the ratio of capital stock investment of the firm between year *t-1* and *t*; it is equal to $\ln[FA_t/FA_{t-1}] = \ln(FA_t) - \ln(FA_{t-1})$.

b. The second indicator is $\Delta \ln(employment)_{i,y}$, the log difference in the number of employees; it measures the employment growth of the firm. An alternative is to use growth of sales, but we consider that the number of employees is preferable as it is less volatile than financial indicators such as sales. Unfortunately, the number of employees is reported by fewer firms in the Orbis dataset than sales, implying that we lose some observations.

c. The third indicator is Labour productivity, here measured by the natural logarithm of the ratio of the value added by the firm compared to the number of its employees. In particular, we proxy value added by adding profits (EBIT = after depreciation, before interest and tax payments) to the cost of salaries. This estimate is frequently

used in firm-specific productivity analysis and avoids the issue of limited availability of data on added value per firm in Orbis.

d. The fourth indicator is MFP*, an estimate of the multifactor productivity gains of the firm. We estimate a Cobb-Douglas productivity function of added value determined by the total fixed assets and the number of employees. The estimated model of the production function is $0.9 \cdot \text{Labour} + 0.2 \cdot \text{Capital}$. The residuals provide with the productivity gain of each firm.

Explanatory variables are $\text{non-zombie}_{i,y}$, a dummy that takes the value one if firm i is a zombie firm in year y , using alternatively the three zombie-firm definitions; $\text{zombie share}_{c,y}$, the share of total capital in sector c and country y held by zombie firms; $\text{non-zombie}_{i,y} \times \text{zombie share}_{c,y}$, an interaction variable between $\text{non-zombie}_{i,y}$ and $\text{zombie share}_{c,y}$; age, the age of the firm which equals the difference between the year of report and the year of incorporation; size, the number of employees. We added interacted industry-year-country fixed effects, where industry is the firm's two digits NACE Rev. 2 code. All variables are defined in Annex A.

The analysis focuses on the variables $\text{non-zombie}_{i,y}$ and $\text{non-zombie}_{i,y} \times \text{zombie share}_{c,y}$. The former captures the difference between non-zombie and zombie firms. The latter captures the effects of the share of zombies on non-zombie firms.

4.3.1 Effects of Zombie Firms on Investment and Growth of Non-zombie Firms

We first look at the investment and growth of non-zombie

firms. The results of the estimates are reported in Table 2 in three panels, which take into account the three definitions of zombie. We find that non-zombie firms invest and grow more than zombie firms at high significance standards, regardless of the definition of zombies we consider. Considering zombie B definition, a firm switching from zombie to non-zombie would gain $0.072/0.469 = 15.4\%$ of the standard deviation in terms of $\ln(I/K)$.

The growth of non-zombies is negatively affected by the existence of zombie firms in their respective countries and sectors, and significantly so at the 1% level. The economic significance is also high; considering the zombie B definition, a non-zombie firm that would switch from an environment with no zombies to one entirely crowded by zombie firms would lose $0.114/0.469 = 24.3\%$ standard deviation of $\ln(I/K)$. As a thought experiment for the most extreme case, non-zombie firms switching from the most extreme sunk capital environment of 27.8% in Greece (definition B) to the lowest sunk capital of 2.7% in Czech republic, would increase $\ln(I/K)$ by $(27.8\% - 2.7\%) \cdot 0.114 = 0.0286$ more than if the switch happened to a zombie. This increase represents 6.10% of the standard deviation increase in investment. Thus, the growth of non-zombies is substantially affected by the existence of zombies in their respective countries.

The significance of the impact on employment growth varies according of the zombie definition, but is negative in all instances. Considering zombie A definition, the share of zombies bears negative effects on non-zombies at one standard level. The economic significance is also high yet lower than the effects on capital growth; switching

Table 2. Effects of incidence of zombie firms on growth of non-zombie firms

	Zombie A		Zombie B		Zombie C	
	$\ln(I/K)$	$\Delta \ln(\text{Employ})$	$\ln(I/K)$	$\Delta \ln(\text{Employ})$	$\ln(I/K)$	$\Delta \ln(\text{Employ})$
Non-zombie firm	0.089*** [0.0025]	0.064*** [0.0018]	0.072*** [0.0023]	0.056*** [0.0017]	0.068*** [0.0025]	0.052*** [0.0020]
Non-zombie firm X zombie firm share	-0.119*** [0.0120]	-0.036*** [0.0095]	-0.114*** [0.0138]	-0.019 [0.0117]	-0.138*** [0.0234]	-0.03 [0.0196]
Mean	0.017	0.049	0.017	0.049	0.017	0.049
Standard deviation	0.469	0.386	0.469	0.386	0.469	0.386
Observations	5,733,207	5,977,604	5,733,207	5,977,604	5,733,207	5,977,604
R-squared	0.019	0.052	0.019	0.052	0.019	0.051

Notes: Estimates of Model (1) of firm performance. Zombie A defines zombies as any firm with coverage ratio less than one in three consecutive years. Zombie B restricts zombie A definition to ten years or older firms. Zombie C restricts zombie B definition to coverage ratio less than one in five consecutive years (see Annex A). The definitions of the variables are reported in Annex B. All specifications control for firm age and size categories, and industry-year-country fixed effects. The last line reports the mean and standard deviation (in square brackets) of the dependent variables. ***, **, * respectively indicates statistical significance at 1%, 5%, and 10% levels.

from zombie free sector to a fully crowded zombie sector implies a loss in standard deviation of $-0.036/0.386=-9.3\%$. Considering zombie B and C definitions, losses are 4.9% and 7.8% respectively, but are insignificant at the 10% level.

4.3.2 Effects of Zombie Firms on Labour and Capital Productivity of Non-zombie Firms

We next look at the effects of zombie firms on the productivity of non-zombie firms. We estimate Model (1) of firm performance and substitute the performance dependent variables with productivity measures. Similar to Caballero et al. and Adalet McGowan et al.^[1,5], we use a proxy of multi-factor productivity MFP. We further investigate the effect on productivity by alternatively considering a proxy for labour productivity, which we construct by scaling the added value by the number of employees, both variables being available in Orbis. Again, the headers zombie A, B, and C columns indicate that we alternatively used zombie A, B, and C definitions.

As expected, and regardless of the specific definition of zombies, healthy non-zombie firms display higher productivity than zombie firms, whichever productivity measure we use. Moreover, consistently with Caballero et al. (2008) and Adalet McGowan et al.^[1,5], non-zombie firms tend to have a higher labour productivity than zombie firms, but the effects of the incidence of zombies on the labour productivity of non-zombies are negative and significant at the 1% level, regardless of the definition of zombies considered. Besides, the effect of the incidence of zombie firms on the MFP of non-zombie firms is found to be

positive, similar to earlier studies. That said, the results are only strongly significant when considering the most restrictive zombie company definition, requiring firms to be unprofitable for at least five consecutive years.

The difference in results obtained here for labour productivity on the one hand and multi-factor productivity on the other might be explained by the use of book value of capital (fixed assets) to calculate multi-factor productivity rather than real capital. An alternative plausible explanation is the observation that it takes firms more time to adjust labour productivity than multi-factor productivity. The immediate effects on productivity of non-zombie firms of a greater incidence of zombie firm are negative but tends to be more positive once the response of non-zombie firms to the situation has more fully played out. Caballero et al.^[5] focus on the ability of firms to implement new and more productive projects. These projects are likely to require the substitution of fixed assets, which is likely to be easier than substituting labour force. Therefore, all-in-all firms may be more productive, but other factors of productivity make up for the drop in labour productivity.

4.3.3 Effects of Incidence of Zombie Firms on Performance of Young Non-zombie Firms

Finally, we investigate to what extent the effects on growth and productivity differ for young non-zombie firms as opposed to non-zombie firms of any age. Caballero et al.^[5] argue that new entrants are most affected by the presence of zombies in their market. As a result of the more intense competition, new entrants would need to be propose more productive project than those pursued by

Table 3. Effects of incidence of zombie firms on productivity of non-zombie firms

	Zombie A		Zombie B		Zombie C	
	MFP	Labour	MFP	Labour	MFP	Labour
Non-zombie firm	0.107*** [0.0049]	0.046*** [0.0043]	0.109*** [0.0055]	0.043*** [0.0051]	0.122*** [0.0055]	0.043*** [0.0051]
Non-zombie firm	0.055* [0.0307]	-0.260*** [0.0243]	0.026 [0.0444]	-0.529*** [0.0512]	0.168*** [0.0633]	-0.529*** [0.0512]
X zombie firm share						
Mean	9.079	9.951	9.079	9.951	9.079	9.951
Standard deviation	0.881	0.940	0.881	0.940	0.881	0.940
Observations	4,663,474	4,758,161	4,663,474	4,758,161	4,663,474	4,758,161
R-squared	0.669	0.739	0.669	0.739	0.668	0.739

Notes: Estimates of Model (1) of firm performance. Zombie A defines zombies as any firm with coverage ratio less than one in three consecutive years. Zombie B restricts zombie A definition to ten years or older firms. Zombie C restricts zombie B definition to coverage ratio less than one in five consecutive years (see Annex A). The definitions of the variables are reported in Annex B. All specifications control for firm age and size categories, and industry-year-country fixed effects. The last line reports the mean and standard deviation (in square brackets) of the dependent variables. ***, **, * respectively indicates statistical significance at 1%, 5%, and 10% levels.

incumbents. Therefore, new entrants are more severely impacted by the share of funds sunk in zombie firms. In order to investigate the hypothesis, we modify model (1) to obtain Model (2) that controls for young firms:

$$Firm\ performance_{i,y} = Non-zombie_{i,y} + Non-zombie_{i,y} \times young_{i,y} + Non-zombie_{i,y} \times zombie\ share_{c,y} + Non-zombie_{i,y} \times zombie\ share_{c,y} \times young_{i,y} + Age_{i,y} + Size_{i,y} + Industry-year-country\ fixed\ effects \quad (2)$$

In particular, compared to Model (1), we add the dummy variable *young_{i,y}* that indicates that firm *i* is young – i.e., six years or younger – in year *y*. We also introduce two interaction variables: *non-zombie_{i,y} x young_{i,y}*, a dummy that captures young non-zombie firms; *non-zombie_{i,y} x zombie share_{c,y} x young_{i,y}*, non-zombie young firms interacted with the share of zombie firms in their respective industries (in a specific country). The estimates of Model (2) are reported in Table 4 (growth) and Table 5 (productivity). Specifically, we are interested in the impact of the share of zombie firms in a sector on the growth and productivity of young non-zombie firms. Notice that considering zombie B and C definitions imply that all young firms are non-zombies, while zombie company definition allows young firms to be either zombies or non-zombies (see also Table A2 in Annex A).

We find evidence that non-zombie young firms grow faster than firms on average, at 1% significance levels, regardless of the zombie definition we use. Interestingly, they add on growth compared to non-young (non-zombie) firms; young non-zombie firms grow about twice as fast as

old non-zombie firms, as reflected in the observation that the estimated coefficient of the variable "non-zombie firm * young firm" in Table 4 is also positive and about the same size as that of "non-zombie firm". The signs and magnitudes of the estimated coefficients are similar to [1], Table A5.

The impact of the share of zombie firms in any sector on the performance of non-zombie firms in that sector is negative overall. Non-zombie firms are "penalized" in their growth in fixed assets investment, although not in terms of employment growth. Young non-zombie firms are negatively affected by the presence of zombie firms in their sector in terms of employment growth, regardless of the type of zombie company definition chosen. By contrast, no significant adverse effect is identified for these firms in terms of their investment. Similarly, no significant adverse effects are identified on the growth in terms of employment of non-zombie firms of any age, and one specification even suggests a significant positive effect. These results differ from Adalet McGowan et al. [1].

Table 5 shows the effects of the share of (zombie firm) sunk cost on productivity of young non-zombie firms. Young non-zombie firms have higher productivity, regardless of the zombie definition and productivity indicator (labour or asset) chosen. The results are significant at the 1% level. The estimates of the effects of the share of zombie firms follows the same pattern as in the estimates of model (1), i.e., MFP* is positively affected at the 1% significance level (except in zombie B definition model), while labour productivity is negatively affected. Young

Table 4. Effects of zombie firms incidence on growth of young non-zombie firms

	Zombie A		Zombie B		Zombie C	
	ln[I/K]	Δln(Employ)	ln[I/K]	Δln(Employ)	ln[I/K]	Δln(Employ)
Non-zombie firm	0.082*** [0.0026]	0.053*** [0.0019]	0.065*** [0.0024]	0.046*** [0.0018]	0.059*** [0.0026]	0.041*** [0.0021]
Non-zombie firm X young firm	0.062*** [0.0022]	0.083*** [0.0033]	0.060*** [0.0022]	0.083*** [0.0031]	0.061*** [0.0019]	0.081*** [0.0027]
Non-zombie firm X zombie firm share	-0.113*** [0.0121]	-0.012 [0.0098]	-0.107*** [0.0139]	0.011 [0.0117]	-0.115*** [0.0237]	0.042** [0.0214]
Non zombie firm X young firm X zombie firm share	0.037*** [0.0140]	-0.038* [0.0197]	0 [0.0170]	-0.092*** [0.0250]	-0.024 [0.0260]	-0.148*** [0.0369]
Mean	0.033	0.070	0.033	0.070	0.033	0.070
Standard deviation	0.492	0.441	0.492	0.441	0.492	0.441
Observations	6,028,707	6,286,636	6,028,707	6,286,636	6,028,707	6,286,636
R-squared	0.029	0.079	0.028	0.078	0.028	0.078

Notes: Estimates of model (2) controlling for young firms. Young is a dummy variable that takes the value one if the firm is six years or younger. Variables are defined in Annex A. ***, **, * respectively indicates statistical significance at 1%, 5%, and 10% level.

Table 5. Effects of zombie firms on productivity of young non-zombie firms

	Zombie A		Zombie B		Zombie C	
	Labour	MFP	Labour	MFP	Labour	MFP
Non-zombie firm	0.029*** [0.0043]	0.094*** [0.0050]	0.062*** [0.0043]	0.115*** [0.0056]	0.049*** [0.0051]	0.131*** [0.0057]
Non-zombie firm X young firm	0.023*** [0.0041]	0.034*** [0.0039]	0.038*** [0.0040]	0.040*** [0.0038]	0.038*** [0.0034]	0.041*** [0.0032]
Non-zombie firm X zombie firm share	-0.222*** [0.0244]	0.086*** [0.0307]	-0.281*** [0.0298]	0.056 [0.0449]	-0.499*** [0.0505]	0.214*** [0.0641]
Non zombie firm X young firm X zombie share	-0.021 [0.0222]	0.036 [0.0239]	-0.025 [0.0281]	0.034 [0.0309]	-0.041 [0.0422]	0.069* [0.0396]
Mean	9.900	9.055	9.900	9.055	9.900	9.055
Standard deviation	0.981	0.901	0.981	0.901	0.981	0.901
Observations	5,205,765	5,064,025	5,205,765	5,064,025	5,205,765	5,064,025
R-squared	0.734	0.658	0.734	0.658	0.734	0.658

Notes: Estimates of model ^[2] controlling for young firms. Young is a dummy variable that takes the value one if the firm is six years or younger. Variables are defined in Annex A. ***, **, * respectively indicates statistical significance at 1%, 5%, and 10% level.

non-zombie firms are not much affected by the zombie firm share, at least not at standard levels of significance (with the exception of the effect on MFP* considering the zombie C definition).

4.4 Persistence of "Zombie Status"

The incidence of zombie firms may be an undesirable effect of the incentives that banking regulation creates on the part of banks. Faced with the alternative of restructuring or extending a loan, a bank may choose to refinance zombie firms rather than restructuring their loans because the latter would reveal substantial losses on existing loans, which would be bad news for shareholders. If the bank's capital is already close to its regulatory threshold, then a large-scale restructuring of its loans might trigger the need for costly recapitalization, which would dilute the value of existing shareholders. There is in fact evidence that more weakly capitalised banks are more forbearing to their creditors than better capitalised banks are Caballero et al. and Acharya et al.^[5,6]. Hence, it is possible that "zombie banks make zombie firms"^[10].

One possibility is that bank forbearance is an optimal response by the bank to what will eventually turn out to be temporary pressure on corporate operating profits. For example, banks may support distressed firms as part of considerations regarding the longer-term benefits of the relationship between bank and borrower (e.g. so-called hausbank relationship). It is feasible that banks hold additional "private" information about their existing

customers, e.g., debt payments records, existing projects, checking accounts, existing suppliers and customers, which enables them to assess the creditworthiness of the borrower with more precision than any outsider. Under those circumstances, banks can effectively provide their existing customers with liquidity insurance^[11].

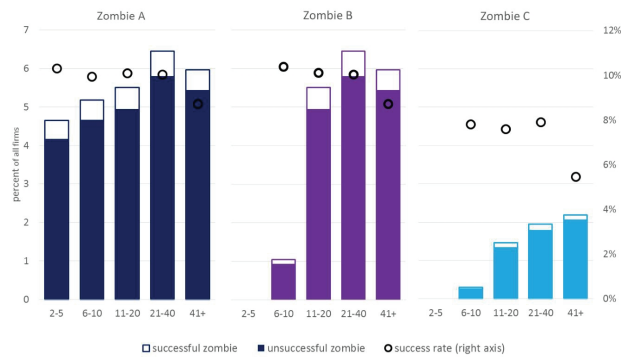
To see to what extent there might be evidence for such effects, we investigate what are the odds that a zombie firm remains a zombie in the next two years, or alternatively, becomes "healthy" again. We refer to "successful" zombies as those firms that are classified as zombies in 2010 or 2013 but that report a coverage ratio above one in the next two years, i.e. making profits again after an extended period without profits.

We compute the share of successful zombies by age and size category considering each of the three zombie definitions. The results are reported in Figure 4; Panel A reports success rates by age category, while Panel B reports success rates by size category. Red part of the bars represents the share of successful zombie firms in the next two years. All numbers are reported in Annex D.

We find that the share of successful zombie firms is 9.73% on average across all categories, varying from 5.47% (zombie C definition, 41+ category) to 11.96% (zombie A definition, 50-99 employee firm category). In other words, about 90% of zombie firms remain zombies in the next two years, or exit from the market and our sample.

Patterns regarding the likelihood of success as a function of firm size are hard to detect. Zombie A definition

Panel A: Share by age



Panel B: Share by number of employees

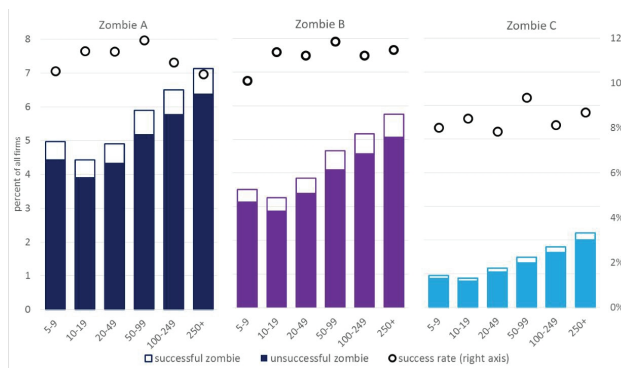


Figure 4. Zombie status persistence

Notes: Share of successful zombies, defined as zombie firms identified as such in 2010 but that have generated positive profits in the subsequent two years. We consider the three zombie A, B, and C definitions, and distinguish firms by age (Panel A) and employee size category (Panel B). The bar represents the share of zombies in 2010 (left axis), with the red (blue) colour part of the bar representing the successful (unsuccessful) zombies. Circles represent the share of successful zombies (right axis).

implies an inverse U-shape, with large firms 250+ employee firms having the lowest rate of success (10.46%), while zombie B and C definitions suggest an upward trend with respect to size (11.5% zombie B, 8.71% zombie C). By contrast, firm age correlates negatively with the success rate. Zombie A definition shows that the success rate falls from 10.29% for firms aged 2-5 years to 8.71% for firms aged 41+; the rate is thus 15.4% lower. Considering zombie B and C definitions, estimates drop from 10.35% and 7.80% to 8.71% and 5.47%, respectively (thus equivalent to declines by 15.9% and 29.9%, respectively). Older companies are thus particularly likely to remain zombies once they enter such status.

One question is what role policy intervention might play in this context³. For example, numerous financial support arrangements exist for firms with up to 250

employees and, in principle, the availability of such support pro-programmes might explain why some firms can continue to operate even if they fail to generate profits for extended periods of time. One way to look at this issue is to see whether there is a break in the series of the cumulative incidence of zombie company rate around the threshold of 250 employees, e.g. to detect whether there are more zombie companies among companies that are just below that threshold than there are among companies that are just above that threshold and thus do not qualify for any financial support.

Another issue that could be addressed in future work is that of the incidence of zombie firms across different sectors. Caballero et al.^[5] argue that the less a sector is subject to international competition the larger the share of zombie firms, given that banks tend to find it more difficult to subsidize firms in sectors characterized by tight international competition. The authors find that manufacturing is the sector that is most subject to international competition, and construction the least. In fact, it turns out that manufacturing displays the lowest share of zombie firms in Japan, while construction the largest. Figure 5 reports the share of zombies by sector in 2013 in our sample. It shows that while the construction sector is characterized by above-average rates of incidence of zombie firms, the relative incidence of zombie firms is even higher in the manufacturing sector. This result contrasts with the estimates in Caballero et al.^[5].

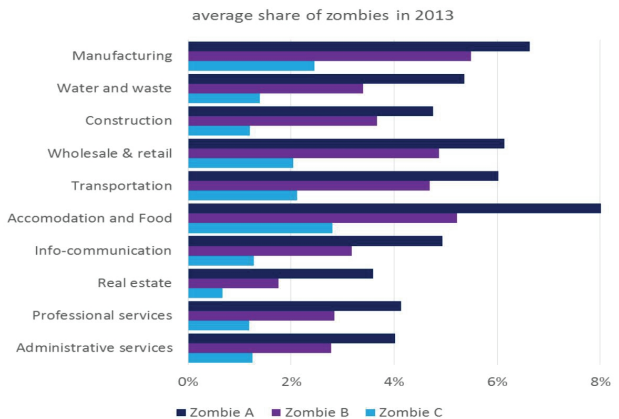


Figure 5. Incidence of zombie firms by sector

Notes: Zombie company incidence by sectors in 2013, full sample.

5. Conclusions

The report identifies the incidence of zombie firms across European countries and the effects of such incidence on the asset growth, employment growth and productivity of non-zombie firms. Using the example of Japan, Peek and Rosenberg (2005) and Caballero et al.^[4,5], each using different definitions of zombie firms, find that the larger

the share of zombies in a sector, the lower the growth and investment decisions of non-zombies, and the larger the productivity of the latter. Adalet McGowan et al.^[1] using yet another definition of zombie firms, identify similar results for a sample of twelve European countries and Korea. We extend the analysis of Adalet McGowan et al.^[1] and include additional European countries and consider three different zombie firm definitions to ensure robustness of estimation results. We confirm that the larger the share of zombie firms in a country the lower the growth of non-zombie firms in that country, and the larger tends to be the productivity of the latter. Young non-zombie firms are most affected by such zombie "congestion" effects. In addition, we find that zombie firms are spreading in Europe. Against this background, the results of the present report suggest that one should indeed fear the spread of zombie firms in Europe.

The limits of the present analysis need to be recognised. Data coverage by Orbis is uneven across years and countries and sample changes cannot be clearly attributed to exit and entry of firms from and to the market, but often reflects artefacts of the way data is reported and collected. Another limitation is that it is not clear what an appropriate share of zombie companies for an economy might be, although a priori, lower shares would appear to be preferable than higher shares. But what might be a natural level of zombie companies and how does that level vary as a function of the conjunctural environment? It should be noted that the zombie companies identified here do not ultimately fail with certainty. In fact, our results suggest that especially young and small firms might ultimately (or again) achieve profitability. Such cases can be seen as evidence of the desirable effects of so-called Hausbank relationships between banks and their customers, whereby banks provide financing through difficult periods when its borrowers have low or no firm operating profits before they ultimately return to profitability. Obviously, to the extent that they never become healthy again and are kept alive artificially through forbearance on the part of banks or through subsidies provided through public financial support programmes, resources are inefficiently trapped among zombie firms. Follow-up work could investigate under what circumstances distorted incentives on the parts of banks and publicly supported financial support programmes are contributing to the incidence and spread of zombie firms.

Foot Note:

- ① Authors use short-term debt (less than a year), long-term debt (more than a year), outstanding bond and commercial papers. They relate financial expenses of the firm (including interest payments and fee payments) to the estimated

amounts. The number is compared with the equivalent lowest market rate the firm should pay controlling for maturities and bond amounts.

- ② Selected NACE Rev. 2 sectors (code in brackets) are: Manufacturing (10-33); Electricity and Water supply services (35-39); Construction (40-43); Wholesale and retail services (45-47); Transportation (49-53); Accommodation and Food services (55-56); Information and Communication services (58-63); Real estate services (68); Professional Services (77-83).
- ③ The sample chosen by [1] consists of the thirteen OECD countries: Austria, Belgium, Finland, France, Germany, Italy, Luxembourg, Portugal, Spain, Slovenia, South Korea, Sweden, and the United Kingdom. Compared with ^[1], we exclude South Korea (non-EU member) and Luxembourg, and add Bulgaria, Czech Republic, Greece, Hungary, Ireland, Poland, Romania, and Slovakia.
- ④ Missing interest payments are substituted by financial expenses. Financial expenses typically include interest payments plus fees on loans.
- ⑤ The real stock of capital is calculated using the Perpetual Inventory Method: for each firm the deflated values of past depreciations and changes in fixed assets are added up. This allows to compare the value of fixed assets acquired in say, 2005, with new fixed assets purchased in 2013. Fixed assets deflation factors are sector and country specific. Similar to ^[1], we removed outliers defined as observations for fixed assets that are equivalent to 100 times the 99th percentile value.
- ⑥ This question was raised plainly by an OECD Secretariat presentation (which drew on collaborative work on financial support programmes for SMEs undertaken in collaboration with the EC JRC) at a meeting of the OECD Committee on Financial Markets in October 2016. The presentation made explicit reference to the preliminary report produced by ^[1] and, subsequently, the latter authors kindly agreed to present their findings at the EC JRC. The question regarding the potential role of policy intervention remains relevant. Another report prepared by the OECD Secretariat in collaboration with the JRC ⁽¹²⁾ suggests that the potential economic costs of such interventions (which would include artificially keeping alive zombie firms through subsidised credit) are often not considered as part of performance assessments of publicly supported credit guarantee programmes, owing in particular to the lack of data that would allow a rigorous analysis including the construction of a proper counterfactual.

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Annex A – Alternative definitions considered for zombie firms

Annex Table A1 presents the three zombie definitions. The first one (zombie A) defines zombies as firms with a coverage ratio below one in three consecutive years, regardless of age. Coverage ratio is defined as the ratio of EBIT – earnings before interest and taxes, after depreciation – to interest payments. The second definition (zombie B) defines zombies as firms that are ten years or older and have a coverage ratio below one for three consecutive years. The third definition (zombie C) defines as zombies those firms that are ten years or older and have a coverage ratio below one for five consecutive years.

Table A1. Zombie firm definitions

	Age Restriction	Coverage ratio ≤ 1
Zombie A	None	At least 3 consecutive years
Zombie B	≥ 10 years	At least 3 consecutive years
Zombie C	≥ 10 years	At least 5 consecutive years

Notes: Age is the difference between year of report and year of incorporation. Coverage ratio is the ratio of profits to interest payments; earnings are earnings after depreciation, and before interest and tax payments (EBIT). We substitute interest payments with financial expenses whenever missing.

Table A2 shows what the definitions imply in terms of estimates of zombie and non-zombie firms across different age groups. Most notably, under zombie B and C definitions, all firms younger than 10 years are considered non-zombies.

Table A2. Firm age and zombie firm definitions

	3 years < age \leq 6 years	7 years \leq age \leq 9 years	10 years \leq age			
	Zombie	Non-zombie	Zombie	Non-zombie	Zombie	Non-zombie
Zombie A	X	X	X	X	X	X
Zombie B		X		X	X	X
Zombie C		X		X	X	X

Notes: This table reports the three definitions of zombies that we use, and whether it may be classified or not as a zombie and non-zombie in function of age. An X denotes that estimates for the respective category of firms indicated as column headers are available according to the definition shown as the row headers.

Annex B – Definitions of variables

This annex provides the definitions of the variables used,

which are obtained from Orbis (the Moody's Bureau van Dijk Orbis dataset of firm-level financial statements).

Table B1. Definitions of the variables used

Non-zombie	Dummy variable that takes the value one if the firm is not a zombie company. A company is classified as a zombie company in a year if its "coverage ratio = earnings before interest and taxes (EBIT) divided by interest payments" is below one in the previous three years. Zombie companies are ten years or older, unless otherwise specified.
Zombie share	Share of fixed assets held by zombie firms at country and sector 2-digit NACE rev 2 level.
ln(I/K)	Investment ratio; equals the difference in the natural logarithm of total fixed assets between two years.
Δ ln(Employment)	Employment growth; equals the percentage change in natural logarithm of number of employees between two years.
Labour productivity	Labour productivity equals the natural logarithm of the ratio of the sum of profits (EBIT) and wage-cost to employment.
MFP*	Multifactor productivity; equals residuals ϵ from the OLS estimate of the Cobb-Douglas function $\ln(\text{Profit} + \text{Wage Cost}) = -\alpha * \ln(\text{Fixed assets}) - \beta * \ln(\text{employees}) + \epsilon$. where the equation includes country and year fixed effects. Profit is operational profit EBIT. Wage Cost is cost of employees. Fixed assets are total fixed assets (including tangible and intangible assets). We obtain $\alpha = 0.9$, and $\beta = 0.2$. We use these coefficients to predict MFP.
Age	Number of years since year of incorporation.
Young	Dummy variables that takes the value one if the firm is six years or younger.
Ln(Employment)	Natural logarithm of the number of employees.
Industry	Two-digit industry NACE rev 2. Classification code.

Annex C – Additional robustness test

As an additional robustness test and to allow a comparison of our results with those reported by [1], this annex reports the results using a sample of firms that is as close as possible to the one considered by [1]. The sample is thus reduced to 11 countries, which are Austria, Belgium, Finland, France, Germany, Italy, Portugal, Slovenia, Spain, Sweden, and the United Kingdom (note that [1] also include Luxembourg and South Korea for which we unfortunately do not have data). The analysis is restricted to the zombie-firm definition considered by [1], namely, firms that are ten years or older and report three consecutive years with coverage less than one (referred to as zombie B definition in the main text).

As regards the effects of the incidence of zombie firms on non-zombie firms, the signs and magnitudes of estimates are similar to [1] for the investment model. Results are less comparable for the employment model. While the estimated coefficient for non-zombie coefficient is positive in our regressions, as it is in [1], the magnitude of

our estimates is only about half that of [1] (which is 7%). Moreover, our results do not suggest a significant effect (Table C 2). Although we use a simple as opposed to a more elaborate proxy for multi-factor productivity unlike [1], our results are close to the latter for the productivity models.

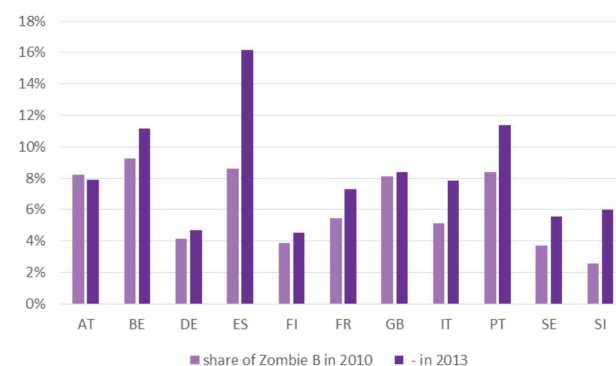


Figure C 1. Incidence of zombie firms in sub-sample
Notes: Figure is similar to Figure 3, but considers only the set of countries considered in [1].

Table C1. Number of observations by country and year in sub-sample

Restricted AAM Country Set	code	2008	2009	2010	2011	2012	2013
Austria	AT				36,611	37,203	37,203
Belgium	BE	38,643	39,557	40,608	41,481	41,667	41,667
Finland	FI	20,784	21,696	22,572	23,385	23,990	24,221
France	FR	189,535	194,889	200,039	204,149	206,600	207,205
Germany	DE				308,962	309,313	309,313
Italy	IT	185,044	194,370	204,112	212,470	216,524	216,524
Portugal	PT		77,256	79,581	81,929	84,137	86,037
Slovenia	SI	10,846	11,060	11,287	11,501	11,662	11,729
Sweden	SE	41,817	43,354	45,114	45,832	45,934	45,934
Spain	ES	234,837	239,484	244,115	248,119	251,562	252,951
United Kingdom	GB	40,071	41,017	41,886	42,641	43,227	43,415
Subtotal		761,577	862,683	889,314	1,257,080	1,271,819	1,276,199

Notes: This table reports the distribution of firms when the sample is restricted to contain only the countries considered by ^[1] (referred to as AAM in the table).

Table C2. Effects of zombie firms incidence on performance of non-zombie firms for sub-sample

	[1]	[2]	[3]	[4]
	ln (I/K)	Δ ln(Employ)	Labour productivity	MFP
Non-zombie B	0.064*** [0.0029]	0.043*** [0.0020]	0.049*** [0.0041]	0.064*** [0.0061]
Non-zombie B x zombie B share	-0.097*** [0.0171]	0.019 [0.0147]	-0.230*** [0.0315]	0.155*** [0.0529]
Firm age and size controls	Yes	Yes	Yes	Yes
Industry-year-country fixed effects	Yes	Yes	Yes	Yes
Observations	2,837,475	2,844,864	2,834,569	2,810,461
R-squared	0.03	0.068	0.455	0.361
Dependent variable:				
Mean and [standard deviation]	0.036 [0.452]	0.045 [0.379]	10.251 [0.568]	9.298 [0.574]

Notes: Estimates of Model (1) of firm performance. We restrict the sample to the countries considered in ^[1] and use zombie B definition only. Zombie B defines zombies as any firm aged ten years or older and with coverage ratio less than one in three consecutive years. The definitions of the variables are reported in Annex B. All specifications control for firm age and size categories, and industry-year-country fixed effects. The last line reports the mean and standard deviation (in square brackets) of the dependent variables. ***, **, * respectively indicates statistical significance at 1%, 5%, and 10% level.

Table C3. Effect of incidence of zombie firms on performance of young non-zombie firms for sub-sample

	[1]	[2]	[3]	[4]
	ln (I/K)	Δln(Employ)	Labour productivity	MFP
Non-zombie B	0.067*** [0.0028]	0.046*** [0.0019]	0.049*** [0.0040]	0.067*** [0.0057]
Non-zombie B x young	0.075*** [0.0035]	0.086*** [0.0042]	0.034*** [0.0039]	0.015*** [0.0056]
Non-zombie B x zombie B share	-0.108*** [0.0173]	0.011 [0.0131]	-0.219*** [0.0299]	0.132*** [0.0487]
Non-zombie B x zombie B share X young	0.109*** [0.0251]	0.089*** [0.0323]	-0.067** [0.0281]	0.159*** [0.0489]
Firm age and size controls	yes	yes	yes	yes
Industry-year-country fixed effects	yes	yes	yes	yes
Observations	2,837,475	2,844,864	2,834,569	2,810,461
R-squared	0.032	0.072	0.456	0.361
Dependent variable				
Mean and (standard deviation)	0.036 [0.452]	0.045 [0.379]	10.251 [0.568]	9.298[0.57]

Notes: Estimates of Model (1) of firm performance. We add young, a dummy variable that takes the value 1 if the firm is 6 years old or younger. We restrict the sample to the countries considered in ^[1] and use zombie B definition only. Zombie B defines zombies as any firm aged ten years or older and with coverage ratio less than one in three consecutive years. The definitions of the variables are reported in Annex B. All specifications control for firm age and size categories, and industry-year-country fixed effects. The last line reports the mean and standard deviation (in square brackets) of the dependent variables. ***, **, * respectively indicates statistical significance at 1%, 5%, and 10% level.

Annex D – Persistence of zombie status

The following tables report the figures we used in Figure 1 and Figure 4. Notice that firms aged less than 10 years

cannot be identified as zombies under zombie B and zombie C definitions (See Annex A).

Table D1. Zombie firms and "success" rate

	Zombie A		Zombie B		Zombie C	
	% zombies	% success	% zombies	% success	% zombies	% success
Number of employees						
5-9	4.96	10.58	3.52	10.13	0.95	8.03
10-19	4.43	11.47	3.26	11.40	0.87	8.43
20-49	4.90	11.45	3.85	11.25	1.16	7.85
50-99	5.89	11.96	4.67	11.86	1.48	9.36
100-249	6.50	10.97	5.17	11.25	1.79	8.14
250+	7.13	10.46	5.75	11.50	2.21	8.71
Firm age in years						
2-5	4.65	10.29				
6-10	5.18	09.92	1.05	10.35	0.29	7.80
11-20	5.50	10.09	5.50	10.09	1.46	7.61
21-40	6.45	10.02	6.45	10.02	1.95	7.92
41+	5.96	08.71	5.96	08.71	2.18	5.47

Notes: "Success" is defined as a situation, where a firm identified as a "zombie" either in 2010 or in 2013 and generates profits that outweigh interest rate expenses during the subsequent two years. The "success rate" measures the proportion of such successful companies as of all zombie companies in the respective category.