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The Walking Dead? Zombie Firms and Productivity Performance in OECD Countries

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ABSTRACT/RÉSUMÉ

The Walking Dead? Zombie Firms and Productivity Performance in OECD Countries

This paper explores the extent to which "zombie" firms – defined as old firms that have persistent problems meeting their interest payments – are stifling labour productivity performance. The results show that the prevalence of and resources sunk in zombie firms have risen since the mid-2000s and that the increasing survival of these low productivity firms at the margins of exit congests markets and constrains the growth of more productive firms. Controlling for cyclical effects, cross-country analysis shows that within-industries over the period 2003-2013, a higher share of industry capital sunk in zombie firms is associated with lower investment and employment growth of the typical non-zombie firm and less productivity-enhancing capital reallocation. Besides limiting the expansion possibilities of healthy incumbent firms, market congestion generated by zombie firms can also create barriers to entry and constrain the post-entry growth of young firms. Finally, we link the rise of zombie firms to the decline in OECD potential output growth through two key channels: business investment and multi-factor productivity growth.

JEL Classification: D24; E22; G32; O16; O40; O47.

Keywords: Productivity; zombie lending; misallocation; investment; firm exit.

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Les Morts-Vivants ? Entreprises Zombies et Productivité dans les Pays de l'OCDE

Ce document examine dans quelle mesure les entreprises "zombies" – définies comme les entreprises de plus de dix ans rencontrant des problèmes persistants dans le remboursement de leurs intérêts – nuisent aux performances de la productivité du travail. Les résultats montrent que la prévalence des entreprises zombies et les ressources qui y sont renfermées ont augmenté depuis le milieu des années 2000 et que l'augmentation de la survie de ces entreprises à faible productivité, au bord de la sortie, accroît la congestion du marché et limite la croissance des entreprises plus productives. Une analyse portant sur différents pays sur la période 2003-2013 et contrôlant pour les effets conjoncturels montre qu'au sein d'un secteur, une part plus importante de capital renfermé dans les entreprises zombies est associée à un moindre investissement et une plus faible croissance de l'emploi pour l'entreprise non-zombie typique, et à une réaffectation du capital moins favorable à la productivité. Outre le fait qu'elle limite les possibilités de croissance des entreprises saines en place, la congestion du marché générée par les entreprises zombies peut également créer des barrières à l'entrée et limiter la croissance après l'entrée des jeunes entreprises. Enfin, nous relions l'augmentation des entreprises zombies au ralentissement de la croissance potentielle de l'OCDE à travers deux mécanismes principaux : l'investissement des entreprises et la croissance de la productivité multifactorielle.

Classification JEL: D24; E22; G32; O16; O40; O47.

Mots-clés: Productivité ; prêts zombies ; mauvaise affectation ; investissement, sortie d'activité.

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THE WALKING DEAD? ZOMBIE FIRMS AND PRODUCTIVITY PERFORMANCE IN OECD COUNTRIES

By Müge Adalet McGowan, Dan Andrews and Valentine Millot[1]

1. Introduction and main findings

1. The productivity slowdown over the past decade brings into closer focus the barriers to productivity growth in OECD economies. Firm-level research is increasingly linking the aggregate slowdown to the widening dispersion in productivity performance across firms (Andrews et al., 2016), rising resource misallocation (Gopinath, et al., 2015) and declining business dynamism (Decker et al., 2016). In this context, one source of concern is that firms that would typically exit in a competitive market are surviving, which may weigh on average productivity and potentially crowd-out growth opportunities for more productive firms. In some countries, these problems are likely symptomatic of structural policy weaknesses, particularly with respect to insolvency regimes. But there are reasons to suspect that non-viable firms may also be increasingly kept alive by the legacy of the financial crisis, with bank forbearance, prolonged monetary stimulus and the persistence of crisis-induced SME support policy initiatives emerging as possible culprits. The experience of Japan in the 1990s suggests that the costs to potential output from exit margin distortions are large (Caballero, Hoshi and Kashyap, 2008; Peek and Rosengren, 2005). Yet, there is little systematic cross-country research on the consequences of the prolonged survival of low productivity firms for aggregate labour productivity.

2. This paper uses harmonised cross-country firm-level data to explore the extent to which "zombie" firms – defined as old firms that have persistent problems meeting their interest payments – are stifling labour productivity growth. We show that the prevalence of and resources sunk in zombie firms have risen since the mid-2000s, which is significant given that recessions typically provide opportunities for restructuring and productivity-enhancing reallocation (Caballero and Hammour, 1994). In turn, we argue that the patterns of prolonged restructuring and depressed creative destruction which underlined the Japanese macroeconomic stagnation during the 1990s may be relevant to understanding contemporary productivity developments in some OECD countries. Specifically, we apply the Caballero et al. (2008) framework from their seminal study of Japan to a broader sample of OECD countries over the period 2003-2013. After controlling for cyclical influences at the industry-country level, within-industry analysis shows that a higher share of industry capital sunk in zombie firms tends to crowd-out the growth – measured in terms of investment and employment – of the typical non-zombie firm. Assuming a causal relationship, our estimates imply that business investment by the typical non-zombie firm would have been on average 2% higher in 2013, had the zombie share not risen from its 2007 level, with significantly higher effects in Italy, Finland and Spain.

3. Besides limiting the expansion possibilities of healthy incumbent firms, market congestion generated by zombie firms can also create barriers to entry. Our results suggest that zombie congestion tends to widen the average multi-factor productivity (MFP) gap between zombie and non-zombie firms, and this effect is more pronounced for young firms. The latter provides new empirical evidence in support of Caballero et al. (2008) theoretical conjecture that this larger MFP gap arises because entrants must clear

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a higher productivity threshold to compensate for lower market profitability, as zombie congestion inflates wages relative to productivity and depresses market prices and (non-zombie) market shares. These results are significant given evidence of rising productivity dispersion and barriers to entry (Andrews, Criscuolo and Gal, 2016), and it is likely that the zombie firm phenomenon is closely connected to – and possibly even a driver of – these developments. Moreover, we show that the employment growth of young non-zombie firms is particularly sensitive to zombie congestion. Thus, zombie congestion not only discourages entry but also constrains the ability of those particularly productive young firms to upscale post-entry.

4. While our baseline methodology focuses on the impact of zombie congestion on the growth opportunities of the average non-zombie firm, the concept of the average can be tenuous given that there is widespread heterogeneity in productivity performance within narrowly defined sectors (Syverson, 2004). Specifically, our baseline methodology may understate the aggregate impact if zombie congestion particularly constrains the growth of high productivity firms. Accordingly, we augment the state-of-the-art dynamic reallocation methodology proposed by Foster, Grim and Haltiwanger (2016) and find that within a given industry, an increase in the capital stock sunk in zombie firms is associated with a decline in the ability of more productive firms to attract capital. These findings are significant given that rising capital misallocation is emerging as a key explanation of the productivity slowdown in some countries (Gopinath et al., 2015).

5. A counterfactual exercise suggests that had the zombie share not risen from pre-crisis levels, the contribution of capital reallocation to aggregate MFP in 2013 would have been around 0.7% to 1% higher in Italy and Spain, respectively. In other countries, reducing zombie congestion to the lowest level observed within each industry could yield gains to MFP of up to 0.5%. The overall impact on aggregate MFP is likely to be higher, however, due to three factors that are not taken into account. Indeed, the continued survival of zombie firms will: *i) directly* lower aggregate productivity by dragging down unweighted industry level average productivity; *ii)* deter the potential entry of young firms which possess a comparative advantage in radical innovation and which place indirect pressure on incumbents to improve their productivity; and *iii)* potentially hinder the reallocation of resources *across* industries above and beyond their effect on within-industry reallocation patterns which we study in this paper.

6. Since the sample period includes crisis years, one concern is that the rise of zombie firms could be partly a cyclical story as shocks that raise the prevalence of zombie firms can also adversely affect firm performance. We take a number of steps to address this potential critique, including a fixed effect structure that controls for unobserved time-varying country-industry specific shocks and a number of robustness tests. Furthermore, the continued rise in zombie firms after the crisis and the fact that there are no valid reasons for cyclical effects to increase the productivity gap between zombie and non-zombie firms or affect disproportionately more productive firms suggest that there is a structural element to the decline in the efficiency of the exit margin.

7. The next section highlights some key micro-level dimensions of the aggregate productivity slowdown, which bring into closer focus the exit margin and the implications of zombie firms. Section 3 describes the underlying firm-level data and provides descriptive evidence on zombie firms. Section 4 outlines the empirical methodology used to estimate the distortionary effects of zombie firms on non-zombie firm performance and patterns of productivity-enhancing capital reallocation. Section 5 discusses the baseline results, robustness tests and extensions, while Section 6 employs some counterfactual simulations to illustrate the potential relevance of zombie congestion for some key components of potential growth. The final section offers some concluding thoughts, highlights the relevance of the findings for policy and outlines an agenda for future research.

2. Zombie firms, resource reallocation and aggregate productivity

2.1 The aggregate productivity slowdown from a micro perspective

8. The productivity slowdown has sparked a lively debate on its underlying causes and the future of productivity more generally, and underpins the collapse in potential output growth – one metric of societies' ability to make good on promises to current and future generations (OECD, 2016). Indeed, potential output growth has slowed by about one percentage point per annum across the OECD since the late 1990s, which is entirely accounted for by a pre-crisis slowing in MFP growth and more recent weakness in capital deepening (Figure 1; Ollivaud, et al., 2016). At the same time, the slowdown in aggregate labour productivity is particularly concerning in light of three stylised facts from micro evidence, which raise questions about the functioning of the exit margin in OECD economies.

9. First, the level of productivity dispersion within industries has risen over time, implying a widening gap between the more productive and less productive firms. For example, Andrews, Criscuolo and Gal (2016) document a rising labour productivity gap between global frontier and laggard firms, which remains after controlling for differences in capital intensity and mark-up behaviour (Figure 2, Panel A). The authors argue that this productivity divergence is not just driven by frontier firms pushing the boundary outward, but by stagnating laggard firm productivity related to the declining ability or incentives of such firms to adopt best practices from the frontier.[2]

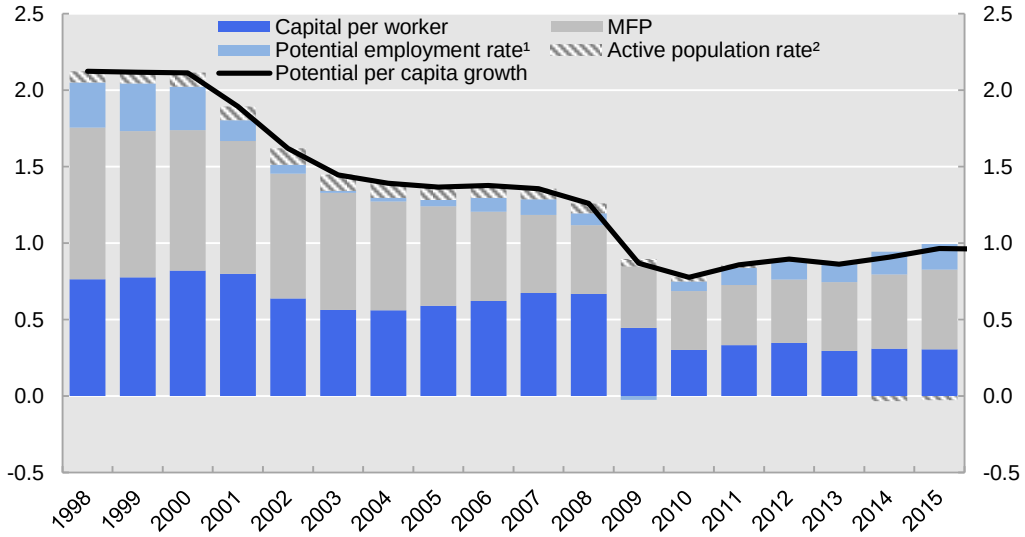
10. Second, rising productivity dispersion has coincided with a decline in a variety of measures of business dynamism, including start-up rates (Figure 2, Panel B), job and worker flows. These trends also imply a rising prevalence of old and small firms in some economies, which can consume scarce resources and crowd-out the growth of more innovative firms (Andrews, Bartelsman and Criscuolo, 2015). The decline in the share of recent entrants has been accompanied by a rising survival probability of marginal firms that would typically exit in a competitive market (Figure 2, Panel C), proxied by the share of old firms that have persistent problems meeting their interest payments (see Section 3). While this pattern was on the rise before the crisis, the continued increase in the share of "zombie" firms in its aftermath is significant given that recessions can be a breeding ground for productivity-enhancing reallocation through the exit or restructuring of low productivity firms (Caballero and Hammour, 1994). This raises questions about whether the "cleansing" effect of the latest crisis has been as large as during previous recessions.[3]

2. Rising productivity dispersion within industries has also been uncovered in other studies that use comprehensive data for the United States (Decker et al., 2016) and cross-country distributed microdata exercises such as MULTIPROD at the OECD (see Berlingieri et al., 2016) and COMPNET at the ECB (see Gamberoni et al., 2016).

3. Unfortunately, available cross-country firm-level data do not go sufficiently far back in time to verify this statistically. However, evidence for the United States suggests that, compared to previous historical episodes, the cleansing effect was much weaker during the Great Recession (Foster et al., 2016).

Figure 1. Decomposition of the growth rate of OECD potential output per capita

Contribution to potential output per capita growth



Note: Assuming potential output (Y*) can be represented by a Cobb-Douglas production function in terms of potential employment (N*), the capital stock (K) and labour-augmenting technical progress (E*) then y* = a * (n*+e*) + (1 - a) * k, where lower case letters denote logs and a is the wage share. If P is the total population and PWA the population of working age (here taken to be aged 15-74), then the growth rate of potential GDP per capita (where growth rates are denoted by the first difference, d( ), of logged variables) can be decomposed into the four components depicted in the figure: d(y* - p) = a * d(e*) + (1-a) * d(k - n*) + d(n* - pwa) + d(pwa - p). Potential employment rate refers to potential employment as a share of the working-age population (aged 15-74), and active population rate refers to the share of the population of working age in the total population.

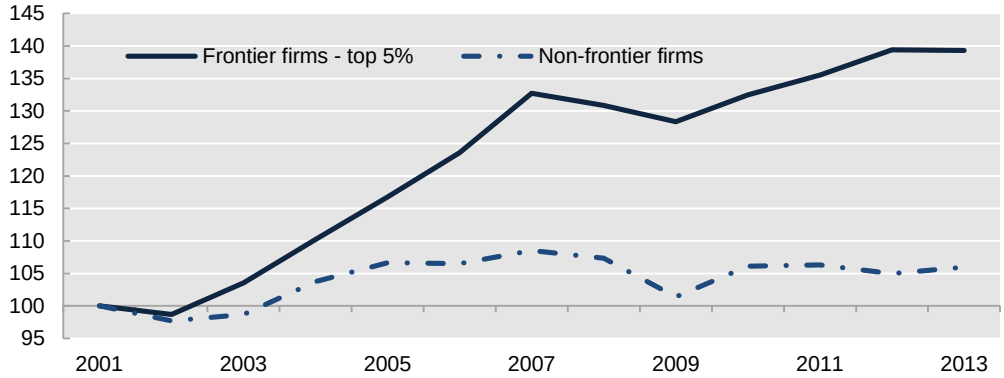
Source: OECD, Economic Outlook 99 database.

11. As discussed in Andrews et al. (2016), the average productivity of recent entrants relative to viable incumbent firms has risen, while the average productivity of firms on the margin of exit has fallen over time. This is in line with the falling labour productivity of zombie firms relative to non-zombie firms between 2003 and 2013 (Figure 2, Panel C). Andrews et al. (2016) note that these patterns are consistent with a decline in the contestability of markets, which implies less indirect pressure on incumbent firms to improve their productivity via technology adoption (Bartelsman, Haltiwanger and Scarpetta, 2004).[4] The corollary is that it has become relatively easier for weak firms that do not adopt the latest technologies to remain in the market. Moreover, the decline in firm turnover coupled with an increase in the implied productivity gap between entering and exiting businesses is what one would typically observe if barriers to entry have risen (Bartelsman, Haltiwanger and Scarpetta, 2009).

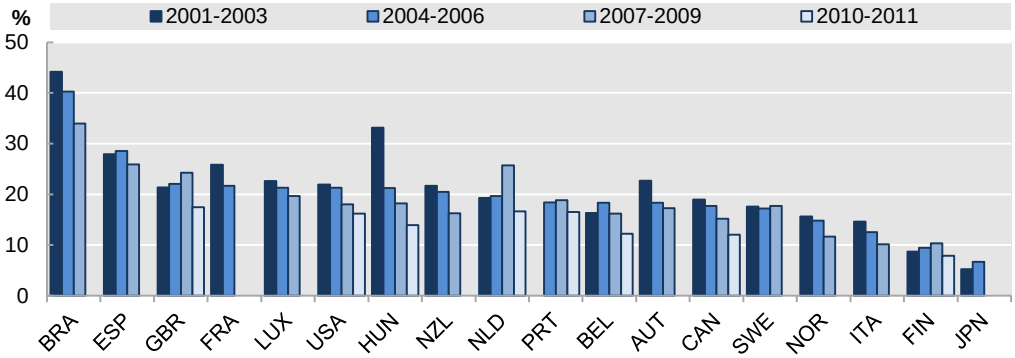
4. For example, using cross-country microdata aggregated to the industry level, Bartelsman, Haltiwanger and Scarpetta (2004) find that productivity growth within incumbent firms is positively correlated with the firm turnover rate.

Figure 2. Micro-level dimensions to the productivity slowdown: dispersion and firm turnover

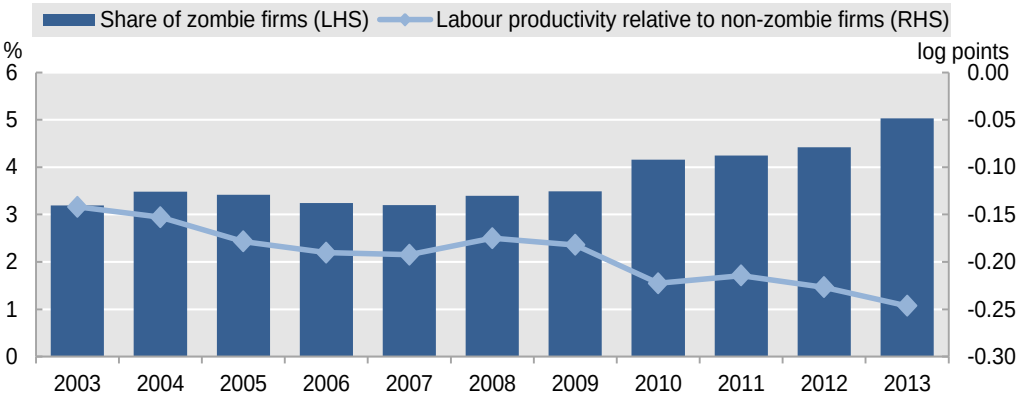
Panel A: Widening productivity gap between frontier and laggard firms; based on 24 OECD countries



Panel B: Declining start-up rates; selected countries



Panel C: The rise of zombie firms; average across 8 OECD countries



Note: Panel A: "Frontier firms" is the average labour productivity (value added per worker) of the 5% globally most productive firms in each two-digit industry. "Non-frontier firms" is the average of all firms, except the 5% globally most productive firms. Included industries are manufacturing and business services, excluding the financial sector. The coverage of firms in the dataset varies across the 24 countries in the sample and is restricted to firms with at least 20 employees. Panel B reports start-up rates (the fraction of firms which are from 0 to 2 years old among all firms) averaged across three-year periods for the manufacturing, construction, and non-financial business services sectors. Panel C shows the share of zombie firms, defined as firms aged ≥10 years and with an interest coverage ratio<1 over three consecutive years, and their labour productivity (based on gross output per employee) relative to other firms, for an unweighted average for Belgium, Finland, France, Italy, Korea, Spain, Sweden and the United Kingdom.

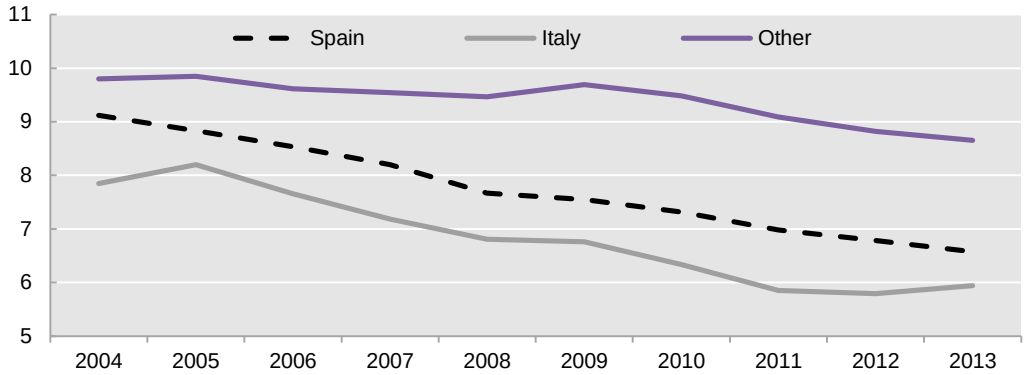
Source: Panel A: Andrews, Criscuolo and Gal (2016); Panel B: Criscuolo, Gal and Menon (2014); Panel C: OECD estimates based on ORBIS.

12. Third, there is evidence that the contribution of resource reallocation to aggregate productivity has declined over time. In the United States, this is reflected in a declining responsiveness of firm growth (employment and investment) to productivity over recent decades, which implies that the propensity of high productivity firms to expand and low productivity firms to downsize or exit has fallen (Decker et al., 2016). Counterfactual simulations show that aggregate labour productivity would have been roughly 2.5% higher in 2013 if their metric of reallocation – i.e. the responsiveness of firm growth to lagged productivity – had returned to the levels observed in the late 1990s, when resource allocation was more efficient.[5] Data for eight European countries and Korea (Figure 3) shows that the implied difference in capital growth between a firm one standard deviation below the industry mean and a firm one standard deviation above the mean has declined by around 2% in Italy and Spain between 2004 and 2013. Moreover, that the decline in the efficiency of capital reallocation is much more apparent in Southern Europe – where policy-induced exit costs are typically higher – than in other OECD countries provides another smoking gun that declining reallocation potential may be connected to the exit margin.

13. Evidence of a decline in productivity-enhancing reallocation is particularly significant in light of rising productivity dispersion, which would ordinarily imply stronger incentives for productive firms to aggressively expand and drive out less productive firms. Instead, the productivity gap between frontier and laggard firms has risen, even while the forces bringing dynamic adjustment are waning. This tension is a red flag that something is wrong with productivity, but also points to a potential deterioration of the exit margin. In the remainder of this paper, we explore the conjecture that weak firms are stifling the recovery in labour productivity, and by implication, potential growth.

Figure 3. Micro-level dimensions to the productivity slowdown: capital allocation

Percentage point difference in capital stock growth of high and low productivity firms



Note: High (low) productivity firms are defined by being one standard deviation above (below) the industry mean multi factor productivity (MFP). The charts show the sensitivity of firm capital growth to firm MFP, based on a firm level regression of the growth in the real capital stock on the lagged deviation of firm MFP from its industry-year average, interacted with time trends (trend and trend-squared). The regressions also control for firm age, firm size classes, industry and year fixed effects. The cross-country regression includes Belgium, Finland, France, Korea, Slovenia, Sweden and the United Kingdom. The results for Spain and Italy are based on regressions for 1999-2014 and 2001-2013, respectively, given better data coverage for a longer time period for these countries. See Table A1 in the Appendix for the regression results.

Source*:* Adalet McGowan, M. and D. Andrews (2017), "Declining Resource Allocation in Spain: Implications for Productivity", *OECD Economics Department Working Paper*, forthcoming.

5. Similar patterns are evident in other studies of capital misallocation, notably: Gopinath et al., (2015), Calligaris (2015), Dias et al. (2015), Gamberoni et al. (2016) and García-Santana et al. (2016).

2.2 Zombie firms, market distortions and productivity

14. In a well-functioning market economy, the creative-destruction process compels poorly performing firms to improve their efficiency or exit the market. However, there are signs from the micro data that this process may be slowing down and a number of factors suggests that there may be a policy dimension to this problem. These include structural policy weakness (e.g. inefficient insolvency regimes), bank forbearance, loose monetary policy and impaired banking systems and the persistence of crisis-induced SME support. Indeed, this confluence of factors has created concerns that "zombie firms" might be holding back potential growth in a number of countries, including Korea, the United Kingdom and Southern Europe (Bank of England, 2013; Bank of Korea, 2013; Acharya et al., 2016).

15. Historically, the distortionary effects of "zombie firms" on healthy firms have been analysed in the context of the Japanese macroeconomic stagnation in the 1990s (Caballero, et al. 2008; Peek and Rosengren, 2005; Hoshi, 2006). These studies have concentrated on forbearance lending, which propped up inefficient firms and encouraged them not to undertake efforts necessary to raise their profitability, as the main reason that zombie firms were kept alive.[6] The effects of such credit misallocation on the economy could be amplified by loose monetary policy to the extent that lowers the opportunity cost for banks to bet on the resurrection of failing firms via forbearance (White, 2012).[7]

16. Indeed, a paper drafted contemporaneously with ours shows that the Outright Monetary Transactions (OMT) Program launched by the European Central Bank in 2012 increased zombie lending motives of banks (Acharya et al., 2016).[8] Using a relatively small sample of large firms, they show that undercapitalised banks used OMT windfall gains to direct loans to zombies to avoid incurring losses on their loan portfolios. In addition, this additional credit to zombie firms did not directly raise real activity but the misallocation of credit adversely affected the investment and employment growth of non-zombie firms due to zombie congestion.

17. The theoretical literature suggests that there are two channels through which zombie firms can contribute to low aggregate labour productivity growth: *i)* zombie firms themselves exhibit low levels of labour productivity; *ii)* zombie firms crowd-out investment by the typical non-zombie firm; and *iii)* zombie firms hinder efficient resource allocation and MFP growth, by either preventing more productive firms from gaining market share, or new and more dynamic firms from replacing inefficient incumbents. Besides these reallocation effects, weak investment by non-zombie firms will also undermine within-firm MFP growth to the extent that new technologies and innovation are embodied in capital (Cooper, Haltiwanger and Power, 1997). Zombie firms can also crowd out new firms' room to experiment with promising but uncertain technologies and business practices, further undermining scope for within-firm productivity gains.

18. In their seminal study of Japan in the 1990s (see Box 1), Caballero et al. (2008) find that zombie-dominated industries exhibit less job turnover and lower investment and employment growth

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6. In this case, banks continued to lend to these firms due to: *i)* relationship banking, whereby the long-standing connection of a bank with a borrower may give rise to perverse ex ante incentives on the part of borrowers, forcing the bank to continue to lend (Chen and Chu, 2003; Nishimura and Kawamoto, 2004); and *ii)* regulatory forbearance that gives perverse incentives to weakly capitalised banks not to realise losses, which in turn would be accentuated by inefficient insolvency regimes (Okamura, 2011).

7. This channel is likely to be reinforced given that the low interest rate environment might be challenging the traditional business models of financial institutions, lowering their profitability and distorting the credit supply (OECD, 2016).

8. This analysis utilises Thomson Reuters LPC's DealScan data on bank-firm relationships in Europe matched with Bureau van Dijk's Amadeus firm-level data.

amongst non-zombie firms. The distortions created by zombie firms via low prices and high wages not only limit the possibility that healthy incumbents expand, but also reduce the profits and collateral that new and more productive firms could generate. Hence, the presence of zombie firms can create barriers to entry, further weakening market selection. In their empirical analysis, Caballero et al. (2008) find that the presence of zombie firms widens the productivity gap between zombie and non-zombie firms since entrants must clear a higher productivity threshold to compensate for the additional barriers to entry that the zombie congestion generates.

Box 1. Zombie congestion and depressed restructuring in Japan

Caballero et al. (2008) explore the effect of zombie firms on growth through two main channels:

- Sclerosis – the preservation of low productivity firms which would exit in the absence of bank subsidies; and
- Scrambling – the retention of firms and projects that are less productive than some of those that do not enter or are not implemented due to the congestion caused by zombies.

Specifically, the model assumes that in an economy without zombie firms, incumbents hit by unfavourable shocks exit and are replaced by entrants hit by favourable productivity draws, increasing aggregate productivity growth. The existence of zombie firms, where subsidised incumbents do not exit when hit by unfavourable shocks, distorts competition through the rest of the economy. Zombie firms can create these distortions by depressing market prices for their products, raising market wages by keeping workers whose productivity at their current firms declined and congesting the markets in general. These distortions adversely affect non-zombie firms that must compete with the inefficient firms for scarce resources and face lower profits due to these lower prices and higher wages.

19. Importantly, the impact of zombie congestion on the growth opportunities of the non-zombie firms and aggregate productivity may be understated if the widespread heterogeneity in firm productivity is not taken into account. Indeed, Table A2 of the Appendix shows that there is considerable heterogeneity in non-zombie productivity performance. This dispersion in firm multi-factor productivity – an average interquartile range of 0.91 corresponding to a productivity ratio of about 2.5 to 1 – can create scope for productivity-enhancing capital reallocation.[9] If the market congestion caused by zombie firms disproportionately affects firms at the higher end of the productivity distribution, the overall negative effect on aggregate productivity will be stronger. Accordingly, the paper also analyses the impact of zombie firms on aggregate productivity through reallocation patterns.

3. Data and cross-country evidence on zombie firms

3.1 Data description

20. We use a harmonised cross-country dataset, where the underlying firm level data are sourced from ORBIS, a commercial database provided to the OECD by the electronic publishing firm Bureau Van Dijk (see Box 2 for details). While ORBIS covers a larger number of countries, the final sample of countries is driven by the availability of data that is necessary to construct MFP and zombie firm measures.[10] Since the analysis of zombie firms requires looking at the bottom of the productivity

9. These calculations show MFP dispersion moments for NACE 2 digit industries based on the sample of nine countries for 2013 (see section 3.1 for details). For all the firms, the average interquartile range of firm-level productivity values is about 0.92. Since MFP is expressed in log-level, this corresponds to a ratio of around 2.50 to 1 between the 75th and 25th percentile firms in an industry's productivity distribution (Table A2).

10. The sample is restricted to countries and years for which ORBIS covers at least 40% of aggregate employment (based on national account figures), and where profit, debt and MFP variables are available for the majority of observations.

distribution and more productive firms are better represented in ORBIS, we adopt a conservative strategy and limit the sample to a set of countries where the data coverage is more complete, especially across time. The analysis is therefore based on a panel of nine countries – Belgium, Finland, France, Italy, Korea, Slovenia, Spain, Sweden and the United Kingdom – for 2003-2013. The cross-section analysis for 2013 adds four additional countries, namely Austria, Germany, Luxembourg and Portugal. The sample is restricted to the non-farm non-financial business sector (NACE Rev.2 codes 10-83, excluding 64-66). The analysis is based on unconsolidated accounts since to avoid duplication when using consolidated accounts, there is a need to use ownership data, which are currently not available.

Box 2. Firm level data

ORBIS is the largest cross-country firm-level database that is available and accessible for economic and financial research. However, since the information is primarily collected for use in the private sector typically with the aim of financial benchmarking, a number of steps need to be undertaken before the data can be used for economic analysis. The steps we apply closely follow suggestions by Kalemli-Ozcan, et al. (2015) and previous OECD experience (Gal, 2013). As discussed in Gal and Hijzen (2016) and Andrews et al. (2016), these data are cleaned and benchmarked using a number of common procedures such as keeping accounts that refer to entire calendar year, using harmonized consolidation level of accounts, dropping observations with missing information on key variables as well as outliers identified as implausible changes or ratios. Monetary variables are deflated using 2-digit industry deflators from OECD STAN and national accounts and prices are expressed in industry purchasing power parities (PPPs).

Following Gal (2013), capital stock variables and firm and industry level productivity measures (labour productivity and multifactor productivity) using several methodologies are created. An estimate of firm level real capital stocks is constructed by deriving the real value of gross investment flows by deflating the difference in the book value of net capital stocks and depreciation between two years and applying the perpetual inventory method to gross investment flows using the book value of fixed tangible assets as the starting value. Three measures of MFP are calculated based on a Solow residual, a residual from OLS regressions based on the estimation of the production function and IV estimation based on Wooldridge (2009).

Nevertheless, a number of issues that commonly affect productivity measurement should be kept in mind, including: *i)* differences in the quality and utilisation of inputs cannot be accounted for as the capital stock is measured in book values; *ii)* firm-level prices cannot be observed, so firm-level differences in measured productivity may also reflect differences in market power; and *iii)* measuring outputs and inputs in internationally comparable price levels remains an important challenge.

21. To address further issues rising from underrepresentation of certain industries and of small and young firms in ORBIS, we also align the ORBIS firm sample with the distribution of the firm population from the Structural Demographic Business Statistics (SDBS) collected by the OECD and Eurostat, based on confidential national business registers.[11] This post-stratification procedure is of course based on the assumption that within each specific cell, ORBIS firms are representative of the true population – an assumption that may be problematic if the nature of selection varies across countries. The robustness of the baseline empirical results is tested by using these weights and also restricting the sample to firms with more than 20 employees.

11. The post-stratification procedure applies re-sampling weights based on the number of employees in each SDBS country-industry-size class cell to 'scale up' the number of ORBIS observations in each cell so that they match those observed in the SDBS (see Gal, 2013). For example, if SDBS employment is 30% higher than ORBIS employment in a given cell, then the 30% 'extra' employment is obtained by drawing firms randomly from the pool of ORBIS firms, such that the 'extra' firms will make up for the missing 30%.

3.2 Cross-country evidence on zombie firms

3.2.1 Identification of zombie firms

22. Past studies of zombie firms have used several definitions, ranging from less restrictive (firms with negative profits) to more restrictive (firms likely receiving subsidised credit), with different advantages and disadvantages. The seminal approach by Caballero et al. (2008) defines zombie firms as those potentially receiving subsidised bank credit. More specifically, actual observed interest payments made by the firm are compared to an estimated benchmark R* based on the firm debt structure and market interest rates. One simplified version of this approach, which is implementable with the data at hand, is the following:

$$R_{i,t}^{*} = rs_{t-1}BS_{i,t-1} + \left(\frac{1}{5}\sum_{j=1}^{5} rl_{t-j}\right)BL_{i,t-j}$$

where $BS_{i,t}$ is the short-term loans (less than one year) and $BL_{i,t}$ is the long-term debt (more than one year) of firm *i* at the end of year *t*, rs_t is the short-term prime rate and rl_t is the long-term rate at year *t* (rs_t and rl_t are both calculated as annual average of monthly rates).

23. This definition is as close as we can get to the measure defined in Caballero et al. (2008), which is hard to replicate exactly with the data available in ORBIS, as it requires very detailed information on the debt distribution of each firm in order to calculate an accurate lower bound measure (distinguishing between short-term and long-term bank borrowings as well as the amount of outstanding corporate bonds). Nevertheless, the use of ORBIS carries the advantage that it allows us to consider a much broader sample of firms than the dataset utilised in Caballero et al. (2008), which focuses on listed firms only.

24. A second approach uses operating characteristics to identify firms with persistent financial weakness. These could include: *i)* firms with an interest coverage ratio (the ratio of operating income to interest expenses) less than one for three consecutive years (Bank of Korea, 2013); *ii)* firms with negative profits (Bank of England, 2013); and *iii)* firms with negative value added. An advantage of these measures is that they are more easily comparable across countries and that ORBIS has the relevant information to construct them, but to the best of our knowledge, none of these measures has been utilised to create cross-country indicators.[12]

25. In the remainder of the paper, we employ a zombie classification based on the interest coverage ratio definition in the baseline analysis. This choice is driven by three main reasons: *i)* interest coverage ratios are better comparable across countries; *ii*) interest coverage ratios are less endogenous to productivity than negative profits; and *iii*) interest coverage ratios encompass channels other than subsidised credit through which zombie firms may be kept alive (e.g. non-performing loans, government guarantees to SMEs, weak insolvency regimes). More explicitly, a firm is defined as a zombie firm in 2013 if it is aged 10 years or older in 2013 and it had an interest coverage ratio less than one for three consecutive years (2011-2013). The age restriction is placed in order to address the fact that it may be difficult to distinguish real zombie firms from young innovative start-ups only based on profitability measures.[13] Looking at the persistence of financial weakness via the three year window somewhat

12. A very recent paper by Acharya et al. (2016) has looked at zombie firms in a number of European periphery countries, but their sample size is limited compared to ours, since they specifically look at firm-bank relationships.

13. In reality, there can be several reasons for a firm to have persistently negative profits. These include: *i)* young firms at the start of their lifecycle which can take a while to start making profits; *ii)* firms with high

addresses the concerns regarding the business cycle effects on the prevalence of zombie firms.[14] Further robustness of the measurement of zombie firms is tested by using various persistence time windows (4 and 5 years instead of 3) and age thresholds (15 and 20 years instead of 10) as well as our modified version of the definition employed in Caballero et al. (2008), as outlined above.

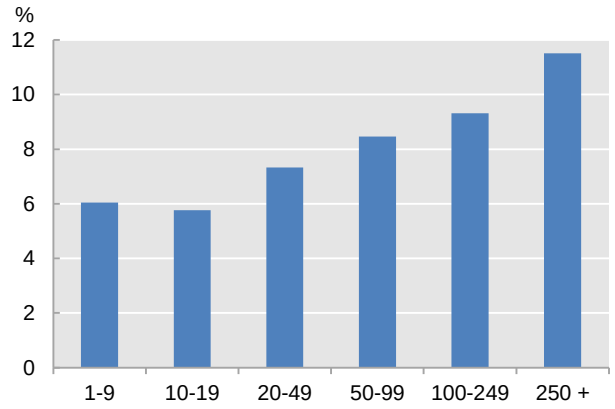
3.2.2 Characteristics of zombie firms

26. Before proceeding, we explore the characteristics of zombie firms, specifically firm age and firm size. A firm is identified as a zombie firm if it has an interest coverage ratio less than one for three consecutive years (2011-2013), but at this stage, we place no restriction on firm age. The estimates below are constructed by taking a simple unweighted average across zombie firms in 13 countries in 2013.

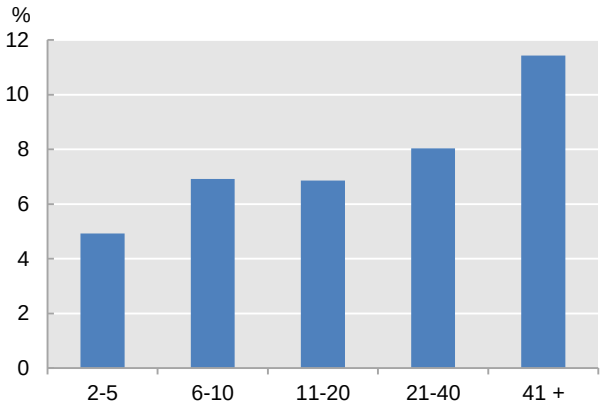
27. Figure 4, Panel A shows that the likelihood of being a zombie firm tends to increase with size. This could be due to the fact that large firms are more likely to receive government subsidies since there is a preference to limit the employment loss due to the exit of large firms, especially during times of crises. Furthermore, banks might have incentives to keep large firms alive due to either relationship banking or bank forbearance (Agostino et al., 2008). This is in line with evidence based on listed firms in Japan, which finds that larger firms are typically more likely to be protected and become zombies, although this pattern tends to reverse for very large firms (Hoshi, 2006).

Figure 4. Characteristics of zombie firms, 2013

A: Share of zombie firms in each size category (number of employees)



B: Share of zombie firms in each firm age category



Note: Share of firms with an interest coverage ratio < 1 over the three years 2011-2013 observed among each size and age groups (average share across countries). The countries in the sample include Austria, Belgium, Germany, Finland, France, Italy, Korea, Luxembourg, Portugal, Slovenia, Spain, Sweden and the United Kingdom.

Source: OECD calculations based on ORBIS.

28. The likelihood of being a zombie firm is higher for older firms, especially firms over 40 years old, which are most likely to have a large number of employees and receive subsidies from banks (Figure

expected future profits which exhibit current weak performance; *iii)* state-owned enterprises that could exist for other reasons than profits. Nevertheless, there remain a number of firms without such characteristics that continue to survive, despite the fact that their exit would raise aggregate growth.

14. In the empirical analysis, the use of a strict fixed effects structure of interacted country, industry and year fixed effects further controls for the potential effect of the business cycle.

4, Panel B). A non-negligible share of young firms (less than 10 years old) also shows weak financial outcomes, which, as already mentioned in Section 3.2.1, may be due to the delay that start-ups face to reach positive economic returns. Thus, firms that are less than 10 years old are excluded from the zombie measure presented in the next sections.

3.2.3 Prevalence of zombie firms

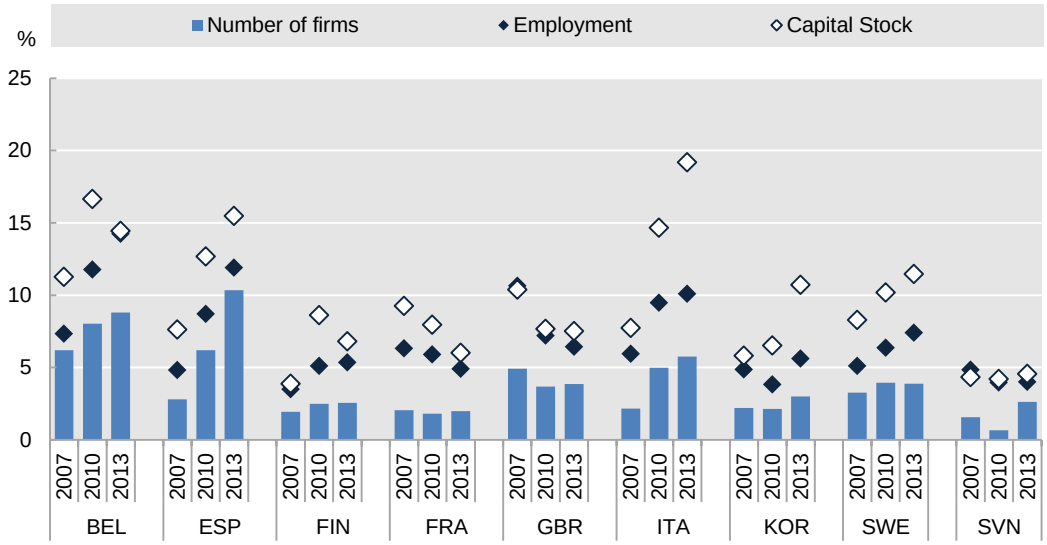
29. Panel A of Figure 5 shows the relative importance of zombie firms, defined as those 10 years or older and with an interest coverage ratio less than one over three consecutive years. For each country, zombie shares are shown for 2007, 2010 and 2013 – for example, the zombie shares in 2007 correspond to the period between 2005 and 2007 – both in terms of the number of zombie firms and for two size weighted measures: the share of industry labour and capital sunk in zombie firms. For presentational purposes and to ensure that the results are not driven by a few large outlier firms and more specifically those with a specific financial structure (e.g. some state-owned enterprises), we exclude firms that are larger than 100 times the 99th percentile of the size distribution in terms of capital stock or number of employees. While there are several differences for some countries, the general pattern across countries and across time remains fairly stable when we reconstruct the zombie estimates using data for all firms (see Figure A2 in the Appendix for estimates based on all firms). [15] In the remainder of the paper, we utilise zombie industry capital shares constructed from the full dataset but the econometric analysis is robust to using zombie shares based on either approach.

30. In Italy in 2013, 6% of firms were classified as zombies, while the share of the capital stock and employment (covered by the ORBIS sample) sunk in zombie firms was 19% and 10%, respectively. Significant cross-country differences also emerge. In 2013, the share of zombies in terms of the number of firms is highest at 10% in Spain, and lowest in France at 2%. The latter is consistent with analysis suggesting that zombie lending is not widespread in France (Avouyi-Dovi et al., 2016). Estimates of the share of the capital stock sunk in zombie firms in 2013 range from under 5% in Slovenia to up to 19% in Italy, while the share of labour sunk in zombies is similarly low in Slovenia and is around 14% in Belgium (Figure 5, Panel A).

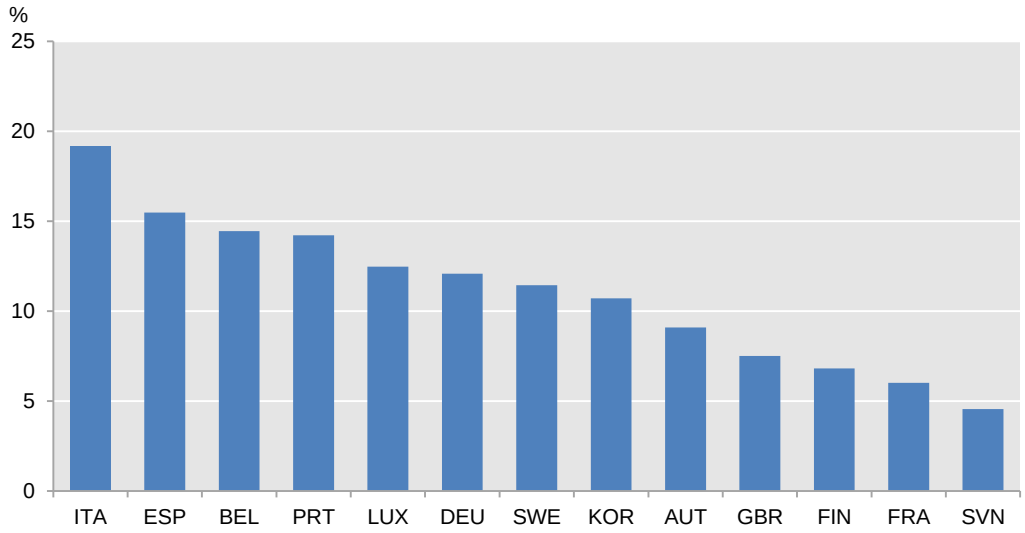
[15] For example, in Finland in 2013, the share of the capital stock sunk in zombie firms is 12% when data for all firms is utilised (see Figure A2), compared to 7% in Figure 5. In Italy, the zombie capital share for 2013 falls from 22% to 19%, when outliers are excluded.

Figure 5. The rise of zombie firms

Panel A: The share of zombie firms over time; 9 OECD countries



Panel B: The share of capital sunk in zombie firms in 2013; 13 OECD countries



Note: Firms aged ≥10 years and with an interest coverage ratio<1 over three consecutive years. Capital stock and employment refer to the share of capital and labour sunk in zombie firms. The sample excludes firms that are larger than 100 times the 99th percentile of the size distribution in terms of capital stock or number of employees. Figure A1 shows zombie shares for two additional countries (Greece and Japan), which are not included in the following empirical analysis due to lack of productivity data.

Source: OECD calculations based on ORBIS.

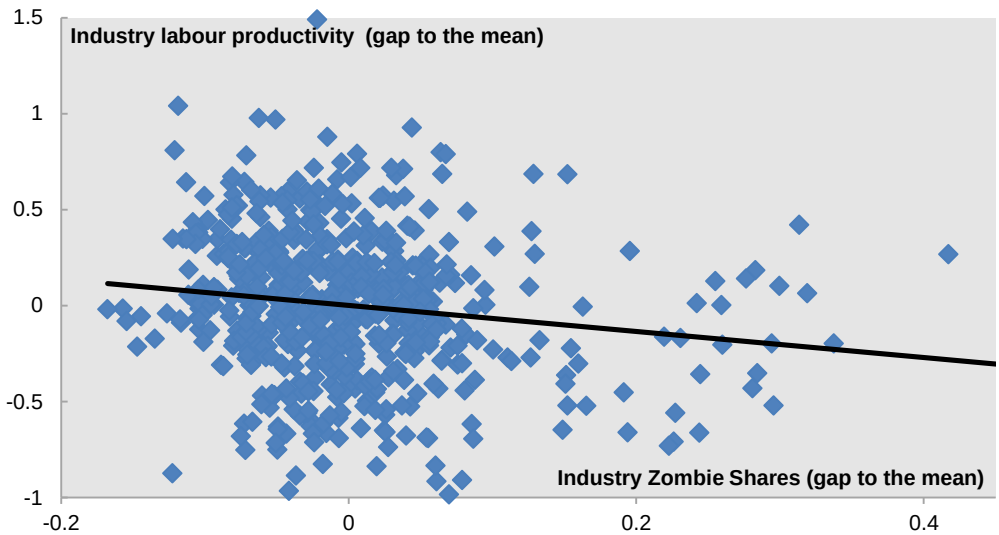
31. Across time, there has been an increase in both the prevalence of zombie firms and the resources sunk in them. In the rest of the paper, we follow Caballero et al. (2008) and utilise the capital sunk in zombie firms as the preferred zombie measure (sometimes referred to as K-share or zombie capital share), which Figure 5, Panel B charts for a broader range of countries in 2013. Looking at this metric, from 2007 to 2010, the prevalence of zombies has increased in Belgium, Spain, Italy, Korea, Finland and Sweden, while it has declined in France, the United Kingdom and Slovenia. Some further divergence is observed from 2010 to 2013. While the capital sunk in zombie firms increased further in Spain, Italy, Korea and

Sweden, it declined in Belgium, Finland and France. On the other hand, in Slovenia and the United Kingdom, there was little change in the prevalence of zombie firms in 2013 compared to 2010. Even if in some countries, the share of zombie firms has not risen since 2007, they still constitute a potential problem. For example, in the United Kingdom, the capital that is stuck in zombie firms is still non-trivial at around 7.5% (Figure 5, Panel B), and can act as a barrier to reallocation and productivity growth.

32. By way of introduction and purely for illustrative purposes, Figure 6 relates the level of labour productivity to the zombie capital share at the country-industry-year unit of observation. Each variable is purged of country, industry and year fixed effects to facilitate a within-industry interpretation and to abstract from time-varying global shocks and time-invariant country and industry factors. A robust negative relationship emerges, whereby an above-average zombie share in an industry is associated with a below-average industry labour productivity performance (Table A3; Figure 6).[16] The coefficient estimates imply that a 3.5% rise in the share of zombie firms – roughly equivalent to that observed between 2005 and 2013 on average across the nine OECD countries in the sample – is associated with a 1.2% decline in the level of labour productivity across industries. Accordingly, the remainder of the paper explores in more detail the channels through which zombie congestion may adversely affect labour productivity performance.

Figure 6. Labour productivity was weaker in industries with a high share of zombie firms

Residual industry labour productivity and zombie shares; 2003-2013



Note: The figure plots one-digit industry labour productivity against industry level zombie shares. The sample includes BEL, ESP, FIN, FRA, GBR, ITA, KOR, SWE and SVN. The observations are purged of country, industry and year fixed effects. The relationship is statistically significant at the 1% level, with robust standard errors clustered at industry and country level. See Table A3 in the Appendix for the regression table.

Source: OECD calculations based on ORBIS and OECD, National Accounts Database.

16. By using 2-digit industry zombie shares, the analysis takes into account within-industry barriers to efficient capital allocation. To take into account reallocation across industries, Table A3 replicates the same analysis at the 1-digit industry level and the relationship is much stronger, even though the confidence interval is larger.

4. Empirical framework

33. The empirical framework uses pooled cross-country micro data to explore the distortionary effects of zombie firms on the performance of non-zombie firms and on the extent of productivity-enhancing capital reallocation.

4.1 Zombie congestion and non-zombie firm performance

34. We estimate the following baseline econometric specification – inspired by Caballero et al. (2008) – on a panel of nine countries from 2003 to 2013:

$$Y_{isct}^{k} = \beta_1 nonZ_{isct} + \beta_2 nonZ_{isct} * Z_{sct} + \beta_3 Firm\ controls_{isct-1} + \delta_{sct} + \varepsilon_{isct} \quad (1)$$

where: Y refers to a measure of activity (the investment rate, the percentage change in employment or the level of multi-factor productivity[17]; k=3) in firm *i*, in industry *s*, in country *c*, at time *t*; nonZ is a dummy equal to 1 if a firm is a non-zombie firm, Z is the share of industry capital sunk in zombie firms and firm controls include dummies for firm age (YOUNG=1 if age<6) and firm size (1-10, 11-19, 20-49, 50-99, 100-249 and 250+).[18] The model also includes interacted country, industry and year fixed effects – to control for unobserved time-varying country-industry specific shocks – while robust standard errors are clustered at the country-industry-year level. We also estimate a cross-section regression of 13 countries in 2013, as a robustness test, which allows us to use a larger sample of countries since data coverage improves significantly for some countries in the later years of the database.

35. The model predicts that $ß_2$ will be negative for the employment growth and investment rate regressions, since zombie congestion reduces the ability or incentives for non-zombie firms to grow. At the same time, the coefficient will be positive for the MFP specification since the MFP gap between zombie and non-zombie firms will widen due to the higher productivity threshold that entrants must clear to overcome the entry barriers that zombie firms create (see Section 2.2). The coefficient on the non-zombie dummy ($ß_1$) is difficult to interpret: it could be positive if zombie firms are not in a position to spend as much as healthy firms, but it could be negative if zombie firms receive very increasingly large subsidies. Hence, in the discussion of the results in Section 5.1, we concentrate on the coefficient of the interaction term of the non-zombie dummy and the industry zombie shares ($ß_2$).

36. We control for cyclical influences which could simultaneously raise the prevalence of zombie firms and adversely affect firm performance in a number of ways. First, the econometric specification is designed with a highly burdensome fixed effect structure that controls for unobserved time-varying country-industry specific shocks, including the overall (un)attractiveness of operating in an industry in a given country for that year. Second, we check the robustness of the results to restricting the sample to the pre-crisis period (Section 5.3.2). Third, a number of robustness tests are conducted, including a cross-section regression for 2013, the use of a more exogenous definition of zombie firms based on Caballero et al. (2008), the use of a longer persistence time windows (4 and 5 years) in the definition of the interest coverage ratio and the exclusion from the sample of countries that were hit especially badly during the crisis (see Section 5.3 for details). Finally, even in absence of country-industry-year fixed effects, there are no obvious reasons why non-zombie firms – and particularly the more productive ones – should be disproportionately affected by an industry-specific macroeconomic downturn, compared to zombie firms.

17. The regression on the level of multi-factor productivity aims to test the effect of a rise in the zombie share on the productivity gap between zombie and non-zombie firms.

18. The specification of Caballero et al. (2008) also includes industry level zombie shares, but this variable is dropped in our baseline model which includes interacted country, industry and year fixed effects. However, the results are robust to including the zombie shares and a separate fixed effect structure.

4.2 Zombie congestion and capital reallocation

37. It is important to note that the coefficient estimates from equation (1) refer to the effect of zombies on the performance of a *typical* non-zombie firm; that is, they correspond to an average effect. However, the concept of the average firm becomes more tenuous in the context of the widespread heterogeneity in firm productivity that exists within narrowly-defined sectors (Section 2.2). Indeed, the distortionary effects might be larger than that captured in the baseline model in equation (1) if zombie congestion disproportionately reduces the ability of more productive firms to attract capital and grow. To test for the potential distortionary effects of zombie congestion on resource allocation, we augment canonical models of firm dynamics which predict that conditional on firm size, firms with higher MFP grow more quickly (see Foster et al., 2016; Decker et al., 2016). [19],[20]

38. We consider a baseline specification for a panel of 9 countries from 2003 to 2013, based on the following model:

$$Kgrowth_{isct} = \alpha + \beta_1 MFP_{isct-1} + \beta_2 MFP_{isct-1} * Z_{sct} + \beta_3 Firm\ controls_{isct-1} + \delta_{sct} + \epsilon_{isct} \quad (2)$$

where K growth is the change in real capital stock for firm *i*, in industry *s*, in country *c*, at time *t;* MFP denotes a measure of firm-level multi-factor productivity which is a deviation from the country-industry-year average to control for MFP differences across industries and countries; Z is the share of industry resources (labour or capital) sunk in zombie firms; firm controls are dummies for firm age and firm size as described above. The model also controls for interacted country, industry and year fixed effects to control for time-varying country-industry-specific shocks, while robust standard errors are clustered at the country, industry and year level. The model predicts that $ß_1$ will be positive since firms with higher productivity are expected to attract resources and grow, while $ß_2$ will be negative if the presence of zombie firms distorts the efficiency of capital reallocation. Similar to the previous model, we also estimate a cross-section regression of 13 countries in 2013 as a robustness check.

5. Empirical results

5.1 Zombie congestion and non-zombie firm performance

39. Table 1 (Panel A) presents the baseline estimates of equation (1) where the distortionary effects of zombie firms are analysed in terms of the investment rate, the employment growth and the level of MFP of non-zombie firms. Industry zombie percentage is based on the share of capital sunk in zombie firms (see Section 3.1). The interaction terms in Columns 1 and 4 show that across countries, an increase in the zombie share at the industry level is associated with lower investment for the average non-zombie firm. The same is true with respect to employment growth (Columns 2 and 5).[21] These results suggest two

19. Canonical models of firm dynamics suggest that the observed pace of firm volatility is driven by the interaction between idiosyncratic firm-specific shocks and the frictions on adjustment (entry, exit, expansion and contraction) for firms (Hopenhayn, 1992; Jovanovic, 1982). This implies that reallocation can be due to either a change in the intensity of shocks or a change in the responsiveness to productivity shocks. Applying these models to US data, Decker et al. (2016) find that the latter can account for the changing pattern of reallocation over time.

20. One advantage of this approach of estimating the contribution of reallocation is that it disciplines firm growth on productivity, in contrast to other methodologies (i.e. Foster, Haltiwanger and Krizan, 1996; Olley and Pakes, 1996) where the estimated contribution of reallocation could arise for a number of reasons, unrelated to productivity-enhancing reallocation.

21. The results on investment and employment growth continue to hold when the share of labour sunk in zombie firms is used to define zombie shares (Table A4).

important issues. First, the prevalence of persistently weak firms that do not exit the market could be one factor behind the post-crisis weakness in business investment (see Section 2.1). Second, these results raise the prospect that zombie congestion may reduce potential output growth by distorting productivity-enhancing reallocation – an issue we return to in Section 5.2.

40. Columns 3 and 6 of Table 1 show that the MFP gap between zombie firms and non-zombie firms rises as the percentage of zombies in an industry rises, which is in line with the predictions of the model in Caballero et al. (2008). The results suggest that the presence of zombie firms creates distortions, which depress productivity by preserving inefficient firms at the expense of more productive potential entrants. At the same time, since zombie firms create "congestion", which creates barriers to entry, the marginal entrant needs to clear a higher productivity threshold for entry to compensate for lower profitability caused by congestion. This, in turn, amplifies the productivity gap between zombie and non-zombie firms.

Table 1. Zombie firms and non-zombie firm performance

	(1)	(2)	(3)	(4)	(5)	(6)
	A: Panel of 9 countries, 2003-2013			***B: Cross section of 13 countries,***		
VARIABLES	*log(I/K)*	*dLog Emp*	*MFP*	*log(I/K)*	*dLog Emp*	*MFP*
Non-zombie dummy$_{i,t}$	0.07372***	0.06943***	0.52738***	0.06342***	0.08335***	0.57842***
	(0.00288)	(0.00172)	(0.01198)	(0.00794)	(0.00479)	(0.02918)
Non-zombie dummy$_{i,t}$ X Industry zombie shares$_{s,t}$	-0.13257***	-0.03759***	0.47019***	-0.07791**	-0.04757*	0.49190***
	(0.01752)	(0.01197)	(0.10471)	(0.03752)	(0.02490)	(0.17904)
Firm Age and Size Controls	YES	YES	YES	YES	YES	YES
Industry*Country Fixed Effects	NO	NO	NO	YES	YES	YES
Industry*Country*Year Fixed Effects	YES	YES	YES	NO	NO	NO
Observations	10,121,532	10,121,532	7,956,552	1,234,596	1,234,596	1,030,477
AdjR2	0.0193	0.0244	0.832	0.0152	0.0218	0.815

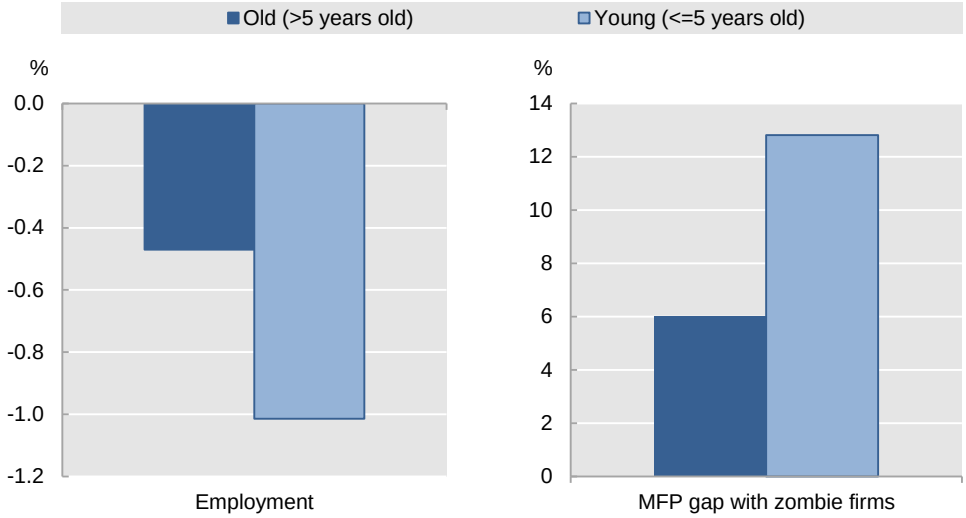
Note: Industry zombie shares refer to the share of industry capital sunk in zombie firms, defined as firms aged ≥10 years and with an interest coverage ratio<1 over three consecutive years. Log(I/K) refers to the investment ratio, i.e. the log difference of the real capital stock; dLogEmp refers to the change in employment and MFP is the level of multi-factor productivity estimations based on the Solow-residual. Robust standard errors are clustered by country, industry and year. Industry refers to 2-digit level detail according to NACE Rev. 2, covering the non-farm non-financial business sector (industry codes 10-83, excluding 64-66). The countries in Panel A include BEL, ESP, FIN, FRA, GBR, ITA, KOR, SWE and SVN, while the cross-section in Panel B adds AUT, DEU, LUX and PRT. *** denotes statistical significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Source: OECD calculations based on ORBIS.

41. If zombie firms were congesting markets and creating entry barriers, one would expect young firms to be disproportionately affected. To test this hypothesis, Table A5 focuses on the effects on such young firms by interacting a young dummy variable (equals 1 if firms aged 5 years and less; 0 otherwise) with the non-zombie dummy and the non-zombie dummy*zombie capital share. The latter triple interaction term suggests that the employment growth of young firms is particularly affected by the prevalence of zombie firms in an industry (Column 2), while the effect on investment is not different for young and mature firms (Column 1). The amplifying effect of zombie congestion on the MFP gap between zombie and non-zombie firms is even larger for young firms, consistent with the idea that zombie firms distort markets and create a higher productivity threshold for entry (Column 3). Moreover, these effects are economically significant: for example, a one standard increase in the zombie capital share – roughly equivalent to the difference between Italy and the United Kingdom in 2013 – is associated with a 1% decline in employment growth in young firms (Figure 7). This is more than double the effect on older firms, while a similar story holds with respect to MFP. Taken together, these results suggest that the zombie phenomenon could be connected to the rising productivity dispersion and barriers to entry evidenced in Andrews, Criscuolo and Gal (2016).

Figure 7. Zombie congestion particularly penalises young firms

Impact of a one standard deviation increase in the zombie capital share on non-zombie firms according to their age



Note: This figure shows the ceteris paribus impact of an increase of a one standard deviation (15.6%) of the zombie share on employment and MFP of non-zombie firms, differentiating between old and young non-zombies. Zombie shares refer to the share of capital sunk in zombie firms, defined as firms aged >=10 years and with an interest coverage ratio <1 over three consecutive years. The estimates are based on nine OECD countries (BEL, ESP, FIN, FRA, GBR, ITA, KOR, SWE and SVN) over the period 2003-13. The effects on old non-zombie firms and the differential effects on young non-zombie firms are all significant at the 5% level.

Source: OECD calculations based on ORBIS.

5.2 Zombie congestion and capital reallocation

42. Table 2 shows the baseline results from equation (2), which estimates the sensitivity of firm capital growth with respect to lagged firm MFP. Columns 1 and 3 refer to the share of capital sunk in zombie firms, while the even columns refer to the share of labour trapped in zombie firms. Across all columns, using both metrics of zombie shares, the first row shows that firms with higher than average productivity are able to attract more capital: in other words, capital reallocation is – on average – productivity-enhancing. However, the interaction term of lagged firm MFP with the industry zombie share is negative, suggesting that more zombie congestion is associated with less productivity-enhancing capital reallocation within industries. In sum, zombie firms constrain the growth of more productive firms, which reduces MFP – and ultimately labour productivity growth – via lower allocative efficiency.

Table 2. Zombie firms and capital reallocation

Sensitivity of Firm Capital to Lagged MFP in the non-farm business sector
Dependent variable: growth in the real capital stock

	(1)	(2)	(3)	(4)
	A: Panel of 9 countries, 2003-2013		***B: Cross section of 13 countries,***	
	Zombie measure		*Zombie measure*	
VARIABLES	K-share	L-share	K-share	L-share
$MFP_{i,t-1}$	0.07819***	0.08241***	0.06458***	0.06588***
	(0.002)	(0.002)	(0.006)	(0.004)
$MFP_{i,t-1}$ X Industry zombie $shares_{s,t}$	-0.14017***	-0.26720***	-0.09088***	-0.15578***
	(0.018)	(0.026)	(0.034)	(0.034)
Firm Age and Size Controls	YES	YES	YES	YES
Industry*Country Fixed Effects	NO	NO	YES	YES
Industry*Country*Year Fixed Effects	YES	YES	NO	NO
Observations	6,405,339	6,405,339	902,271	902,271
AdjR2	0.0308	0.0310	0.0211	0.0211

Note: Zombie shares refer to the share of industry capital sunk in zombie firms, defined as firms aged ≥10 years and with an interest coverage ratio<1 over three consecutive years. MFP is the lag of the level of multi-factor productivity estimations based on the Solow-residual, defined as the deviation from country-industry-year mean. Robust standard errors are clustered by country, industry and year. Industry refers to 2-digit level detail according to NACE Rev. 2, covering the non-farm non-financial business sector (industry codes 10-83, excluding 64-66). The countries in Panel A include BEL, ESP, FIN, FRA, GBR, ITA, KOR, SWE and SVN, while the cross-section in Panel B adds AUT, DEU, LUX and PRT. The sample size differs from Column 3 of Table 1 since this specification drops some observations due to the use of lagged MFP and the way MFP is defined as a deviation from the mean. *** denotes statistical significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Source: OECD calculations based on ORBIS.

5.3 Extensions and robustness checks

5.3.1 Exploring the channel of bank forbearance

43. Section 2 has highlighted a number of factors that might have contributed to the rise in the prevalence of zombie firms. By taking the interest coverage ratio definition of zombie firms, the baseline analysis covers a range of possible channels through which zombie congestion might constrain labour productivity performance.

44. The previous studies on zombie firms have focused on the case of Japan in the 1990s and specifically on the channel of bank forbearance – that is, banks' reluctance or lack of incentives to deal with non-performing loans and realise losses on their balance sheets that may arise from corporate insolvencies, which may lead to "evergreening" of the loans of insolvent firms. As a robustness check and an attempt to shed light on this specific channel, this section replicates the baseline regressions in Tables 1 and 2, using our proxy for the Caballero et al. (2008) definition outlined in Section 3.2. While it is impossible to perfectly replicate this measure, our proxy may go some way to providing a rough estimate of whether low productivity firms receive subsidised credit. Before proceeding, we conduct several tests to establish whether the interest coverage ratio (defined for firms aged 10 and older) and our Caballero-based (defined for all firms regardless of age) zombie classifications are correlated. Table A6 shows that controlling for country, industry and year fixed effects, the two measures have a positive and significant

relationship, both with respect to whether a particular firm is classified as a zombie and zombie capital shares at the industry level.[22]

45. The baseline results presented in Tables 1 and 2 are robust to using zombie shares based on this alternative definition for a panel of seven countries for the period 2003 to 2013.[23] Across countries, a rise in the subsidised credit definition of the zombie share at the industry level is associated with: *i)* lower investment and employment growth for non-zombie firms (Table A7, Columns 1-2); *ii)* a larger MFP gap between zombie and non-zombie firms (Table A7, Columns 3); and *iii*) less productivity-enhancing capital reallocation (Table A8).[24] These results suggest that bank forbearance might be a channel through which zombie firms contribute to the productivity slowdown.

5.3.2 Restricting the sample to the pre-crisis period

46. As discussed in Section 4, to address the concerns that the relationship between zombie firms, the performance of non-zombie firms and productivity-enhancing capital reallocation could be partly driven by cyclical effects, we test the robustness of the baseline results in Tables 1 and 2 by restricting the sample period to 2003-2007. The first two columns of Table A9 show that an increase in the zombie share at the industry level is associated with lower investment and employment growth for the average non-zombie firm in the pre-crisis period.[25] Columns 3 and 4 of Table A9 show that more zombie congestion is associated with less productivity-enhancing capital reallocation within industries between 2003 and 2007. These results suggest that resources trapped in zombie firms was a policy issue even before the crisis and further support the view that there is a structural dimension to the conjecture that the continued survival of weak firms is stifling labour productivity performance.

5.3.3 Other robustness checks

47. The baseline results in Tables 1 and 2 are robust to a number of further specifications:

- Addressing the representativeness issues discussed in Section 3.1 by: *i)* using weights based on the Structural Demographics and Business Statistics of the OECD (SDBS) in the regressions and the construction of the industry level zombie shares (Columns 1-3 of Panel A of Table A10 and Columns 1 and 2 of Panel A of Table A11)[26]; and *ii)* excluding firms with less than 20 employees (Columns 4-6 of Panel B of Table A10 and Columns 3 and 4 of Panel B of Table A11).

- Using: *i)* different definitions of the zombie measure based on the interest coverage ratio such as looking at only firms aged above 15 and 20 years instead of 10 years, and persistence measures based on 4 and 5 years instead of 3 years; *ii)* different fixed effects and clustering techniques; *iii)*

22. Our analysis suggests that the firm level correlation is robust to including firm fixed effects and firm controls, such as age and size, to control for the fact that the interest coverage ratio is defined for firms aged 10 and older.

23. The use of this definition lowers the number of countries in the sample to seven with Korea and Slovenia being dropped due to lack of data availability.

24. The results are robust to using a cross-section of 13 countries for 2013 (Column 3 of Table A8) and using resampling weights based on the SDBS to address representativeness issues (Columns 2 and 4).

25. The baseline results of the rising MFP gap between zombie firms and non-zombie firms with higher shares of zombies in an industry do not hold in the pre-crisis period, suggesting that the prevalence of zombie firms might affect entry with a lag.

26. The results are also robust to only using the weights in the regression with the unweighted zombie shares and only using the weighted zombie shares without weighing the regressions.

excluding Italy and Spain – which were particularly affected by the crisis – from the sample; and *iv)* excluding outliers from the sample.[27]

48. The baseline results in Table 1 are also robust to: *i)* including, as an additional variable, the interaction of the non-zombie dummy with the share of old firms in the industry to check that the negative interaction term does not simply reflect the effect of a growing share of old firms in the economy, i.e. declining business dynamism (Table A12); and *ii)* including firm sales growth as an additional control, following Caballero et al. (2008).[28]

49. The baseline results presented in Table 2 – linking capital reallocation and zombie shares – are also robust to: *i)* using different estimates of MFP based on an OLS production function (Columns 1 and 2 of Table A13) and derived from an IV estimation method proposed by Wooldridge (2009) (Columns 3 and 4 of Table A13); *ii)* excluding non-zombie firms from the sample (Table A14).

6. Zombie firms and potential growth

50. The aim of this section is to provide some suggestive evidence on the links between the rise in zombie firms and aggregate labour productivity performance via two main channels: weak business investment and the slowdown in MFP performance in OECD countries. These results should be treated with caution as they only identify correlations, as opposed to causal effects. To illustrate the economic magnitude of our estimates, we conduct two counterfactual exercises to explore the effects of zombie firms on investment, employment (Section 6.1) and capital reallocation (a component of aggregate MFP; Section 6.2). First, in the cross section (as of 2013), we estimate how much scope there is to boost labour productivity performance from reducing the zombie share – via higher investment and MFP – with a view to assess the potential for reforms which affect the exit margin to boost potential growth. Second, utilising our panel estimates, we explore how much higher labour productivity would have been if the zombie capital share had not risen from its pre-crisis level. This speaks more to the possible contribution of the rise of zombie firms to the labour productivity slowdown. It is important to note, however, that the rise of zombie firms will also drag down average productivity, deter the potential entry of innovative firms and potentially hinder the reallocation of resources *across* sectors, implying that the estimates presented below may in fact understate the impact of zombie congestion on aggregate MFP.

6.1 Implications for capital and employment

51. Based on the results of Table 1, Figure 8 illustrates the potential gains to investment and employment growth of a typical non-zombie firm from reducing zombie shares in each country to the lowest shares observed in Slovenia in 2013 (4%). If interpreted causally, these results suggest that reducing zombie shares in Belgium to the lowest level in the sample would be associated with a 1.7% gain in investment for a typical non-zombie firm in 2013, which is significant given that aggregate business investment in Belgium remained some 4% lower in 2013, compared to its 2008 level.

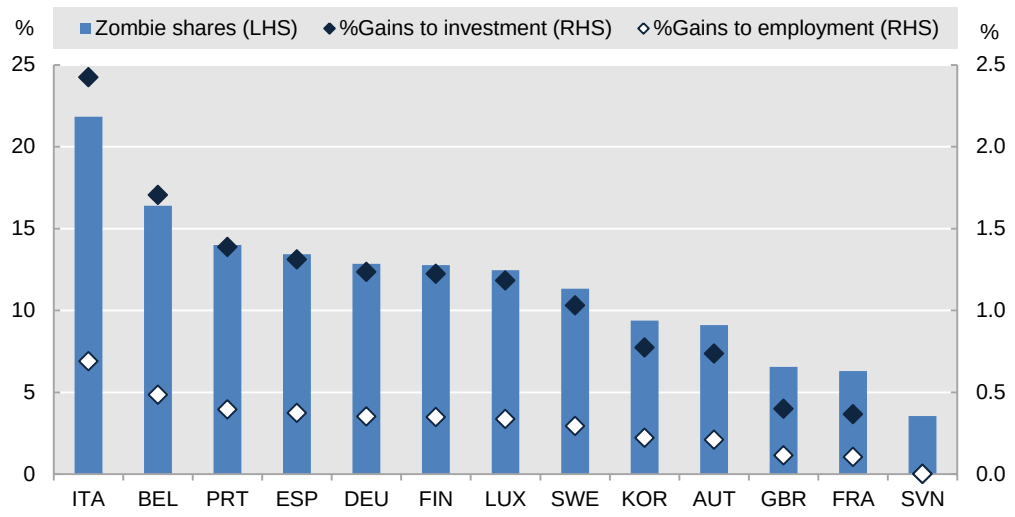
52. To better understand the link between the rise of zombie firms and weak potential growth in the post-crisis period, we estimate how much more a typical non-zombie firm would have invested or

27. We use the sample excluding firms that are larger than 100 times the 99th percentile of the size distribution in terms of capital stock or number of employees, which may affect zombie shares significantly in some countries (e.g. Italy and Finland). These results are available on request.

28. Including firm sales growth controls for business opportunities for the healthy firms, which could be another explanation for the lower investment and employment growth of non-zombie firms. These results are available on request.

increased employment if the share of zombie firms had stayed at its 2007 level in each country.[29] Figure 9 shows the cumulative investment and employment loss of non-zombie firms for the nine countries in the sample. For example, if the zombie shares had stayed at their 2007 level, the investment and employment of a typical non-zombie firm in Italy would have been around 6% and 1.7% higher respectively in 2013.[30] This is significant given that aggregate non-residential private investment declined by over 20% in Italy between 2008 and 2013, while the corresponding decline in employment was 4%.[31] A simple back-of-envelope calculation suggests that zombie firms could account for perhaps one-quarter of the actual decline in private non-residential business investment in Italy between 2008 and 2013.[32]

Figure 8. Counterfactual gains from reducing the zombie capital share to the sample minimum, 2013



Note: This figure shows the counterfactual gains to investment and employment of a typical non-zombie firm from reducing the share of zombies to the sample minimum level (i.e. Slovenia in 2013). Zombie shares refer to the share of capital sunk in zombie firms, defined as firms aged ≥10 years and with an interest coverage ratio<1 over three consecutive years.

Source: OECD calculations based on ORBIS.

53. For the OECD average, the increase in zombie shares compared to the pre-crisis period is associated with a 2% cumulative loss in investment and a 0.7% loss in employment. This conceals some good news in the United Kingdom, however, where the decline in the zombie share after 2007 (Figure 5) boosted investment by 1.5%, relative to a counterfactual where the zombie share had stayed at its 2007

29. For each year, investment or employment are estimated to have been higher than their actual level by [ß2 from equation (1)*(counterfactual zombie share - actual zombie share)] and then these differences are cumulated from 2008 to 2013.

30. Excluding outliers from this counterfactual exercise has two opposing effects. While the ß2 coefficient of the investment regression from a sample excluding outliers is higher compared to the baseline, for some countries, the actual zombie shares are lower. For example, in Italy, the zombie capital share excluding outliers in 2013 is 19% and the potential gain to investment would be 6.1%, 0.2% higher than the baseline counterfactual gains.

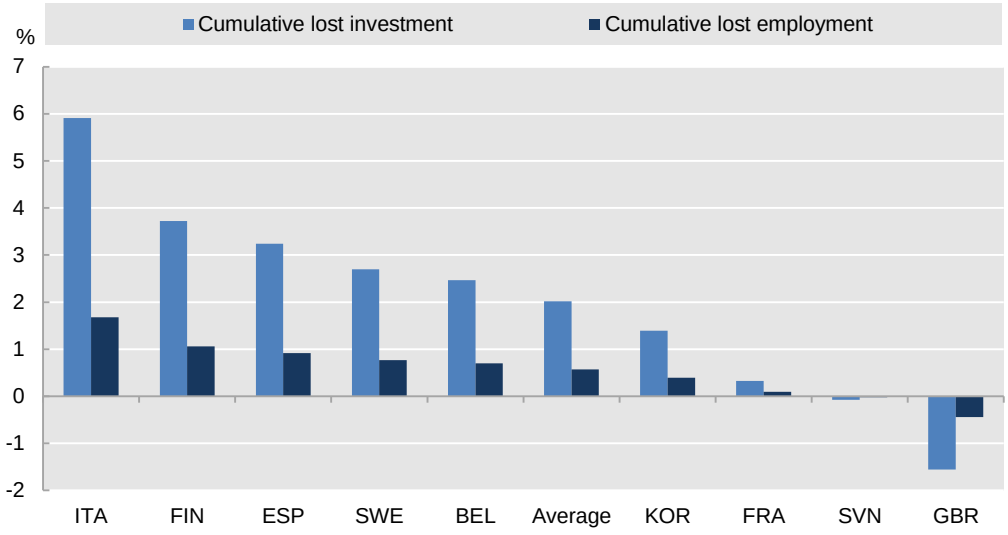
31. Estimates from various editions (2012 and 2013) of the Bank of Italy's survey of industrial and service firms imply a decline in private non-residential business investment of 24% over the same period.

32. For example, if non-zombie firms account for 80% of the aggregate business capital stock, then a 6% decline in non-zombie business investment due to zombie congestion would imply a contribution of -5% (-6%*0.8) to the 20% fall in the aggregate business investment.

level. This finding is potentially significant for policy, given that insolvency proceedings in the United Kingdom are quite efficient, compared to other OECD countries (Adalet McGowan and Andrews, 2016).

Figure 9. Impact of zombie firms on non-zombie firm performance

Cumulative investment and employment loss of a typical non-zombie firm due to a rise in the zombie share after 2007



Note: This figure shows the cumulative lost investment and employment between 2008 and 2013 due to the presence of zombie firms, using the results of Table 1. The counterfactual is to keep the zombie shares at their 2007 level for the period 2008 to 2013. The average refers to the unweighted average of the 9 countries in the sample. Figure A3 shows the cumulative investment and employment loss for two additional countries (Greece and Japan), which are not included in the empirical analysis due to lack of productivity data.

Source: OECD calculations based on ORBIS.

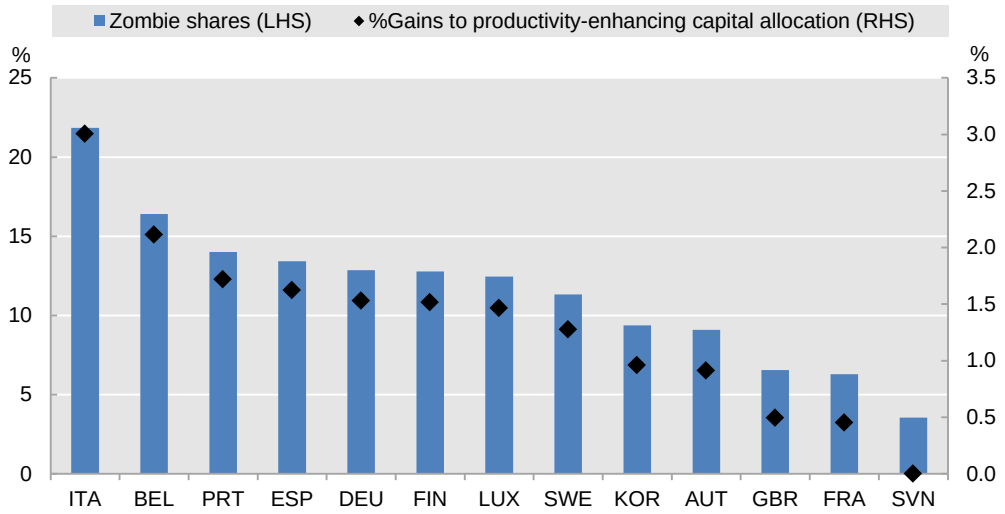
6.2 Implications for MFP via capital reallocation

54. Based on the coefficient estimates in Panel B of Table 2, Figure 10 simulates the gains to productivity-enhancing capital reallocation from lowering zombie shares in each country to the low level observed in Slovenia in 2013. For example, in Spain, the difference in capital growth between high and low productivity firms, – defined as the implied difference in capital growth between a firm one standard deviation below the mean and a firm one standard deviation above the mean – would be 1.5% higher, if zombie shares were reduced to the sample minimum. This is economically significant, given that the efficiency of capital allocation declined by around 2.6% in Spain from 2004 to 2013 (Figure 3).

55. How much of the decline of the estimated responsiveness of capital growth to (lagged) firm MFP shown in Figure 3 can be ascribed to the rise in zombie congestion? In Spain, for example, our estimates suggest that about one-half of the decline can be accounted for by the rise in the zombie congestion, based on a comparison of actual data with a counterfactual where the zombie share stayed at its 2004 level. The corresponding estimate for Italy is significantly higher, while in the remaining country grouping, the rise in the zombie share can account for around 15% of the decline in the efficiency of capital reallocation.

Figure 10. Impact of zombie firms on capital reallocation

Difference in capital growth between high and low productivity firms, 2013



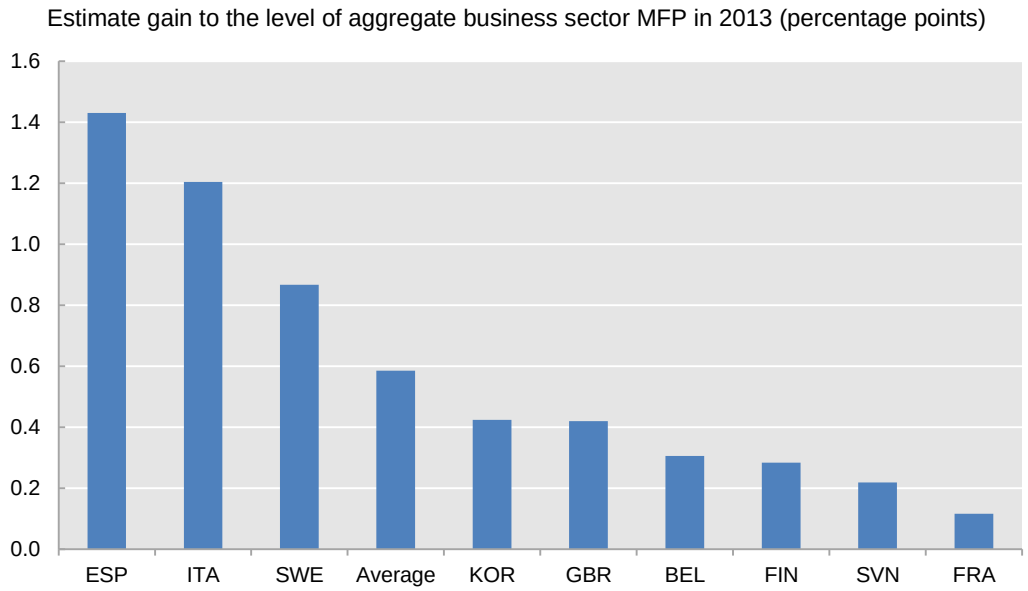
Note: This figure shows the counterfactual gains to the efficiency of capital allocation (i.e., the difference in capital growth between high and low productivity firms, defined as the implied difference in capital growth between a firm one standard deviation below the industry mean and a firm one standard deviation above the mean) from reducing the share of zombies to the sample minimum level (i.e. Slovenia in 2013). Zombie shares refer to the share of capital sunk in zombie firms, defined as firms aged ≥10 years and with an interest coverage ratio<1 over three consecutive years.

Source: OECD calculations based on ORBIS.

56. The exercise conducted in Figure 10 can be expanded to estimate how much scope there is to boost aggregate MFP from reducing zombie shares. The counterfactual MFP is calculated, based on the assumption that zombie shares in each country are reduced to the sample minimum level observed in each industry and year in the sample (note that the nature of this exercise differs somewhat from that above).[33] Figure 11 shows that on average across the nine countries in the sample, the potential gains to MFP from lowering zombie shares to the lowest level is 0.6% in 2013, with the gains ranging from 1.4% in Spain to 0.1% in France.

33. Note that the cross-country ranking that results from this exercise differs somewhat from the estimates in Figure 10 for two reasons. First, the counterfactual uses coefficient estimates from the panel specification and time series variation from 2003-2013, as opposed to cross-sectional information from 2013. Second, the sample minimum zombie share is based on the minimum level in each industry, as opposed to the minimum zombie share at the country level as in Figures 8 and 10.

Figure 11. Counterfactual MFP gains from reducing zombie shares to industry minimum level



Note: This figure shows the counterfactual gains to MFP via higher capital reallocation from reducing the shares of zombies in each country to the sample minimum level in each industry and year. The country level numbers are an unweighted average of all industries (2-digit level detail according to NACE Rev. 2, covering the non-farm non-financial business sector).

Source: OECD calculations based on ORBIS.

57. We also calculate a counterfactual MFP, based on the assumption that for each country, industry zombie shares had stayed at their 2004 levels, to explore how the rise of zombie firms might have contributed to the slowdown in labour productivity. The difference between the baseline and the counterfactual MFP provides an estimate of the aggregate cost to MFP from lower productivity-enhancing capital allocation due to higher zombie shares. For example, these results suggest that had the zombie capital shares not risen from their 2004 levels, – and thus adjustment dynamics reverted back to their (more responsive) 2004 levels – the contribution of capital reallocation to aggregate MFP in 2013 would have been about 0.7% and 1% higher in Italy and Spain, respectively.[34] This is economically significant given that in both countries, MFP subtracted significantly from potential growth over the sample period.

7. Policy discussion

58. This paper provides evidence that the prevalence of financially weak or "zombie" firms – that increasingly linger as opposed to exit the market – are stifling labour productivity growth. We apply the framework from the seminal study of zombie firms in Japan (see Caballero et al., 2008) to a broader sample of OECD countries and show that a higher share of industry capital sunk in zombie firms is associated with lower investment and employment growth of a typical non-zombie firm. Besides limiting the expansion possibilities of healthy incumbent firms, market congestion generated by zombie firms can also exacerbate productivity dispersion, create barriers to entry and constrain the post-entry growth of young firms. Finally, we find that an increase in the capital stock sunk in zombie firms is associated with less productivity-enhancing capital reallocation, measured as the decline in the ability of more productive firms to attract capital.

34.. These numbers are calculated as an unweighted average of the industry level aggregate cost for each country.

59. Taken together, our estimates imply that zombie firms may be a significant barrier to the recovery in potential output in some countries, through their adverse effects on capital deepening and MFP. In turn, this raises a number of issues for policy: To what extent is policy weakness responsible for the rise in zombie congestion? What can policy do to alleviate this source of productivity weakness? For example, in the early phases of the crisis, some crisis-induced policy initiatives such as government loan guarantees and low interest rates might have been useful in facilitating credit and preventing firm exit that would lead to mass layoffs. However, given the length of the crisis, the persistence of some of these policies may now be detrimental to productivity growth by distorting credit supply, especially given asymmetric information problems making it difficult to identify unviable firms, and curbing the potentially positive contribution of exit.

60. The finding that a better functioning exit margin provides considerable scope to boost labour productivity motivates future empirical research on how a range of structural, macroeconomic and financial policies can *directly* shape aggregate productivity along the exit margin through their impact on two key channels (see Adalet McGowan and Andrews, 2016):

- the strength of market selection, which increases in the economy's ability to dispose of non-viable firms and facilitate the restructuring of viable firms, is key for boosting within-firm productivity growth in the future; and
- the scope and speed at which scarce resources consumed by failing firms can be reallocated to more productive uses is key to ensure a strong contribution of between firm reallocation to aggregate productivity.

61. Since market imperfections often generate obstacles to the orderly exit of failing firms, research on the link between insolvency regimes and cross-country differences in productivity is a high priority, but this first requires the development of reliable policy indicators (see Adalet McGowan and Andrews, 2016). This analysis will also take into account the legal environment, given that an efficient judicial system is crucial for the effectiveness of formal insolvency procedures. Product market regulations also appear relevant for the exit margin, given the evidence that rising productivity dispersion and declining incentives of laggard firms to adopt latest technologies may be linked with the slowdown in the pace of market reforms (Andrews et al., 2016).

62. The links between the exit margin and ultra-loose monetary policy and the changing nature of financial regulation, with an emphasis on their effect on credit supply, is a key question for future research. It is also likely that financial market distortions may exacerbate the adverse impact of structural policy weakness on labour productivity. For example, the positive relationship within countries over time between the zombie capital share and non-performing loans (NPLs; see Table A15) suggests that financial sector health is related to the operation of the exit margin. Indeed, the interaction of weak financial systems with inefficient insolvency regimes and judicial systems has been especially highlighted for Italy (Garrido et al., 2016; Garrido, 2016; OECD, 2015), and may explain the particularly tight relationship between NPLs and zombie shares in that country (Figure A4). This suggests that more in-depth analysis of the relationship between banks and zombie firms, with a focus on banking sector fragility and the role of banking supervision may be warranted.

63. Finally, reallocation-friendly policies such as those facilitating job turnover or labour mobility will also be important in allowing more productive firms to expand with resources released from the exiting firms. Since the exit of low productivity firms implies more labour market churn, however, there is a case for policy to manage the costs of worker displacement and facilitate efficient worker reallocation through well-designed active labour market policies (Andrews and Saia, 2016), which could be financed out of the growth dividends illustrated above. While the exit of zombie firms may initially entail a hit to aggregate employment, over time the costs to displaced workers will be mitigated by two factors. First, the

removal of the zombie congestion implies higher non-zombie employment growth, especially amongst young firms which disproportionately contribute to aggregate job creation (Haltiwanger et al., 2013; Criscuolo, et al., 2014). Second, the exit of zombie firms creates scope for some displaced workers to be reallocated to a job that better matches their skill, which is significant given evidence that highly-skilled labour is trapped in relatively low productivity firms in many OECD countries (Adalet McGowan and Andrews, 2015). A better matching of skills to jobs makes workers more productive, implying scope for higher wages, and reduces the risk that under-utilised skills will quickly depreciate.

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APPENDIX: ADDITIONAL TABLES AND FIGURES

Table A1. Responsiveness of firm capital growth to lagged firm MFP

Dependent variable: growth in the real capital stock

	(1)	(2)	(3)	(4)	(5)	(6)
	A: Other 7 countries		***B: Spain***		***C: Italy***	
	2003-2013		**1998-2014**		**2001-2013**	
MFP_{t-1}	0.07942***	0.09018***	0.05920***	0.09202***	0.05548***	0.11343***
	(0.001)	(0.003)	(0.000)	(0.002)	(0.001)	(0.003)
MFP_{t-1} X Time Trend		-0.00199***		-0.00359***		-0.01116***
		(0.000)		(0.000)		(0.001)
MFP_{t-1} X Time Trend Squared				0.00004*		0.00046***
				(0.000)		(0.000)
Firm age and size controls	YES	YES	YES	YES	YES	YES
Industry Fixed Effects	YES	YES	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES	YES	YES
Country Fixed Effects	YES	YES	NO	NO	NO	NO
Observations	2,255,916	2,038,043	4,351,165	4,351,165	1,937,707	1,937,707
AdjR2	0.0272	0.0283	0.0337	0.0340	0.0227	0.0231

Note: This table is based on firm level regressions based on the following model: $Capital\ growth_{isct} = \alpha + \beta_1 MFP_{isct-1} + \beta_2 MFP_{isct-1} * Trend_t + \beta_3 MFP_{isct-1} * TrendSQ_t + \beta_4 Firm\ controls_{isct-1} + \delta_s + \delta_t + \delta_c + \epsilon_{isct}$. MFP is the lag of the level of multi-factor productivity estimations based on an OLS production function, defined as the deviation from the industry-year average, and trend is a simple linear time trend and trendSQ is a quadratic trend. Panel A: the quadratic trend is dropped because it is not significant. The regression also controls for country fixed effects, with robust standard errors clustered at country, industry and year. The 7 countries are Belgium, Finland, France, Korea, Slovenia, Sweden and the United Kingdom.

Source: OECD calculations based on ORBIS.

Table A2. Productivity dispersion

Dispersion across industries of within-industry multi-factor productivity distribution moments, 2013

Within-industry moment	Mean	Std. Dev.	IQ range
	All firms		
Median	5.785	1.841	2.258
IQ range	0.917	0.443	0.439
90-10 percentile range	1.844	0.778	0.867
95-5 percentile range	2.477	1.008	1.180
	Non-zombie firms		
Median	5.809	1.841	2.244
IQ range	0.906	0.454	0.453
90-10 percentile range	1.805	0.775	0.850
95-5 percentile range	2.418	0.985	1.129

Note: Summary of firm-level productivity distribution moments across 62 industries (at the NACE 2-digit level) in 13 countries in 2013 (AUT, BEL, DEU, ESP, FIN, FRA, GBR, ITA, KOR, LUX, PRT, SWE and SVN). Following Syverson (2004), the rows correspond to moments of within-industry MFP distribution (based on the Solow Residual), and the columns show the across-industry mean and dispersion of these moments. "IQ range" is the interquartile range. The top part of the table corresponds to productivity distributions calculated on the whole sample, while the bottom part corresponds to the sample restricted to non-zombie firms.

Source: OECD calculations based on ORBIS.

Table A3. Zombie firms: links with aggregate labour productivity

OLS regression of aggregate productivity on zombie shares at the industry-year level

	Panel of 9 countries, 2003-2013	
	Industry Labour Productivity $_{c,s,t}$	
	2-digit industries	1-digit industries
Industry zombie shares$_{c,s,t}$	-0.33708***	-0.69330***
	(0.078)	(0.181)
Industry Fixed Effects	YES	YES
Year Fixed Effects	YES	YES
Country Fixed Effects	YES	YES
Observations	3,972	625
AdjR2	0.920	0.869

Note: Industry refers to 1-digit and 2-digit level detail according to NACE Rev. 2, covering the nonfarm non-financial business sector (industry codes 10-83, excluding 64-66). The sample includes BEL, ESP, FIN, FRA, GBR, ITA, KOR, SWE and SVN. The labour productivity data are from OECD National Accounts. *** denotes statistical significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Source: OECD calculations based on ORBIS and OECD, National Accounts.

Table A4. Zombie firms and the performance of non-zombie firms: labour sunk in zombie firms

	(1)	(2)	(3)
	Panel of 9 countries, 2003-2013		
VARIABLES	*log(I/K)*	*dLog Emp*	*MFP*
Non-zombie dummy$_{i,t}$	0.07533***	0.07039***	0.58828***
	(0.00270)	(0.00172)	(0.01257)
Non-zombie dummy$_{i,t}$ X Industry zombie shares$_{s,t}$	-0.19753***	-0.06195***	-0.08921
	(0.02079)	(0.01635)	(0.13441)
Firm Age and Size Controls	YES	YES	YES
Industry*Country Fixed Effects	NO	NO	NO
Industry*Country*Year Fixed Effects	YES	YES	YES
Observations	10,121,532	10,121,532	7,956,552
AdjR2	0.0193	0.0244	0.832

Note: Industry zombie shares refer to the industry share of labour sunk in zombie firms, defined as firms aged ≥10 years and with an interest coverage ratio<1 over three consecutive years. *Log(I/K)* refers to the investment ratio, i.e. the log difference of the real capital stock; *dLogEmp* refers to the change in employment and *MFP* is the level of multi-factor productivity estimations based on the Solow-residual. Robust standard errors are clustered by country, industry and year. Industry refers to 2-digit level detail according to NACE Rev. 2, covering the nonfarm non-financial business sector (industry codes 10-83, excluding 64-66). The countries include BEL, ESP, FIN, FRA, GBR, ITA, KOR, SWE and SVN. *** denotes statistical significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Source: OECD calculations based on ORBIS.

Table A5. Zombie firms and the performance of young firms

	(1)	(2)	(3)
	Panel of 9 countries, 2003-2013		
VARIABLES	log(I/K)	dLog Emp	MFP
Non-zombie dummy$_{i,t}$	0.07414***	0.06888***	0.53513***
	(0.00284)	(0.00170)	(0.01159)
Non-zombie dummy$_{i,t}$ X Young dummy$_{i,t}$	0.07552***	0.04154***	0.01062
	(0.00271)	(0.00151)	(0.00739)
Non-zombie dummy$_{i,t}$ X Industry zombie shares$_{s,t}$	-0.13488***	-0.03005***	0.38566***
	(0.01665)	(0.01132)	(0.09507)
Non-zombie dummyi,t X Industry zombie shares$_{s,t}$ X Young dummy$_{i,t}$	0.01501	-0.03478**	0.43342***
	(0.01799)	(0.01579)	(0.07222)
Firm Age and Size Controls	YES	YES	YES
Industry*Country*Year Fixed Effects	YES	YES	YES
Observations	10,121,532	10,121,532	7,956,552
AdjR2	0.0203	0.0249	0.832

Note: Industry zombie shares refer to the industry share of capital sunk in zombie firms, defined as firms aged ≥10 years and with an interest coverage ratio<1 over three consecutive years. Young dummy is equal to 1 if firm age is less than 6. *Log(I/K)* refers to the investment ratio, i.e. the log difference of the real capital stock; *dLogEmp* refers to the change in employment and *MFP* is the level of multi-factor productivity estimations based on the Solow-residual. Robust standard errors are clustered by country, industry and year. Industry refers to 2-digit level detail according to NACE Rev. 2, covering the nonfarm non-financial business sector (industry codes 10-83, excluding 64-66). The countries include BEL, ESP, FIN, FRA, GBR, ITA, KOR, SWE and SVN. *** denotes statistical significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Source: OECD calculations based on ORBIS.

Table A6. Different measures of zombie firms

	(1)	(2)	(3)
	Panel of 7 countries, 2003-2013		
		Interest coverage ratio	
VARIABLES	*Industry level shares*	*Non-zombie dummy*	*Non-zombie dummy*
Industry level Caballero-based zombie shares	0.07596***		
	(0.010)		
Caballero-based non-zombie dummy		0.01515***	0.01476***
		(0.000)	(0.000)
Firm Age and Size Controls	NO	YES	NO
Year Fixed Effects	YES	YES	YES
Industry Fixed Effects	YES	YES	NO
Country Fixed Effects	YES	YES	NO
Firm Fixed Effects	NO	NO	YES
Observations	4,762	6,732,049	6,732,049
AdjR2	0.143	0.237	0.0275

Note: The countries include BEL, ESP, FIN, FRA, GBR, ITA and SWE. *** denotes statistical significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Source: OECD calculations based on ORBIS.

Table A7. Zombie firms and the performance of non-zombie firms: robustness to a different definition of zombie firms

	(1)	(2)	(3)
		Panel of 7 countries, 2003-2013	
VARIABLES	*log(I/K)*	*dLog Emp*	*MFP*
Non-zombie dummy$_{i,t}$	0.08046***	0.01496***	0.11542***
	(0.00239)	(0.00105)	(0.01778)
Non-zombie dummy$_{i,t}$ X Industry zombie shares$_{s,t}$	-0.03185***	-0.01271***	0.79426***
	(0.00971)	(0.00399)	(0.07566)
Industry*Country*Year Fixed Effects	YES	YES	YES
Firm Age and Size Controls	YES	YES	YES
Observations	9,465,566	9,465,566	7,627,803
AdjR2	0.0171	0.0229	0.833

Note: Zombie shares are calculated based on the methodology of Caballero et al. (2008). See Section 3.2 for further details. *Log(I/K)* refers to the investment ratio, i.e. the log difference of the real capital stock; *dLogEmp* refers to the change in employment and *MFP* is the level of multi-factor productivity estimations based on the Solow-residual. Robust standard errors are clustered by country, industry and year. Industry refers to 2-digit level detail according to NACE Rev. 2, covering the nonfarm non-financial business sector (industry codes 10-83, excluding 64-66). The countries include BEL, ESP, FIN, FRA, GBR, ITA and SWE. *** denotes statistical significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Source: OECD calculations based on ORBIS.

Table A8. Zombie firms and capital reallocation: robustness to a different definition of zombie firms

Dependent variable: growth in the real capital stock

	(1)	(2)	(3)	(4)
	Panel of 7 countries, 2003-2013		***Cross section of 12 countries, 2013***	
VARIABLES	*Zombie measure: Based on Caballero et al. (2008)*		*Zombie measure: Based on Caballero et al. (2008)*	
MFP$_{i,t-1}$	0.08241***	0.07081***	0.06940***	0.06091***
	(0.003)	(0.004)	(0.006)	(0.008)
MFP$_{i,t-1}$ X Industry zombie shares$_{s,t}$	-0.08278***	-0.05576***	-0.06285***	-0.05592**
	(0.010)	(0.013)	(0.016)	(0.023)
Firm Age and Size Controls	YES	YES	YES	YES
Industry*Country*Year Fixed Effects	YES	YES	YES	YES
Resampling weights	NO	YES	NO	YES
Observations	6,158,509	5,257,000	901,861	755,828
AdjR2	0.0272	0.0379	0.0212	0.0458

Note: Zombie shares are calculated based on the methodology of Caballero et al. (2008). See Section 3.2 for further details. MFP is the lag of the level of multi-factor productivity estimations based on the Solow-residual, defined as the deviation from the country-industry-year mean. Robust standard errors are clustered by country, industry and year. Industry refers to 2-digit level detail according to NACE Rev. 2, covering the nonfarm non-financial business sector (industry codes 10-83, excluding 64-66). The countries in the panel include BEL, ESP, FIN, FRA, GBR, ITA and SWE and the cross-section adds AUT, DEU, KOR, PRT and SVN. *** denotes statistical significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Source: OECD calculations based on ORBIS.

Table A9. Zombie firms: pre-crisis regressions

	(1)	(2)	(3)	(4)
	Panel of 9 countries, 2003-2007		***Panel of 9 countries, 2003-2007***	
			Zombie measure	
VARIABLES	*log(I/K)*	*dLog Emp*	K-share	L-share
Non-zombie dummy$_{i,t}$	0.09596***	0.06305***		
	(0.00280)	(0.00204)		
Non-zombie dummy$_{i,t}$ X Industry zombie shares$_{s,t}$	-0.10575***	-0.02980		
	(0.02537)	(0.01871)		
MFP$_{i,t-1}$			0.08945***	0.09280***
			(0.003)	(0.003)
MFP$_{i,t-1}$ X Industry zombie shares$_{s,t}$			-0.09195***	-0.19959***
			(0.031)	(0.040)
Firm Age and Size Controls	YES	YES	YES	YES
Industry*Country*Year Fixed Effects	YES	YES	YES	YES
Observations	4,240,811	4,240,811	2,635,235	2,635,235
AdjR2	0.0175	0.0170	0.0324	0.0325

Note: Zombie shares refer to the industry share of capital (labour) sunk in zombie firms, defined as firms aged ≥10 years and with an interest coverage ratio<1 over three consecutive years. *Log(I/K)* refers to the investment ratio, i.e. the log difference of the real capital stock; *dLogEmp* refers to the change in employment and *MFP* is the level of multi-factor productivity estimations based on the Solow-residual. Robust standard errors are clustered by country, industry and year. Industry refers to 2-digit level detail according to NACE Rev. 2, covering the nonfarm non-financial business sector (industry codes 10-83, excluding 64-66). The countries include BEL, ESP, FIN, FRA, GBR, ITA, KOR, SWE and SVN. *** denotes statistical significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Source: OECD calculations based on ORBIS.

Table A10. Zombie firms and the performance of non-zombie firms: robustness to the representativeness of the sample

	(1)	(2)	(3)	(4)	(5)	(6)
			Panel of 9 countries, 2003-2013			
	A: Resampling weights with weighted zombie shares			*B: Sample of over 20 employees*		
VARIABLES	*log(I/K)*	*dLog Emp*	*MFP*	*log(I/K)*	*dLog Emp*	*MFP*
Non-zombie dummy$_{i,t}$	0.08278***	0.08640***	0.51019***	0.08426***	0.08142***	0.43408***
	(0.00470)	(0.00501)	(0.02290)	(0.00229)	(0.00222)	(0.00809)
Non-zombie dummy$_{i,t}$ X Industry zombie shares$_{s,t}$	-0.20517***	-0.04878	0.63105**	-0.09373***	-0.03109*	0.35750***
	(0.03554)	(0.03665)	(0.26735)	(0.01541)	(0.01595)	(0.06698)
Firm Age and Size Controls	YES	YES	YES	YES	YES	YES
Industry*Country*Year Fixed Effects	YES	YES	YES	YES	YES	YES
Observations	8,645,362	8,645,362	7,031,924	1,753,007	1,753,007	1,501,645
AdjR2	0.0242	0.0408	0.820	0.0422	0.118	0.834

Note: Zombie shares refer to the industry share of capital sunk in zombie firms, defined as firms aged ≥10 years and with an interest coverage ratio<1 over three consecutive years. *Log(I/K)* refers to the investment ratio, i.e. the log difference of the real capital stock; *dLogEmp* refers to the change in employment and *MFP* is the level of multi-factor productivity estimations based on the Solow-residual. Robust standard errors are clustered by country, industry and year. Industry refers to 2-digit level detail according to NACE Rev. 2, covering the nonfarm non-financial business sector (industry codes 10-83, excluding 64-66). The countries include BEL, ESP, FIN, FRA, GBR, ITA, KOR, SWE and SVN. *** denotes statistical significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Source: OECD calculations based on ORBIS.

Table A11. Zombie firms and capital reallocation: robustness to the representativeness of the sample

Dependent variable: growth in the real capital stock

	(1)	(2)	(3)	(4)
	Panel of 9 countries, 2003-2013			
	A: Resampling weights with weighted zombie shares		*B: Sample of over 20 employees*	
	Zombie measure		*Zombie measure*	
VARIABLES	K-share	L-share	K-share	L-share
$MFP_{i,t-1}$	0.07211***	0.08063***	0.07794***	0.08027***
	(0.003)	(0.003)	(0.002)	(0.002)
$MFP_{i,t-1}$ X Industry zombie $shares_{s,t}$	-0.13885***	-0.33670***	-0.05798***	-0.11518***
	(0.029)	(0.042)	(0.012)	(0.017)
Firm Age and Size Controls	YES	YES	YES	YES
Industry*Country*Year Fixed Effects	YES	YES	YES	YES
Observations	5,456,861	5,456,861	1,301,789	1,301,789
AdjR2	0.0456	0.0460	0.0477	0.0477

Note: Zombie shares refer to the share of industry capital (labour) sunk in zombie firms, defined as firms aged ≥10 years and with an interest coverage ratio<1 over three consecutive years. MFP is the lag of the level of multi-factor productivity estimations based on the Solow-residual, defined as the deviation from country-industry-year mean. Robust standard errors are clustered by country, industry and year. Industry refers to 2-digit level detail according to NACE Rev. 2, covering the nonfarm non-financial business sector (industry codes 10-83, excluding 64-66). The countries include BEL, ESP, FIN, FRA, GBR, ITA, KOR, SWE and SVN. *** denotes statistical significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Source: OECD calculations based on ORBIS.

Table A12. Zombie firms and performance of non-zombie firms: robustness to controlling for the share of old firms

	(1)	(2)	(3)
	Panel of 9 countries, 2003-2013		
VARIABLES	*log(I/K)*	*dLog Emp*	*MFP*
Non-zombie $dummy_{i,t}$	0.08085***	0.05668***	0.46277***
	(0.00995)	(0.00704)	(0.06015)
Non-zombie $dummy_{i,t}$ X	-0.12960***	-0.04290***	0.44247***
Industry zombie $shares_{s,t}$	(0.01855)	(0.01215)	(0.10557)
Non-zombie $dummy_{i,t}$ X	-0.00948	0.01696*	0.08610
Industry old firm $percentage_{s,t}$	(0.01344)	(0.00920)	(0.07498)
Firm Age and Size Controls	YES	YES	YES
Industry*Country*Year Fixed Effects	YES	YES	YES
Observations	10,121,532	10,121,532	7,956,552
AdjR2	0.0193	0.0244	0.832

Note: Industry zombie shares refer to the industry share of capital sunk in zombie firms, defined as firms aged ≥10 years and with an interest coverage ratio<1 over three consecutive years. Industry old firm percentage refers to the share of firms aged 6 years or older in the industry. *Log(I/K)* refers to the investment ratio, i.e. the log difference of the real capital stock; *dLogEmp* refers to the change in employment and *MFP* is the level of multi-factor productivity estimations based on the Solow-residual. Robust standard errors are clustered by country, industry and year. Industry refers to 2-digit level detail according to NACE Rev. 2, covering the nonfarm non-financial business sector (industry codes 10-83, excluding 64-66). The countries include BEL, ESP, FIN, FRA, GBR, ITA, KOR, SWE and SVN. *** denotes statistical significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Source: OECD calculations based on ORBIS.

Table A13. Zombie firms and capital reallocation: robustness to different measures of MFP

Dependent variable: growth in the real capital stock

	(1)	(2)	(3)	(4)
	Panel of 9 countries, 2003-2013			
	MFP: OLS definition		***MFP: Wooldridge***	
	Zombie measure		*Zombie measure*	
VARIABLES	K-share	L-share	K-share	L-share
$MFP_{i,t-1}$	0.06825***	0.07152***	0.04528***	0.04873***
	(0.002)	(0.001)	(0.001)	(0.001)
$MFP_{i,t-1}$ X Industry zombie $shares_{s,t}$	-0.07674***	-0.16045***	-0.02693***	-0.08978***
	(0.012)	(0.017)	(0.010)	(0.015)
Firm Age and Size Controls	YES	YES	YES	YES
Industry*Country*Year Fixed Effects	YES	YES	YES	YES
Observations	6,405,339	6,405,339	6,405,339	6,405,339
AdjR2	0.0228	0.0229	0.0193	0.0194

Note: Zombie shares refer to the industry share of capital (labour) sunk in zombie firms, defined as firms aged ≥10 years and with an interest coverage ratio<1 over three consecutive years. MFP is the lag of the level of multi-factor productivity estimations based on an OLS estimation or Wooldridge (2009), defined as the deviation from country-industry-year mean. Robust standard errors are clustered by country, industry and year. Industry refers to 2-digit level detail according to NACE Rev. 2, covering the nonfarm non-financial business sector (industry codes 10-83, excluding 64-66). The countries include BEL, ESP, FIN, FRA, GBR, ITA, KOR, SWE and SVN. *** denotes statistical significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Source: OECD calculations based on ORBIS.

Table A14. Zombie firms and capital reallocation: robustness to excluding zombie firms

	(1)	(2)	(3)	(4)
	Panel of 9 countries, 2003-2013		***Cross section of 13 countries, 2013***	
	Zombie measure		*Zombie measure*	
VARIABLES	K-share	L-share	K-share	L-share
$MFP_{i,t-1}$	0.08127***	0.08595***	0.06593***	0.07063***
	(0.002)	(0.002)	(0.006)	(0.005)
$MFP_{i,t-1}$ X Industry zombie $shares_{s,t}$	-0.13036***	-0.26268***	-0.07254**	-0.16482***
	(0.019)	(0.028)	(0.036)	(0.044)
Firm Age and Size Controls	YES	YES	YES	YES
Industry*Country Fixed Effects	NO	NO	YES	YES
Industry*Country*Year Fixed Effects	YES	YES	NO	NO
Observations	5,963,206	5,963,206	677,061	677,061
AdjR2	0.0307	0.0309	0.0206	0.0208

Note: The sample excludes non-zombie firms. Zombie shares refer to the industry share of capital (labour) sunk in zombie firms, defined as firms aged ≥10 years and with an interest coverage ratio<1 over three consecutive years. MFP is the lag of the level of multi-factor productivity estimations based on the Solow-residual, defined as the deviation from country-industry-year mean. Robust standard errors are clustered by country, industry and year. Industry refers to 2-digit level detail according to NACE Rev. 2, covering the nonfarm non-financial business sector (industry codes 10-83, excluding 64-66). The countries include BEL, ESP, FIN, FRA, GBR, ITA, KOR, SWE and SVN. *** denotes statistical significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Source: OECD calculations based on ORBIS.

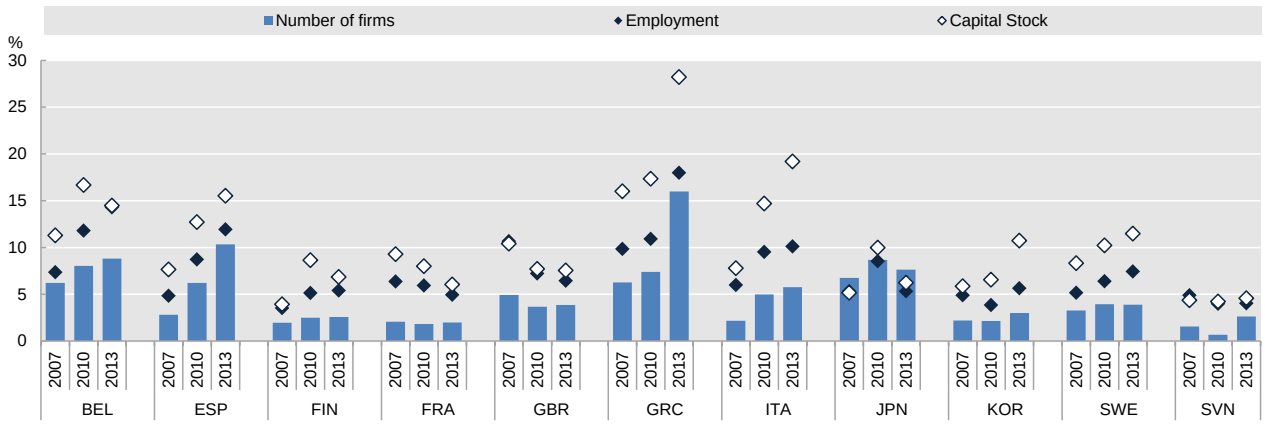
Table A15. Zombie firms and non-performing loans

Dependent Variable: Zombie Capital Share		
	(1)	(2)
	2002-2013	2002-2004 to 2011-2013
$NPL_{c,t-2}$	0.010**	0.017**
	(0.004)	(0.007)
GDP $Growth_{c,t-2}$	-0.002	0.002
	(0.003)	(0.006)
Country Fixed Effects	YES	YES
Time Fixed Effects	YES	YES
Observations	94	31
AdjR2	0.641	0.572

Note: This table shows the link between country-level non-performing loans and capital zombie shares, using all the annual observations between 2002 and 2013 (Column 1), and only observations for non-overlapping three year periods, i.e. 2002-2004, 2005-2007, 2008-2010 and 2011-2013 (Column 2). The sample includes BEL, ESP, FIN, FRA, GBR, ITA, KOR, SWE and SVN. The robust standard errors are clustered by country and year. *** denotes statistical significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Source: OECD calculations based on IMF, Financial Soundness Indicators and ORBIS.

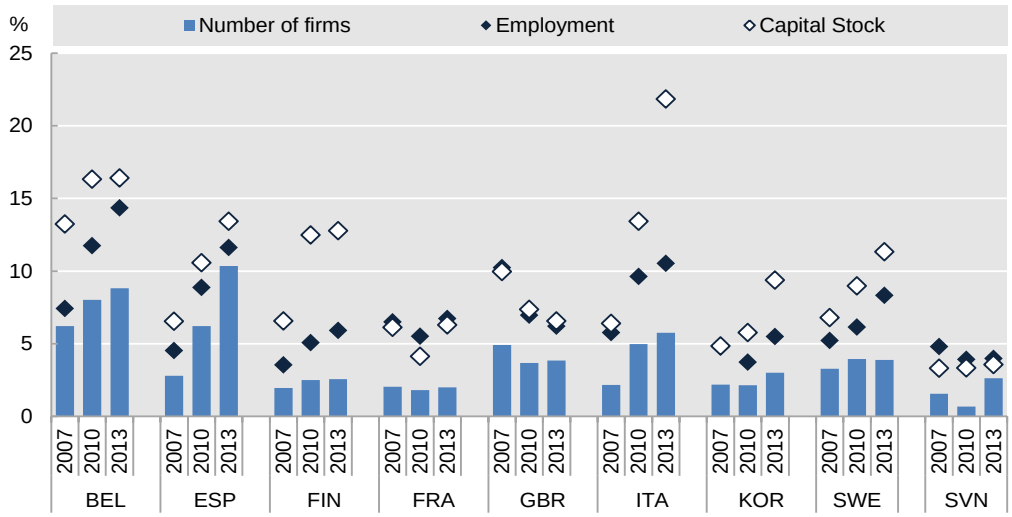
Figure A1. The prevalence of zombie firms: additional countries



Note: Firms aged ≥10 years and with an interest coverage ratio<1 over three consecutive years. Capital stock and employment refer to the share of capital and labour sunk in zombie firms. . The sample excludes firms that are larger than 100 times the 99th percentile of the size distribution in terms of capital stock or number of employees

Source: OECD calculations based on ORBIS.

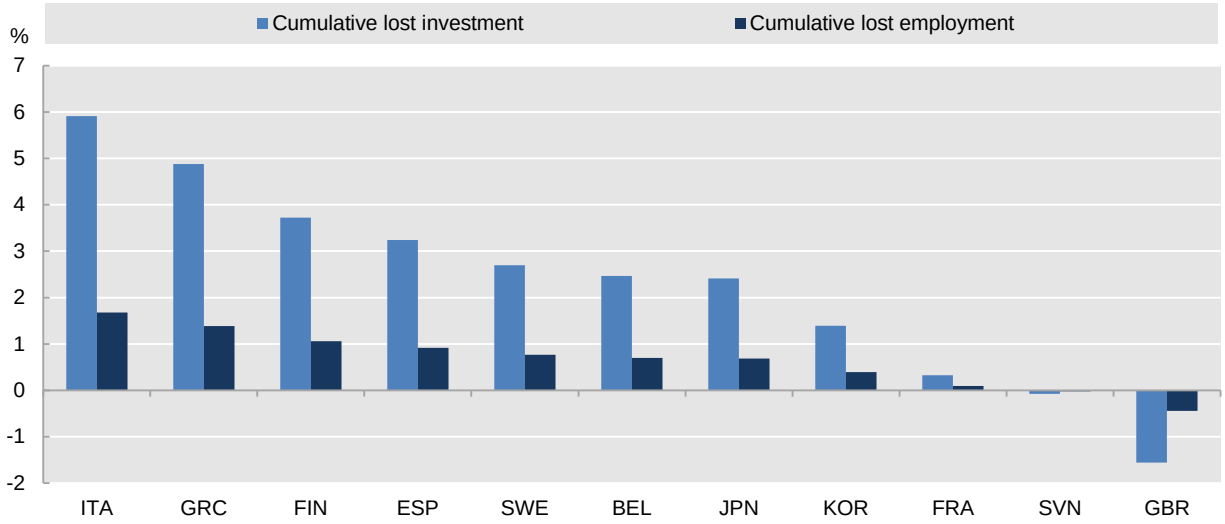
Figure A2. The prevalence of zombie firms: full sample



Note: Firms aged ≥10 years and with an interest coverage ratio<1 over three consecutive years. Capital stock and employment refer to the share of capital and labour sunk in zombie firms. For presentation purposes, a specific outlier has been removed from the share of employment sunk in zombie firms in France.

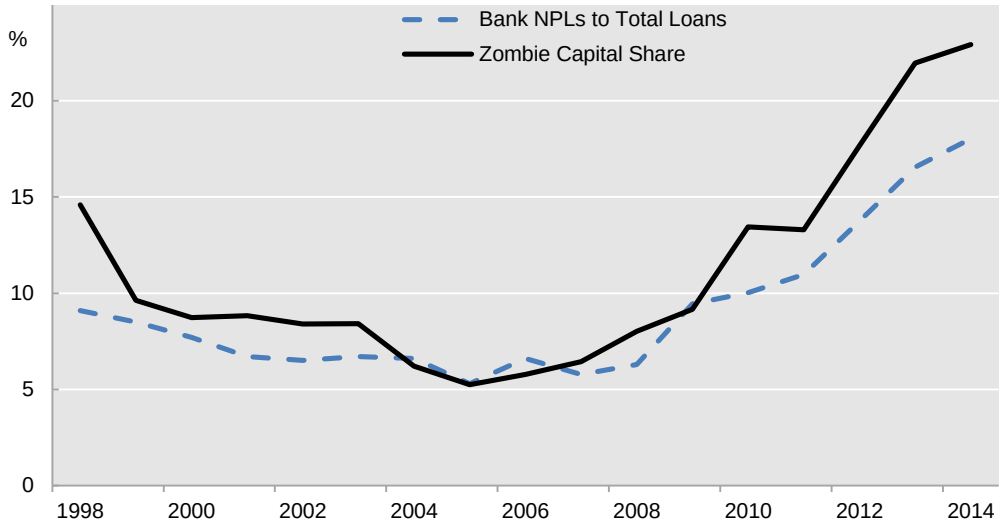
Source: OECD calculations based on ORBIS

Figure A3. Impact of zombie firms on non-zombie firm performance: additional countries



Note: This figure shows the cumulative lost investment and employment between 2008 and 2013 due to the presence of zombie firms, using the results of Table 1 (panel regression based on nine countries). The counterfactual is to keep the zombie shares at their 2007 level for the period 2008 to 2013.

Figure A4. Zombie firms and NPLs: the case of Italy



Note: Zombie capital share refers to the share of capital sunk in zombie firms, defined as firms aged ≥10 years and with an interest coverage ratio<1 over three consecutive years.

Source: OECD calculations based on IMF, Financial Soundness Indicators and ORBIS.

Box A1. Methodology of the calculation of aggregate multi-factor productivity

For each country-industry-year cell, the baseline aggregate MFP ($MFP_{c,s,t}^{BL}$) and the counterfactual MFP ($MFP_{c,s,t}^{CF}$) are calculated by aggregating firm MFP, using weights derived from computations following the Cobb-Douglas production function approach, where the capital share is 1/3 and labour share is 2/3 .

For the baseline, the composite input weight series (w_{BL}) is created from actual employment data (L) and the model's prediction of capital at the firm level based on the actual path of the zombie share(K_{BL}), while the counterfactual weights (w_{CF}) are based on the predicted capital using a counterfactual zombie share(K_{CF}).

$\mathrm{w}_{BL} = (\frac{1}{3} * \mathrm{K}_i^{BL} + \frac{2}{3} * \mathrm{L}_i) / \sum_i (\frac{1}{3} * \mathrm{K}_i^{BL} + \frac{2}{3} * \mathrm{L}_i)$ and $\mathrm{w}_{CF} = (\frac{1}{3} * \mathrm{K}_i^{CF} + \frac{2}{3} * \mathrm{L}_i) / \sum_i (\frac{1}{3} * \mathrm{K}_i^{CF} + \frac{2}{3} * \mathrm{L}_i)$, where the denominator is the sum for each country, industry and year.