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Fear the walking dead: zombie firms, spillovers and exit barriers

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Abstract
Productivity growth is slowing down among OECD countries, coupled with increased misallocation of resources. A recent strand of literature focuses on the role of non-viable firms ("zombie firms") to explain these developments. Using a rich firm-level dataset for one of the OECD countries with the largest drop in barriers to firm exit and restructure, we assess the role of zombies on firm dynamics, both in the extensive and intensive margins. We confirm the results on the high prevalence of zombie firms, significantly less productive than their healthy counterparts and thus dragging aggregate productivity down. Moreover, while we find evidence of positive selection within zombies, with the most productive restructuring and the least productive exiting, we also show that the zombies' productivity threshold for exit is much lower than that of non-zombies, allowing them to stay in the market, distorting competition and sinking resources. Zombie prevalence curbs the growth of viable firms, in particular the most productive, harming the intra-sectoral resource reallocation. We show that a reduction in exit and restructuring barriers promotes a more effective exit channel and fosters the restructuring of the most productive, highlight the role of public policy in addressing zombies' prevalence, fostering a more efficient resource allocation and enabling productivity growth.

JEL: D24, E22, E24, G33, J24, L25

Keywords: Zombie Firms, Resource Allocation, Labor Productivity, Firm Dynamics, Insolvency Frameworks.

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1. Introduction

The last decades have seen enormous progress in information and communication technologies (ICT), increased participation of firms in global value chains, improved healthcare and a better than ever educated workforce (Peña-López, 2017; Jack and Lewis, 2009). These developments can be seen everywhere except in productivity statistics, as aggregate data show a slowdown in global productivity growth.[1] The "productivity paradox" has raised a debate about the underlying reasons. The mismeasurement of productivity in the era of the digital economy is certainly playing a role but its contribution seems to be limited.[2] Beyond measurement, there are a number of structural headwinds - such as the aging workforce, the slowing global trade and the fading ICT boom - that weigh on productivity growth (Adler et al., 2017). And some authors point to fundamental differences between current innovations and past breakthroughs, such as the steam engine or electricity.[3]

Firm-level data adds an interesting result to this discussion: not all firms have slowed down. The most productive (those at the frontier) continue to grow, while the other firms (the "laggards") have stagnated, thus contributing to a growing performance gap vis-à-vis the frontier (Adalet McGowan et al., 2017a; Andrews et al., 2016). Portugal is no exception to this pattern (Figure 1). The increased dispersion is a surprising result, as one would expect the gap to close rather than widen: models of competitive diffusion would predict laggard companies to adopt frontier technology; and, in line with the Neo-Schumpeterian growth theory, laggard firms would be forced to exit (Andrews et al., 2016).

On the diffusion models, some scholars point to the emergence of "winner takes it all" dynamics and increased market concentration (Autor et al., 2017; Grullon, Larkin and Michaely, 2017; Loecker and Eeckhout, 2017; Blonigen and Pierce, 2016; Reich, 2016; Krugman, 2015), with a structural breakdown in the usual technological diffusion mechanism. For the United States, Gutierrez and Phillipon (2017a/b) show that the increased market concentration is

1. Already in 1987, in a book review to the The New York Times, Robert M. Solow stated "You can see the computer everywhere but in the productivity statistics."

2. Adler et al. (2017) argue that while mismeasurement is an issue, the change in the measurement error accounts for less than one-tenth of the productivity growth slowdown in the US. Byrne et al. (2016) provide a measure of the error, comparing the period 1995-2004 and 2004-2014, finding no evidence that it has increased. Please refer to Box 1 in Adler et al., 2017 for further details on measurement issues.

3. Gordon (2017) argues that innovation has actually stalled, with recent innovations being much less disruptive than others, such as the steam engine, were in the past. Brynjolfsson and McAfee (2014) disagree with this view, considering that, as it was the case with the steam engine, one needs time before the gains from the new technology are actually absorbed and potentiated. The authors consider that we are approaching an inflection point, entering what they call the Second Machine Age.

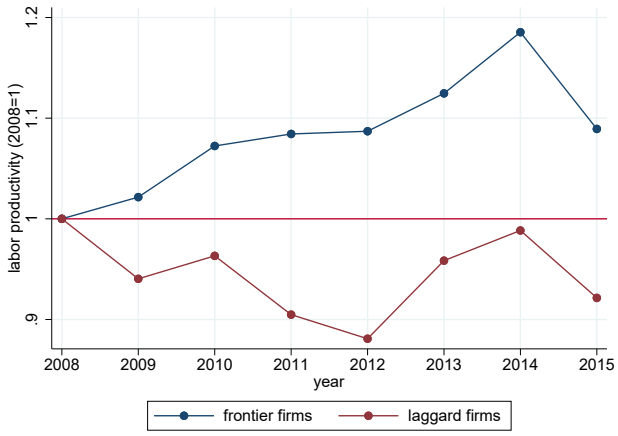

FIGURE 1: Labor productivity developments in Portugal from 2008 to 2015 - frontier v. laggard firms.

Source: Authors' own computations based on firm-level data from Informação Empresarial Simplificada (IES). Notes: Labor productivity defined as gross value added per worked hour. Frontier firms are the top 10% most productive companies in each two-digit sector (non-financial and non-farming 2-digit NACE Rev. 2) in each year. Indices are computed at industry level and averaged across industries.

potentiated by regulation and discourages laggards investment.[4] This is further exacerbated by poor governance at firm-level and increased short-termism (Gutierrez and Phillipon, 2017a/b). Moreover, human capital limitations, in particular at managerial level - an important determinant of ICT absorption - have been acting as a drag on growth, in particular in some European countries that are lagging behind US counterparts (Bloom et al., 2012; Pellegrino and Zingales, 2017; Queiró, 2016). Tackling these bottlenecks could therefore provide a boost to more widespread productivity growth.

On the Neo-Schumpeterian predictions, an increasing body of research uncovers a rising capital and labor misallocation, in particular within industries, harming the creative destruction process and being an important driver of the productivity slowdown (Cette et al., 2016, García-Santana et al., 2016; Gopinath et al., 2017; ECB, 2017; Lenzu and Manaresi, 2018; Andrews and Petroulakis, 2017). This trend is also visible for Portugal, both across sectors (Reis, 2013; Benigno and Fornaro, 2014) - in particular towards non-tradables - and within sectors (Dias et al., 2014; Gopinath et al. 2017) - with within industry misallocation almost doubling between 1996 and 2011. Increased

4. The authors also show that increased market concentration is less of an issue in Europe, with some industries becoming less concentrated.

misallocation is linked with curtailed firm dynamics, both in the extensive and intensive margins: the least productive are able to remain in the market, congesting markets and thus hampering entry and hindering the growth of viable firms (Criscuolo et al., 2014; Decker et al., 2016). Recent research highlights the role of the banking sector in promoting misallocation and curbing productivity, both within and across firms, by lending to firms that are not necessarily the most productive (Duval et al., 2017; Storz et al., 2017; Acharya et al., 2017; Schivardi et al., 2017; Blattner et al., 2018).

Building on the work for the Japanese economy (Caballero et al., 2003; Hoshi and Kashyap, 2004; Caballero et al., 2008), a recent strand of literature, led by the OECD, links these developments with the emergence of zombie firms (Adalet McGowan et al., 2017a/b/c), as the result of depressed creative destruction.[5] By remaining in the market, despite their low productivity, zombie firms increase productivity dispersion and drag aggregate productivity down. This is reinforced by their negative spillovers in particular on laggard healthy firms (and on potential entrants), as zombies crowd out available resources - both financing and human capital - and distort competition in product and input markets, by congesting markets, depressing prices, increasing wages above productivity and reducing the market share available for viable firms to grow (Caballero et al., 2008; Adalet McGowan et al., 2017a; Schivardi et al., 2017).

Using a comprehensive set of firm-level data for Portugal, covering all firms from 2006 to 2015, we contribute to the literature on the role of zombie firms in explaining resource misallocation, by reinforcing the evidence on the negative spillovers on healthy firms (intensive margin) and by providing novel evidence on the extensive margin. Portugal is a rich case study as it is one of the OECD countries with the largest decrease in exit and restructure barriers in recent years (see Section 3.2). This provides a good quasi-natural experiment to assess the role of policy barriers. Also, studying zombie spillovers on a country that underwent a deep crisis brings additional insights into the literature, also on the intensive margin channel: while spillovers may be lower during deep recessions, as there are lower outside opportunities for the resources captured by zombies, externalities may also be potentiated given the more restricted supply of credit, thus amplifying the crowding out effect.[6] Finally, the coverage of our database, including all Portuguese firms, is an improvement vis-à-vis studies that focus only on listed-firms and also solves the possible selection bias in cross-country

5. As noted by Timothy Taylor, editor of the Journal of Economic Perspectives, the reference to zombie firms dates back to the 1980s, on a study on the savings and loan industry in the US (Kane, 1989).

6. It adds that, as noted by Schivardi et al. (2017), there may be positive externalities from the non-failure of zombies, due to aggregate demand effects both on input and product markets, and that are particularly important during deep recessions. These effects, however, affect both zombies and non-zombies and are thus not captured by models of relative effects.

studies that use samples where certain industries and smaller, younger firms are underrepresented. The results for Portugal are certainly relevant for a number of countries that face similar challenges, as the increased misallocation is a widespread phenomenon and the zombies' characteristics and prevalence display cross-country regularities.

We confirm the results in the literature on the high prevalence of zombie firms in the economy, being significantly less productive than their healthy counterparts.Therefore, zombies increase the productivity dispersion and drag aggregate productivity down. Furthermore, and although we find evidence of positive selection within zombies, with the most productive restructuring and the least productive exiting, we also show that the zombies' productivity threshold for exit is much lower than that of non-zombies, allowing them to stay in the market, distorting competition and sinking resources. This curbs the growth of viable firms, in particular the most productive, harming the intra-sectoral resource reallocation. We show that a reduction in exit and restructuring barriers promotes a more effective exit channel, disproportionately fostering the exit of the non-viable firms, and fosters the restructuring of the most productive within zombies, highlighting the role of public policy in promoting an improved resource allocation within sectors and thereby unlock productivity growth.

The remainder of the paper is organized as follows. Section 2 reviews the literature on zombie firms, including a discussion on the quantitative criteria to define a zombie. Section 3 elaborates on the rich set of data used in the analysis and Section 4 takes stock of the characteristics of zombie firms and their dynamics. The empirical framework for assessing the impact of zombie congestion on non-zombie firms and the impact of policy induced-barriers on zombies' exit and restructuring is developed in Section 5, where we also present and discuss the results. Section 6 concludes, discussing avenues for future work and possible policy complementarities.

2. Literature Review on Zombie Firms

2.1. A prior on the definition of zombies

In economic terms, a zombie is a firm that is not viable and therefore, when competitive forces are at play, should be compelled to exit the market or, where feasible, restructure. Translating this into a quantitative definition is an important challenge. The literature offers different possibilities (see Adalet McGowan et al., 2017a for an overview).

Caballero et al. (2008) consider a firm to be a zombie if it receives financial help from their creditors to survive, in spite of poor profitability. In practice, the authors compare the interest rate paid by the firm to a reference interest rate, that of the highest quality borrowers. Those firms with a negative interest

rate gap are receiving subsidized credit and thus are considered to be zombies. The method is very data demanding, implying detailed knowledge of each firm debt distribution. The authors focus on a sub-set of listed firms with publicly available information and for which it is possible to compute the reference rate, by relying on data for those firms with AAA-ratings. Their dataset covers the period 1981-2002, reaching, at most, 2500 firms per year.

Other authors rely on the operating characteristics of the firm. Bank of Korea (2013) classifies a firm as a zombie if the operating income is lower than interest expenses - i.e. if the interest coverage ratio is lower than 1 - for at least three consecutive years. Building on this, recent work by the OECD (see, for example, Adalet McGowan et al. 2017a) add an age criterion - firms need to be older than 10 years, in order to avoid erroneously classifying start-ups as zombies. Another option, followed by Storz et al. (2017), classifies a firm as zombie if, for two consecutive years, it shows negative return on assets and negative net investment and, also, a debt servicing capacity (EBITDA to total financial debt) lower than 5%. Schivardi et al. (2017) combine two criteria: return on assets below the cost of capital for the safest borrowers (three year average) and financial debt over assets above 40% (testing, also, alternative thresholds).

Given that we rely on administrative data, the application of Caballero et al. (2008) methodology is not possible. In any case, as we have the population of firms in Portugal rather than a sub-sample of listed - and thus larger - firms, it would be difficult to motivate the use of AAA-rated firms interest rates as benchmarks. We could compute the implicit interest rate on the stock of debt for each firm and compare it with that of top performing firms or those with lowest rates but, given the level of detail and the type of data in IES database (on top of an important break on the debt series in 2010), it would be a rather crude measure of interest rate subsidies.

In this paper, we focus on the OECD criterion. However, given changes in accounting standards, EBIT as reported in IES has an important break in 2010. To overcome this, we compile a simplified EBIT measure - turnover and subsidies to production net of cost of goods sold, services and external supplies, labor costs and depreciation - consistent across the entire period. Importantly, it excludes financial income, due to the difficulties in compiling a consistent time series over the entire period, and thus it is a less stringent zombie definition in comparison with that used by the OECD.

The three-year condition is important in addressing the pro-cyclicality concerns on the zombie status (also addressed with the sectoral-time fixed effects included in the regressions that follow). Given the severity of the crisis that impacted Portugal, we also test for a more stringent time criteria, imposing a five-year period. Moreover, in order to have a more symmetric measure on the non-zombies status, we compute an alternative specification where firms, once declared zombies, can only become non-zombies after three periods of interest coverage ratios higher than 1. On the criticism that by focusing only

on firms with more than 10 years, one ignores many firms that enter and leave the market before completing 10 years, it should be noted that the objective is not to focus on unhealthy firms, but on unhealthy firms that endure in the market. That is the very definition of a zombie firm.

In any case, it is not likely that the results depend critically on the criteria chosen as they are broadly consistent. By computing a simplified version of Caballero at al. (2008) methodology, Adalet McGowan et al. (2017a) show that it is positively and significantly correlated with their own definition. Storz et al. (2017) and Schivardi et al. (2017) replicate their results using the interest coverage ratio criteria followed by the OECD, with limited impact on the results. Adalet McGowan et al. (2017a) also test for different variations of their own criteria, again with no major changes. This highlights that more important than the level of zombie congestion - which is different for different criteria - what matters are the dynamics of zombie prevalence across time and sectors.

2.2. Existing results on zombie firms

Historically, the academic analysis of zombie firms originated with the Japanese macroeconomic stagnation in the 1990's (Caballero et al., 2003; Hoshi and Kashyap, 2004; Caballero et al., 2008), but there are even earlier references (see the application to the savings and loans industry in the US in Kane, 1989). Caballero et al. (2008) argue that zombies in the Japanese economy reduce market prices, increase market wages and congest markets, reducing profits, discouraging entry and investment and limiting viable firms' expansion. Applying the definition discussed in the previous subsection, the authors show a sharp increase of zombie prevalence in the early 1990's, stabilizing at high levels from mid 1990's to 2002, the end year of the sample. By relying on a reduced form model of spillovers of zombie congestion, the authors show that a higher share of capital sunk in zombie firms reduces the growth differential of healthy firms vis-à-vis zombies.

Building on this work, a recent OECD workstream studies the zombie phenomenon for a sample of OECD countries over the period 2003-2013. Adalet McGowan et al. (2017a) show that the share of zombie firms has increased in several OECD countries which, coupled with the fact that zombies are, on average, larger than non-zombies, translates into high shares of capital sunk in non-viable firms. The increased zombie prevalence is a widespread phenomenon, particularly among European countries, with a steady decline in interest rate coverage ratios since 2011, despite the low interest rate environment (IMF, 2017 and Mahtani et al., 2018). The spillover mechanisms detailed in Caballero et al. (2008) are corroborated for OECD countries: within industries, the capital sunk in zombies reduces employment growth and investment for the average non-zombie in relation to zombies, and more so for the most productive firms, harming the process of resource reallocation (Adalet McGowan et al., 2017a). The reduced investment by non-zombie firms stifles innovation and technology

advances, also depressing within-firm productivity growth (Cooper et al., 1995; Adalet McGowan et al., 2017a).

An increasing body of literature deals with the link between the financial sector and the prevalence of zombies. Financial frictions harm the most vulnerable firms - i.e. those with higher rollover risk, higher debt overhang and/or lower collateral - which are not necessarily the least productive (Duval et al. 2017). Also, in particular when exit barriers are high, financial frictions foster the survival of firms that should otherwise exit the market, via bank forbearance, as a way to avoid realization of losses, in particular as weaker firms are associated with weaker banks (Blattner et al., 2018; Storz et al., 2017; Schivardi et al., 2017; Acharya et al., 2017; Arrowsmith et al., 2013; Peek and Rosengren, 2005). Relationship banking is also a potential factor fostering zombie lending, as zombies are on average older (Peek and Rosengren, 2005). In China, zombie firms, strongly linked to state-owned enterprises, are not only less productive than the rest, but are also a significant part of the rising level of corporate debt (Lam et al., 2017). Furthermore, there is again evidence of negative spillovers, as the restricted credit availability reduces the exit of non-viable firms at the expense of healthier firms (Schivardi et al., 2017 and Anderson et al., 2017).

Exit and restructuring barriers play an important role in zombie congestion. Evidence suggests that better insolvency frameworks are associated with a higher likelihood of zombie restructuring, higher TFP growth for laggards (by providing incentives to experimentation and by allowing for easier structural changes at the firm-level) and reduced zombie congestion (Adalet McGowan et al., 2017b/c), also as they increase the incentives for banks to initiate restructuring (Andrews and Petroulakis, 2017). This is particularly relevant given that healthy firms have more difficulties to access credit in markets with higher zombie prevalence and that improvements in bank health are more likely to reduce zombie congestion when insolvency regimes are of better quality (Andrews and Petroulakis, 2017).

3. Data

3.1. Firm-level data

We rely on a comprehensive set of firm-level data for the period 2006 to 2015, the *Informacao Empresarial Simplificada*(IES) provided by Banco de Portugal. IES covers the entire population of Portuguese firms, including profit and loss and balance sheet data. The classification of industries is made in accordance with the Statistical Classification of Economic Activities in the European Union, Revision 2 (NACE Rev. 2). The data used in this paper cover NACE

Rev. 2 industry codes 10-83, excluding 64-66.[7] Values are deflated either by industry-specific gross value added (GVA) deflators or industry-specific gross fixed capital formation (GFCF) deflators, depending on the variable, at one-digit level, obtained from Statistics Portugal (INE).

A number of adjustments to the dataset are needed to ensure the robustness of the results. Observations with negative and nil values for the variables turnover, assets, tangible assets, total workers, paid workers, worked hours and labor costs are dropped. Assumptions of feasible working hours are made to account for misreporting. If a firm fulfills the zombie definition but has a one year gap in data reporting, the "three consecutive years" criterion does not hold, hence the firm would falsely be classified as a non-zombie. To account for this and in order not to bias the zombie identification in favor of non-zombies, one year reporting gaps have been interpolated linearly. Firms with overall more than a one-year reporting gap are discarded. After data treatment, the unbalanced panel dataset includes 343,180 firms and 1,875,545 observations.

A change in accounting standards has taken place from 2009 to 2010 and therefore, for some variables, it was necessary to do a detailed mapping between the two datasets (2006-2009 and 2010-2015), to maximize comparability. The use of ratios and time controls also minimizes the impact of these changes (Banco de Portugal, 2011). To apply the zombie classification, we compute the interest coverage ratio as earnings before interest and tax (EBIT) divided by interest expenses. As discussed in Section 2.1 and due to an important break in the EBIT series in 2010, our measure of EBIT is a simplified one, to allow for a consistent time series over the entire period. Labor productivity is defined as gross value added (GVA) per hour worked. We calculate GVA as the sum of turnover and operating subsidies, minus cost of goods sold and supplies and external services, following Banco de Portugal (2014). Robustness checks with GVA per worker are also performed. Concerning tangible and intangible assets, as the accounting rules have changed considerably and given the issues with intangible assets measurement and (under)reporting, intangibles are only included for the robustness checks. To limit the impact of outliers, in the regression analysis we focus on firms with at least 3 workers and exclude the percentiles 1 and 99 of the dependent variable.

Figure 2 presents descriptive statistics for the main variables used in the paper.

7. The following sectors are excluded: Agriculture, forestry and fishing; Mining and quarrying; Financial and insurance activities; Public administration and defense, compulsory social security; Education; Human health services; Residential care and social work activities; Arts, entertainment and recreation; Other services; Activities of households as employers; Activities of households for own use; and Activities of extra-territorial organizations and bodies.

Variable	Unit	Mean	Median	Std. Dev.	Min	Max
Turnover	10^3 €	1.349	152	27.501	0	9.699.709
GVA	10^3 €	289	44	4.934	- 150.234	1.287.741
Worked Hours	hour	21.039	6.336	195.607	961	37.989.600
Total Workers	unit	12	4	108	1	23.768
Tangible Assets	10^3 €	444	22	15.699	0	4.646.097
Intangible Assets	10^3 €	82	0	8.289	0	2.964.748
EBIT	10^3 €	39	2	2.315	- 379.964	792.503
Interest paid	10^3 €	25	1	1.229	0	783.815

FIGURE 2: Descriptive Statistics for Portuguese Firm-Level Data, 2006-2015

Source: Authors' own computations based on IES.

3.2. Data on exit and restructuring barriers

To study the link between insolvency regimes and firm dynamics, we use the new country-level OECD composite insolvency indicator, ranging from 0 to 1 and increasing in exit and restructuring barriers. The indicator is available for 2010 and 2016 and is a combination of 12 different sub-indicators, as presented in Figure 3 (see also Adalet McGowan et al., 2017c). When the composite indicator is high, i.e. close to 1, the attached exit and restructuring costs most likely lead to a delay in the initiation of the insolvency or restructuring process and prolong the duration of the proceedings (Adalet McGowan et al., 2017b).[8]

Portugal registered one of the largest improvements among OECD countries in recent years (Figure 4). Major changes occurred in 2012, in the context of the 2011-2014 Economic Adjustment Programme. The reforms, inspired by the US insolvency framework (the famous Chapter 11), aimed at fostering the recovery of viable firms and the liquidation of non-viable ones. Changes included the amendment of the insolvency code, bringing it closer to international best practice (for instance by granting priority for new financing); a in-court fast track procedure for pre-arranged restructuring plans (PER - *Programa Especial de Revitalização*); and an out-of-court corporate recovery system (SIREVE - *Sistema the Recuperação de Empresas por Via Extra-Judicial*), targeting mainly smaller firms (World Bank, 2017; Dinis and Cordas, 2017; European Commission, 2016; IMF, 2016). Moreover, in 2014 Banco de Portugal developed an early warning tool for banks to detect firms in risk of default and in 2015 IAPMEI (the Portuguese competitiveness and innovation agency) created a tool for firms' self-assessment. Based on the dates of these changes, we annualized

8. The indicator is a *de jure* measure, focusing on the quality of the framework in each country. Although the OECD also collects some information on outcome measures, it is difficult to build a comparable *de facto* indicator on a cross-country basis.

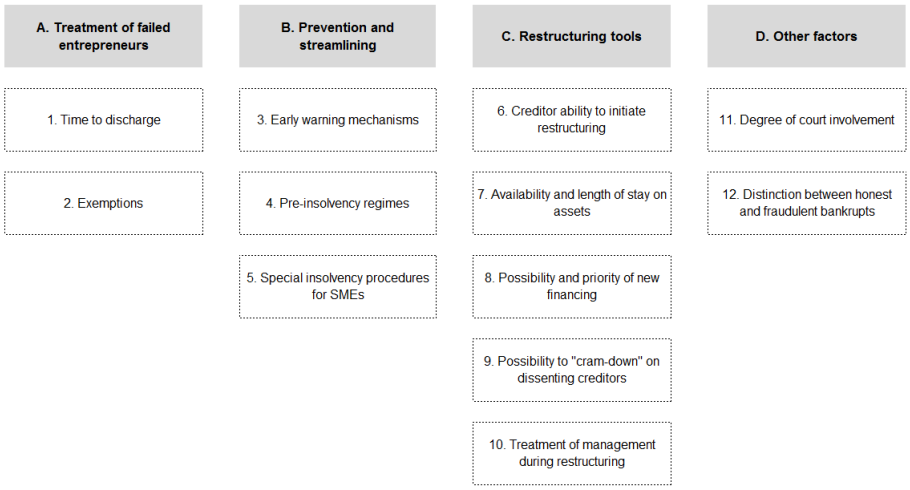

FIGURE 3: Composition of the OECD indicator on insolvency regimes

Source: OECD.

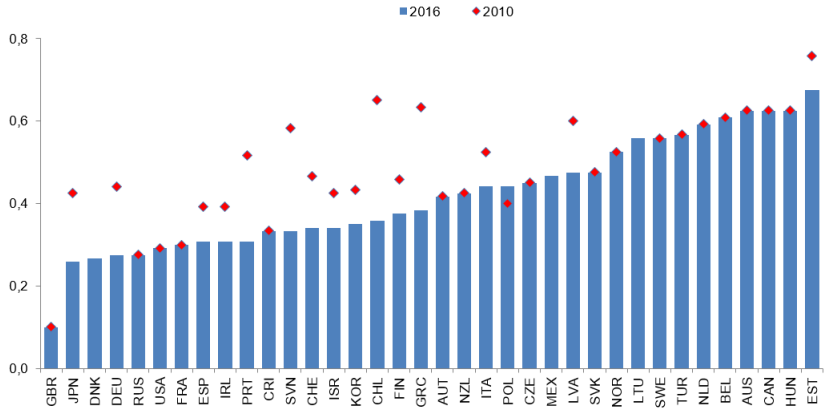

FIGURE 4: OECD indicator on insolvency regimes: 2010 and 2016

Source: OECD.
Notes: Increasing in the extent to which the insolvency regime delays the initiation and resolution of proceedings.

the OECD indicator in order to build an annual time series capturing exit and restructuring barriers.[9]

9. PER was established by Law 16/2012 and SIREVE by Decree-law 178/2012. They were fine-tuned by Decree-law 26/2015. More recently, Law 8/2018 created RERE - *Regime Extrajudicial de Recuperação de Empresas*, largely replacing SIREVE.

As it is not expected that these barriers affect all industries equally, data on industry-level firm turnover rates (entry plus exit rate) of the UK and the US are used to measure the exposure of each industry (a similar approach is conducted by Bottasso et al., 2017 and Adalet McGowan et al., 2017c). The markets of the UK and the US are relatively unregulated and are thus used to approximate *natural* turnover rates of each two-digit industry. Industries with higher *natural* turnover rates are more exposed to policy-induced insolvency regime changes than industries with lower turnover rates. By using turnover rates for the UK and the US we account for endogeneity issues as the industry-level firm turnover rates in Portugal are dependent on the existing structural policies and, in particular, on the existing insolvency framework. For the UK data, the SDBS Business Demography Indicators (ISIC Rev. 4) OECD database is used to compose a three-year average between 2012 and 2014 in NACE Rev. 2 industry classification. For the US data, the SDBS Business Demography Indicators (ISIC Rev. 3) is matched to ISIC Rev. 4 classification and aggregated to 2-digit NACE Rev. 2. A six-year average between 2007 and 2012 is used for the US. Exposure ranges from 11 to 44 in the case of the UK and from 7 to 22 for the US data.

The industry-level measure of exit and restructuring barriers is thus computed as:

$$Barriers_{s,t} = InsolvencyFramework_t \times NaturalTurnoverRate_s^{uk,us}$$

where the annualized insolvency indicator, *InsolvencyFramework*, is weighted by the proxied *natural* industry turnover rate $NaturalTurnoverRate$ of the UK or US.

4. Zombie prevalence

Following Adalet McGowan et al. (2017a), we define zombie firms as those that are at least ten years old and whose interest coverage ratio is smaller than one for at least three consecutive years.[10] Data are available as of 2006, hence the zombie classification can be applied from 2008 onwards, the first year in which a firm could possibly trespass the "three consecutive years" condition. This section provides an overview of the patterns of zombie prevalence over time and of the characteristics of zombie firms.

Our data show a positive correlation between size and labor productivity in all but four 2-digits sectors (from a total of 63 sectors) - hinting that, within

10. Alternative specifications are tested for robustness checks. As explained in Section 2.1, our level results are not comparable with those of the OECD (which study Portugal only in 2013), given the need to have an EBIT measure fully consistent across the entire time span (2006-2015).

each sector, the most productive are able to grow. However, there are also signs of increased intra-sectoral misallocation, with increases in the within-sector interquartile range and standard deviation of labor productivity, suggesting problems at the exit margin. An analysis of zombie firm patterns confirms this. While zombies are more likely to leave the market, with an average exit rate of 13.3% (10.7% for non-zombies; 7.9% if one considers those in the same age bracket as zombies, i.e. 10 years or more), zombie firms that leave are 100% below the average of the sector (which means that they have around zero labor productivity) while the average non-zombie leaving the market is 30% below average. Conversely, while the average non-zombie that remains in the market is 9% more productive than the sectoral average, for zombies the deviation is negative (-50%).

While zombie status is quite persistent, with more than two-thirds of zombies remaining zombies in the subsequent two years, there is also evidence of positive market selection within zombies, with the less productive exiting and the most productive restructuring.[11] However, these positive market forces do not hold across zombies and non-zombies. Zombies remain in the market even if they are half as productive as the average firm in their industry. In general, while firms that exit are, on average, less productive than those that stay (in relation to the sectoral average), the labor productivity deviation threshold for exit is much more lenient for zombies.

From this analysis, one expects zombie firms to be rather prevalent in the economy.[12] Overall, zombies are around 6.5% of all Portuguese firms in 2008, increasing steadily to 8.5% in 2013. This pattern is similar to that of other countries, such as Spain, Belgium and Italy (Adalet McGowan et al., 2017a). Since 2013, the relative number of zombies decreased to close to 6% in 2015. These figures are, however, poor measures of zombie prevalence. As illustrated in Figure 5, zombie firms are not only less productive than their healthier counterparts (average deviation towards the 2-digits sectoral mean), but they are also larger - in terms of employment, turnover and assets - and older.[13]

11. Firms that restructure are defined as those that were zombies in t-1 and managed to become non-zombies in t and remain healthy in t+1).

12. Note that a direct comparison with other studies is difficult as the universe of firms considered does not coincide and the quantitative measures to define zombie vary. For these reasons, a qualitative comparison of dynamics is more appropriate than a direct comparison of levels.

13. These characteristics make them more prone to get access to credit, as they have more collateral, in the form of tangible assets, and are more likely to have longer relations with banks. Gopinath et al. (2017) find that capital is allocated to firms with higher net worth, not necessarily the more productive. Being larger in terms of employment also implies large social costs from failure, which, as argued by Adalet McGowan et al. (2017a), may make them more likely to receive government subsidies or support in order to limit potential employment losses, in particular during recessions.

Variable	Unit	Zombie	Non-Zombie	p-value*
Total Workers	unit	23	15	0,000
Turnover	10^3 €	3.168	1.871	0,000
Tangible Assets	10^3 €	1.418	546	0,000
Intangible Assets	10^3 €	191	136	0,000
Firm Age	years	24	22	0,000
Labor Prod Deviation	%	- 57	19	0,000
No of Obs	unit	111.527	662.328	

FIGURE 5: Comparison of the average zombie and non-zombie firms

Source: Authors' own computations based on IES.
Notes: In this Table, the non-zombie population is restricted to those with more than 10 years in order to allow for a meaningful comparison with the data on zombies (which by definition are older than 10 years). Labor productivity is defined as gross value added per hour worked. The Shapiro-Wilk W test for normal distribution shows that the variables are not normally distributed. Thus a Mann-Whitney test, a generalized t-test, is being used.

Thus, zombies' economic relevance is better ascertained with measures of capital and labor sunk - i.e. the share of resources that they capture. Given important sectorial heterogeneity (as also described by Caballero et al., 2008), Figures 6 and 7 present sunk resources aggregated by main sector of activity, comparing the evolution from 2013 (where the share of zombies in the overall economy reached its maximum) to 2015 (the most recent period).[14] Zombie prevalence for the different sectors, ranges, in 2015, from below 10% to more than 30% in terms of capital and from below 5% to 25% in terms of labor. While the overall tendency is of reduced zombie congestion, there are some sectors where resources sunk in zombies increased from 2013 to 2015. The figures also show that capital is more flexible, with more cross-time variation than labor.[15]

Overall, results of the descriptive analysis are consistent with OECD findings, pointing at cross-country regularities. Zombie firms are on average larger companies and significantly less productive than their healthy counterparts, pushing labor productivity down. Furthermore, there is evidence

14. For presentational purposes, we aggregate data at the branch of activity CAE letter code, whereas in the analytical part that follows we use the more detailed 2-digits breakdown. Industries, with weights in 2015 turnover: C - Manufacturing (27%); D - Electricity, gas, steam and air conditioning supply (4%); E - Water supply, sewerage, waste management and remediation activities (1%); F - Construction (5%); G - Wholesale and retail trade, repair of motor vehicles and motorcycles (43%); H - Transportation and storage (5%); I - Accommodation and food service activities (3%); J - ICT (5%); L - Real estate activities (1%); M - Professional, scientific and technical activities (3%); N - administrative and support service activities (3%).

15. As explained before, the level varies with the use of more or less stringent zombie definitions. Therefore, the analytical focus should be on the time dynamics and the sectoral differences, which are broadly robust to the zombie definition.

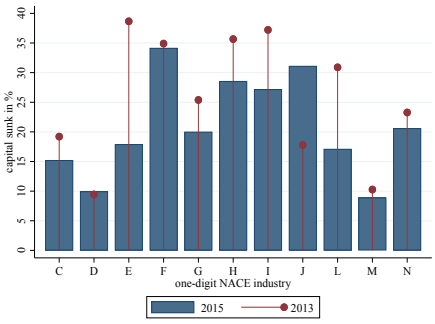

FIGURE 6: Capital sunk - industry level

Source: Authors' own computations based on IES. For each branch of activity, the chart displays the share of tangible assets held by zombie firms.

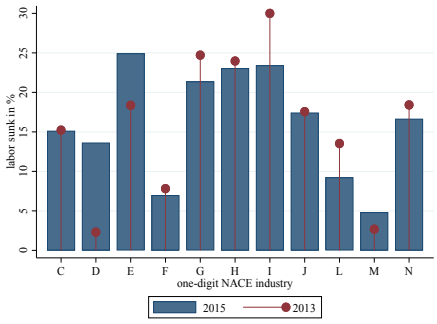

FIGURE 7: Labor sunk - industry level

Source: Authors' own computations based on IES. For each branch of activity, the chart displays the share of workers employed in zombie firms.

of distortions at the exit margin, as zombies remain in the market and absorb a significant part of capital and labor, with high heterogeneity at sectoral level.

In the next section, we explore the sectoral asymmetries to assess the consequences of zombie congestion on within-industry reallocation and shed light on the role of policy-induced barriers on the exit and restructuring of zombies.

5. Empirical Framework

Zombie firms are less productive than their non-zombie counterparts and capture a non-negligible part of capital and labor, providing evidence of misallocation of resources towards non-viable firms. It is thus important to understand the possible adverse effects of zombie congestion on healthy firms' growth and on intra-sectorial resource allocation towards the most productive (intensive margin) and, also, to assess the role of policy-induced barriers in hampering the exit or restructuring of zombies (extensive margin).

5.1. Intensive margin

Following the specification in Caballero et al. (2008) and Adalet McGowan et al. (2017a), we test whether zombies entail negative spillover effects on viable firms. In particular, we rely on panel data from 2006 to 2015 to estimate a reduced-form equation on the impact of zombie sectoral congestion on investment and employment growth of the average non-zombie firm in that sector:

$$\delta Y_{i,s,t} = \beta_0 + \beta_1 nonzombie_{i,s,t} + \beta_2 nonzombie_{i,s,t} \times RS_{s,t} + \beta_3 Firmcontrols_{i,s,t-1} + FE_{s,t} + \varepsilon_{i,s,t} \quad (1)$$

where δY denotes capital or employment growth of firm i in a 2-digit industry s in year t, defined as the log difference in tangible assets or in total workers from one year to the other. The dummy *nonzombie* takes the value 1 for non-zombie firms and 0 otherwise. RS is a measure of industry resources sunk in zombie firms, which, depending on the specification, is measured either as KS or LS, taking values between 0 and 1. KS represents the share of tangible assets of zombie firms as a fraction of total tangible assets of all firms in each 2-digit sector. The share of total workers employed in zombie firms as a fraction of all workers employed in the sector is denoted by LS. Firm controls may include, depending on the specification, the age of the firm, workers and workers squared (to account for non-linear effects of size) and the turnover growth, as a proxy of growth opportunities. We include interacted two-digit industry-year fixed effects to control for sectorial aggregate shocks (as they impact both resources sunk and firm growth) and robust standard errors clustered by industry-year (Adalet McGowan et al., 2017a). Firm fixed effects are not suitable in this analytical framework, as zombie status is persistent (Caballero et al., 2008).

The fixed effects structure implies that the absolute effect of resources sunk cannot be estimated, as it is absorbed by the sectorial-year dummy structure. Therefore, β_2 captures the effect on the average non-zombie in deviation from the effect on zombies and not an absolute effect. A negative β_2 implies that more resources sunk in zombie firms, representing higher misallocation of capital and labor, adversely affects the *relative* performance of non-zombie firms.

Tables 1 and 2 present the results of the estimation of equation 1 for capital and employment growth, respectively. The interaction term is always negative for capital growth, meaning that the investment of the typical healthy firm in relation to that of non-zombies within a sector is negatively affected by the resources (capital and labor) sunk in zombies. As an illustration, these results mean that the capital growth differential between a non-zombie and a zombie is 0.9pp lower in the textile industry (capital sunk close to 20%) vis-à-vis the consulting sector (capital sunk of around 10%).[16]

16. Although intangibles have poor coverage in our dataset, we run a regression on the effect of tangibles+intangibles sunk on the investment on intangibles. The number of observations is reduced to 20%. We find no spillovers from zombies on the average non-zombie. A possible explanation is that the type of capital that zombies capture is not the relevant one to finance intangibles; whereas the first is more bank related, the second one, as it cannot be pledged as collateral relies on alternative financing sources. For a discussion on the effects of firms' and banks' health on the investment in intangibles, please refer to Duval et al. (2017).

There is, however, no effect on relative employment growth for the average non-zombie, which may reflect the flexibility of capital vis-à-vis labor. Indeed, in our dataset employment is unchanged from one year to the other in more than 50% of the observations (0.4% for the case of capital). These results are consistent with those in Caballero et al. (2008). Adalet McGowan et al. (2017a) find negative spillovers on employment growth, but much smaller than those on investment.

TABLE 1. Zombie congestion and capital growth (equation 1)

	(1) dlncapital	(2) dlncapital	(3) dlncapital	(4) dlncapital
nonzombie	0.076***	0.065***	0.066***	0.053***
	(0.005)	(0.005)	(0.006)	(0.005)
KS*nonzombie	-0.084***	-0.089***		
	(0.022)	(0.022)		
LS*nonzombie			-0.060**	-0.056**
			(0.028)	(0.027)
Industry-Year FE	yes	yes	yes	yes
firm-level controls:				
Age and size	yes	yes	yes	yes
Turnover growth	no	yes	no	yes
Observations	702667	702667	702667	702667
Adjusted R^2	0.020	0.036	0.020	0.036

Source: Authors' own computations.
Notes: Standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$.

TABLE 2. Zombie congestion and employment growth (equation 1)

	(1) dlnemp	(2) dlnemp	(3) dlnemp	(4) dlnemp
nonzombie	0.040***	0.031***	0.041***	0.031***
	(0.004)	(0.003)	(0.003)	(0.003)
KS*nonzombie	0.007	0.003		
	(0.014)	(0.012)		
LS*nonzombie			0.005	0.008
			(0.016)	(0.013)
Industry-Year FE	yes	yes	yes	yes
firm-level controls:				
Age and size	yes	yes	yes	yes
Turnover growth	no	yes	no	yes
Observations	701299	701299	701299	701299
Adjusted R^2	0.067	0.129	0.067	0.129

Source: Authors' own computations.
Notes: Standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$.

In order to further test the non-existence of labor market effects on the average firm, we estimate a number of alternative specifications. It may be that the relevant market for labor is the regional one. Including regional-sectoral-year fixed effects (and the corresponding regional-sectoral-year shares of capital and labor sunk), as proposed by Schivardi et al. (2017), does not impact our results. Additionally, one may argue, as pointed in Caballero et al. (2008), that firms may want to keep the labor-to-sales ratio unchanged and thus one needs to control for lagged sales and lagged employment. Again, this does not impact our results, which remain not significant for employment growth. The same holds when controlling for the wage level.

The effects presented in Tables 1 and 2 are relative, i.e. they provide us the differential between healthy and zombies. Schivardi et al. (2017) argue that zombie lending may positively impact zombies' growth and therefore a negative β_2 may not translate a spillover but a positive absolute effect on zombies. Moreover, they consider that the two groups of firms need not respond to shocks in a similar way and thus the negative coefficient may not be solely related to spillovers. To partially address this criticism, we compute equation 1 with separate year and industry fixed effects while controlling for sectoral turnover growth. This allows us to directly estimate the effect of RS on the performance of zombie firms and therefore to quantify absolute effects. We confirm the negative spillovers of zombie prevalence on non-zombies capital growth (Table 3). Furthermore, we show that labor sunk adversely affects the (capital and employment) growth of all firms, zombies and non-zombies.

TABLE 3. Zombie congestion and capital growth (alternative specification of equation 1)

	(1) dlncapital	(2) dlncapital	(3) dlncapital	(4) dlncapital
nonzombie	0.079***	0.068***	0.070***	0.057***
	(0.006)	(0.006)	(0.006)	(0.005)
KS*nonzombie	-0.091***	-0.097***		
	(0.024)	(0.023)		
KS	0.002	-0.006		
	(0.046)	(0.044)		
LS*nonzombie			-0.075**	-0.072**
			(0.029)	(0.029)
LS			-0.170**	-0.195***
			(0.069)	(0.071)
Industry FE	yes	yes	yes	yes
Year FE	yes	yes	yes	yes
Industry-Year FE	no	no	no	no
firm-level controls:				
Age and size	yes	yes	yes	yes
Turnover growth	no	yes	no	yes
$\beta_2 + \beta_3 = 0$ p-value	0.061	0.0.021		
$\beta_4 + \beta_5 = 0$ p-value			0.000	0.000
Observations	702667	702667	702667	702667
Adjusted R^2	0.018	0.034	0.018	0.034

Source: Authors' own computations.
Notes: Standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$.

TABLE 4. Zombie congestion and employment growth (alternative specification of equation 1)

	(1) dlnemp	(2) dlnemp	(3) dlnemp	(4) dlnemp
nonzombie	0.050***	0.035***	0.054***	0.036***
	(0.005)	(0.004)	(0.005)	(0.003)
KS*nonzombie	0.001	-0.009		
	(0.019)	(0.015)		
KS	-0.023	-0.036		
	(0.027)	(0.022)		
LS*nonzombie			-0.021	-0.017
			(0.022)	(0.017)
LS			-0.074*	-0.113***
			(0.038)	(0.037)
Industry FE	yes	yes	yes	yes
Year FE	yes	yes	yes	yes
Industry-Year FE	no	no	no	no
firm-level controls:				
Age and size	yes	yes	yes	yes
Turnover growth	no	yes	no	yes
$\beta_2 + \beta_3 = 0$ p-value	0.3305	0.018		
$\beta_4 + \beta_5 = 0$ p-value			0.003	0.000
Observations	702667	702667	702667	702667
Adjusted R^2	0.067	0.173	0.067	0.173

Source: Authors' own computations.
Notes: Standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$.

The discussion so far focuses on the average firm. But it is particularly important to understand how zombie prevalence affects the most productive firms within each sector. Therefore, following Foster et al. (2016) and Decker et al. (2016) and the application to zombies in Adalet McGowan et al. (2017a), we assess how zombie congestion affects the effective resource allocation towards the most productive companies. While firms with higher productivity are expected to grow faster, shrinking the least productive and driving them out of the market, this process may be adversely affected by an increased prevalence of zombies.

$$\begin{aligned}\delta Y_{i,s,t} =& \beta_0 + \beta_1 LPdev_{i,s,t-1} + \beta_2 RS_{s,t} \times LPdev_{i,s,t-1} + \beta_3 Firmcontrols_{i,s,t-1} \\ &+ FE_{s,t} + \varepsilon_{i,s,t}\end{aligned} \tag{2}$$

where the variables are defined as in equation 1. $LPdev$ is the deviation of labor productivity of each firm from the 2-digits industry-year average, to account for sectoral differences in productivity levels. A negative β_2 implies that zombie prevalence adversely impacts the growth of the most productive firms vis-à-vis the average firm in the sector.

Tables 5 and 6 present the results. We show that capital sunk limits the reallocation of resources towards the most productive, both in terms of capital and employment growth. As an illustration, take a consulting and a textile firm that are twice as productive as the average firm in their respective sectors (LPdev=1, KS=0.1 in the consulting sector and KS=0.2 in the textile industry). The differential to the capital growth rate of the average productivity firm is 0.2-0.3pp lower for the productive textile in comparison to the productive consulting (0.4-0.5pp lower for employment growth). Overall, the result seems to be driven by reduced access to finance, which limits investment and firm growth and thus also limits employment growth. Indeed, there is no evidence of effects from labor congestion on investment or employment growth (when controlling for firms' growth opportunities), as the positive reallocation towards the most productive remains unaffected. This is in line with Dias et al. (2014), who underscore the role of capital distortions in relation to labor distortions.

Interestingly, the effect of capital sunk is more severe for laggards, contributing to the increased dispersion between laggards and frontiers. It is not surprising that frontiers are less affected by zombies, as top performing firms are larger than non-zombie laggards (in terms of assets, workers and turnover), even when restricting laggards to the most productive, and have thus access to other sources of financing beyond the finance captured by zombies, which rely more strongly on bank finance.

Given that both the zombie definition and labor productivity depend on gross value added, it may be that the negative β_2 presented in Tables 5 and 6 results from a mechanical relation between resources sunk in zombies and

labor productivity. To address this, we re-estimate equation 2 by excluding the observation i from the measure of resources sunk. The results hold.

TABLE 5. Zombie congestion and resource reallocation - capital growth (equation 2)

	(1) dlncapital	(2) dlncapital	(3) dlncapital	(4) dlncapital
LaborProd	0.023***	0.030***	0.007*	0.023***
	(0.005)	(0.004)	(0.004)	(0.004)
KS*LaborProd	-0.032**	-0.020*		
	(0.014)	(0.012)		
LS*LaborProd			0.060***	0.015
			(0.020)	(0.017)
Observations	648156	648156	648156	648156
Adjusted R^2	0.018	0.035	0.018	0.035
Industry-Year FE	yes	yes	yes	yes
firm-level controls:				
Age and size	yes	yes	yes	yes
Turnover growth	no	yes	no	yes

Source: Authors' own computations.
Notes: Standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$.

TABLE 6. Zombie congestion and resource reallocation - employment growth (equation 2)

	(1) dlnemp	(2) dlnemp	(3) dlnemp	(4) dlnemp
LaborProd	0.029***	0.036***	0.011***	0.027***
	(0.004)	(0.003)	(0.004)	(0.004)
KS*LaborProd	-0.048***	-0.039***		
	(0.011)	(0.011)		
LS*LaborProd			0.045*	0.000
			(0.024)	(0.021)
Observations	651031	651031	651031	651031
Adjusted R^2	0.046	0.127	0.046	0.127
Industry-Year FE	yes	yes	yes	yes
firm-level controls:				
Age and size	yes	yes	yes	yes
Turnover growth	no	yes	no	yes

Source: Authors' own computations.
Notes: Standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$.

Given the severity of the crisis that affected Portugal in the period considered, we re-estimate our regressions by using a more stringent zombie

definition (5 years instead of 3), to address potential cyclical effects. Also, we test a more symmetric zombie definition, where a zombie needs three periods of $ICR > 1$ to become non-zombie. The original version potentially underestimates zombie prevalence as a firm becomes a non-zombie for three periods even if it has an ICR>1 for only one period. Our main conclusions are robust to these different specifications.

We also consider a different specification of capital, including tangibles and intangibles as a broader (but also less robust) measure of capital and labor productivity as GVA per worker instead of GVA per hours worked, given the possible problems with the accuracy of reported working hours. Again, the main conclusions are kept unchanged.

5.2. Extensive margin

Distorted market competition and resource misallocation can enable a prolonged survival of unviable firms. From a public policy perspective, it is important to understand the role of exit and restructuring barriers in mediating firm dynamics. Well-designed insolvency regimes may promote productivity growth through various channels (Adalet McGowan et al., 2017c): by fostering the exit of unviable firms, they promote virtuous market selection also freeing up resources that are otherwise sunk in zombies; also, by facilitating restructuring of viable firms, they spur within-firm growth; and, finally, they promote firm entry and bolder business projects, by not excessively penalizing failure and by reducing zombie congestion.

To assess the first channel, we develop a differences-in-differences specification à la Rajan and Zingales (1998) that allows to test for the role of insolvency regimes in mediating exit. Our identification strategy relies on the assumption that industries more exposed to exit and restructuring barriers (the treatment group) are more affected by changes in those policies in comparison with less exposed industries (control group):

$$\begin{aligned} Exit_{i,s,t} = &\beta_0 + \beta_1 Z_{i,s,t-1} + \beta_2 Z_{i,s,t-1} \times Insolvency_{t-1} \times Exposure_s \\ &+ \beta_3 Firmcontrols_{i,s,t-1} + FE_{s,t} + \varepsilon_{i,s,t} \end{aligned} \tag{3}$$

where $Exit$ is a dummy variable, indicating whether a firm i exits ($Exit = 1$) or stays in the market ($Exit = 0$) in year t.[17] The variable $Insolvency$ denotes a measure of the height of barriers to exit imposed by the insolvency regime in year t and $Exposure$ is measured by the natural turnover rate of each 2-digit industry s (see Section 3.2 for details). The dummy Z takes the value 1

17. Ideally, one would like to focus on firms that exited due to insolvency procedures and not on all firms that exited the market (for instance because they merged with another firm). However, we do not have access to a reliable source on the reason of exit.

for zombie firms and 0 otherwise. Firm controls may include age, number of workers and number of workers squared, firm turnover growth and relative labor productivity vis-à-vis the sectoral-year average, depending on the specification. Two digits sectoral-year fixed effects are included and robust standard errors are clustered at the sectoral-year level.A negative β_2 implies that lower barriers to exit increase the exit rate of zombie vis-à-vis non-zombies in sectors more exposed to those barriers, contributing to an improved resource allocation.

Table 7 presents the results for the exit regression (equation 3), where we indeed find a negative coefficient for β_2 but only when considering a lag of two periods for the insolvency framework. This is not surprising as exit procedures take time to be finalized (and our dependent variable captures the moment when the firm actually exits from the market). To illustrate these results, take the administrative sector, with one of the highest exposures to exit barriers, and the machinery and equipment production industry, one of the least exposed. The reforms introduced since 2012 increase the exit rate differential between zombies and non-zombies by 1.8pp in the most exposed industry in comparison with the least exposed one. Comparing industries with an exposure differential equivalent to the percentiles 75-25, the increase in the exit rate differential is 0.4pp.

As the *Exit* dummy is a proxy for the start of the exit procedures, we re-estimate our model with different leads of the dependent variable (e.g. $Exit = 1$ if the firm is no longer in the database in $t + 2$), with no qualitative changes to the results.

TABLE 7. Exit rates and exit barriers (equation 3)

	(1) exit	(2) exit	(3) exit	(4) exit	(5) exit	(6) exit	(7) exit	(8) exit
L2.Zombie	0.055***	0.053***	0.054***	0.053***	0.053***	0.051***	0.053***	0.051***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
L2.InsolvencyXExposureUK	-0.002**		-0.002**		-0.002**		-0.002**	
	(0.001)		(0.001)		(0.001)		(0.001)	
L2.InsolvencyXExposureUS		-0.002**		-0.002**		-0.002**		-0.002**
		(0.001)		(0.001)		(0.001)		(0.001)
Industry-Year FE	yes	yes	yes	yes	yes	yes	yes	yes
firm-level controls:								
Age and size	yes	yes	yes	yes	yes	yes	yes	yes
Turnover growth	no	no	yes	yes	no	no	yes	yes
Labor productivity	no	no	no	no	yes	yes	yes	yes
Observations	416622	415437	416622	415437	396753	395717	396753	395717
Adjusted R^2	0.013	0.013	0.013	0.013	0.014	0.014	0.014	0.014

Source: Authors' own computations.
Notes: Standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$.

According to the second channel presented above, effective insolvency regimes should not only potentiate the exit of not-viable firms but also the restructuring of the most productive zombie firms, where it is feasible. In a certain sector, can lower exit and restructuring barriers potentiate the exit of

the least productive zombies and the restructuring of the most productive? To answer this question, we again apply a differences-in-differences specification:

$$R_{i,s,t} = \beta_0 + \beta_1 LPdev_{i,s,t-1} + \beta_2 LPdev_{i,s,t-1} \times Insolvency_{t-1} \times Exposure_s + \beta_3 Firmcontrols_{i,s,t-1} + FE_{s,t} + \varepsilon_{i,s,t} \quad (4)$$

where R takes the value 1 if a zombie firm in $t-1$ turns non-zombie in t and stays healthy the period after (ICR>1). $LPdev$ is the deviation of the firm labor productivity in relation to the sectoral-year average. The variable $Insolvency$ denotes a measure of the height of barriers to exit imposed by the insolvency regime in year t and $Exposure$ is measured by the natural turnover rate of each 2-digit industry s (see Section 3.2 for details). firm-level controls may include age, number of workers and number of workers squared and turnover growth, depending on the specification. As before, two digits sectoral-year fixed effects are included and robust standard errors are clustered at the sectoral-year level. A negative β_2 implies that lower exit and restructuring barriers potentiate the restructuring of the most productive zombies in sectors relatively more exposed to those barriers.

Conversely, from the population of zombies, we would expect the least productive within each sector to have a higher likelihood of leaving and effective insolvency regimes to potentiate this positive selection. We thus re-estimate equation 4 with a dummy that takes the value 1 if the zombie leaves the market as the dependent variable. A positive β_2 implies that lower exit and restructuring barriers improve the efficient resource allocation, by strengthening the relation between lower productivity and higher probability of exit in sectors relatively more exposed to the barriers.

In Table 8 we provide evidence that lower exit and restructuring barriers potentiate the restructure of the most productive in sectors relatively more exposed to the policy change, but we fail to find a significant effect for the exit margin (although the sign is the expected one).[18] Again as an illustration, the results indicate that the reforms introduced since 2012 increase the likelihood

18. The significant effect on restructuring is present already with only one lag of the policy variable, whereas in equation 3 two lags are needed. This may reflect the different nature of exit and restructuring procedures, with the former taking more time than the latter. In any case, we do not find a significant effect of lowering exit barriers on fostering the exit of the least productive zombies within each sector, even when using lags higher than 1. This may relate to the limitations of our exit variable, which may wrongly classify a M&A as an exit. The lack of significance of the coefficient may also be due to the reduced sample size, by considering only the population of zombies and comparing those with different productivity levels within each sector. Using the sub-components of the insolvency indicator does not change the results. This is expected given the high interrelation among the different sub-policy areas. When estimating the exit model for the entire sample [columns 5-8], i.e. including also non-zombie firms, we find a statistically significant effect for the interaction term in columns 6 and 8, i.e. using US data to measure exposure.

of restructuring of a zombie firm 10% more productive than the average in the sector by 0.4pp when comparing the administrative sector, with one of the highest exposures to exit and restructuring barriers, and the machinery and equipment production industry, one of the least exposed.

TABLE 8. Zombie dynamics - exiting and restructuring (equation 4)

	(1) restructure	(2) restructure	(3) restructure	(4) restructure	(5) exit	(6) exit	(7) exit	(8) exit
L.LaborProd	0.055***	0.054***	0.056***	0.054***	-0.031***	-0.028**	-0.031***	-0.028**
	(0.016)	(0.019)	(0.017)	(0.019)	(0.011)	(0.012)	(0.011)	(0.012)
L.LaborprodXInsolvencyXExposureUK	-0.004**		-0.004**		0.002		0.002	
	(0.002)		(0.002)		(0.001)		(0.001)	
L.LaborprodXInsolvencyXExposureUS		-0.005**		-0.005**		0.001		0.002
		(0.003)		(0.003)		(0.002)		(0.002)
Industry-Year FE	yes	yes	yes	yes	yes	yes	yes	yes
firm-level controls:								
Age and size	yes	yes	yes	yes	yes	yes	yes	yes
Turnover growth	no	no	yes	yes	no	no	yes	yes
Observations	32499	32415	32499	32415	33299	33222	33299	33222
Adjusted R^2	0.019	0.019	0.019	0.019	0.011	0.011	0.011	0.011

Source: Authors' own computations.
Notes: Standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$.

Finally, we provide preliminary evidence on entry dynamics. Accounting for the entry channel is particularly challenging, given that it is not possible to estimate the pool of potential entrants. We therefore focus on two predictions, one on the quality of the entrants and another on their quantity.

We start by testing whether there is evidence that higher zombie congestion increases the threshold of productivity that a new entrant must surpass, given that zombies increase wages relative to productivity, reduce market prices and reduce the market share for non-zombies (Caballero et al., 2008). We find that the sectoral mean productivity of new entrants (deviation towards sectoral mean) is positively correlated with the prevalence of zombies in the sector, measured by capital sunk (controlling for industry and/or time fixed effects; when controlling for sectoral turnover growth the effects become not significant). We do not find an effect for labor sunk.

Lastly, we check whether sectoral entry is hampered by zombie congestion, given the increased productivity threshold and the crowd-out of capital and labor. To do so, we compute the correlation between measures of zombie congestion and sectoral yearly entry rates. As in Schivardi et al. (2017), we fail to find any significant results for labor and capital sunk, also when controlling for sectoral turnover growth (to control for growth opportunities). However, we do find a negative correlation with the share of zombies in the sector, meaning that sectors with a higher number of zombie players display lower entry rates.

6. Conclusion

There is widespread evidence of resource misallocation across OECD countries, harming productivity growth. By making use of a comprehensive set of firm-level data for Portugal, we contribute to the literature on the role of zombie firms in explaining resource misallocation, by reinforcing the evidence on spillovers (intensive margin) and by providing novel evidence on the exit and restructuring channels (extensive margin).

Portugal is a rich case study, as it is one of the OECD countries with the largest drop in exit and restructuring barriers in recent years, being particularly suited for an assessment of the extensive margin effects. Furthermore, given the severity of the crisis that hit the country during the period studied, this research brings additional insights into the literature on zombies' spillovers. While during deep recessions the opportunity costs of sunk resources are lower, given the limited outside opportunities for reallocation, it is also the time where capital is scarcer and thus where crowding out effects could be stronger. The balance of the two opposing forces is determinant for the final outcome. Moreover, by relying on an administrative database covering all Portuguese firms, we improve on the robustness of studies that rely on specific types of firms (e.g. listed firms) or on datasets with limited coverage (e.g. covering only larger firms or sectors). The results of this research for Portugal are certainly relevant for other countries that face similar challenges, as the productivity slowdown and the increased misallocation are common features across several economies and, also, as zombie prevalence and patterns display cross-country regularities.

Overall, we confirm the results in the literature on the high prevalence of zombie firms, being significantly less productive than their healthy counterparts and thus dragging aggregate productivity down. Furthermore, while we find evidence of positive selection within zombies, with the most productive restructuring and the least productive exiting, we also show that the zombies' productivity threshold for exit is much lower than that of non-zombies, allowing them to stay in the market, distorting competition and sinking a sizable share of existing resources. This curbs the growth of viable firms, in particular the most productive, therefore harming a more efficient intra-sectoral resource reallocation. We show that a reduction in exit and restructuring barriers promotes a more effective exit channel, disproportionately fostering the exit of non-viable firms, and potentiates the restructuring of the most productive zombies. These results highlight the role of public policy in addressing zombies' prevalence and thus in promoting productivity growth.

While fostering the exit of the least productive is appealing, one needs to carefully consider the broad implications. Zombies are responsible for a significant part of employment: in some sectors, more than 1 out of 5 workers are employed in a zombie firm. Thus, the policy mix must be carefully designed to address important social costs that may arise, also at regional level. In some

regions, 1 out of 3 workers is employed in a zombie firm, calling for targeted action. While there is evidence of high-skill labor sunk in low productivity firms (Adalet McGowan and Andrews, 2015), suggesting large gains from a more efficient reallocation, one needs to minimize social costs during the transition, also for those with lower skills. The reallocation of employment is not only crucial from a social perspective but it is also determinant for positive aggregate effects on potential output, as otherwise the stock of human capital in merely reduced. Therefore, a flexible education system and effective Active Labor Market Policies have a particular role to play (Andrews and Saia, 2017). Going forward, it would be important to understand better the employment dynamics, both in terms of type of contract (permanent v. temporary v. contract work) and level of skills in order to better inform policy makers.

The same concern holds for capital: in some industries, more than 25% of the sectoral fixed capital is allocated to zombies. In case they exit the market, can the stock of capital be reallocated to more productive uses? While there is some sectoral evidence that at least part of the stock of capital can be reassigned (e.g. for the case of the airline industry, as described in Australian Productivity Commission, 2015), one can expect a part of this stock to be lost, as it is firm (and in particular zombie firm) specific. On improving the allocation of capital flows, there are important complementarities between bank health and good insolvency regimes, as the latter reduce the incentives for evergreening and bank forbearance. In any case, it should be noted that zombies are, on average, larger than non-zombies, with more tangible assets to pledge as collateral. If banks' financing criteria focus on the existence of collateral, rather on the quality of the project or the (prospective) quality of the firm, zombie lending lasts even without evergreening motives. There is again role for policy action, in particular as non-collateralizable assets (the intangibles) gain weight in the economy. Public policy may be key in correcting the asymmetries of information existing in the bank financing market, for instance via well-designed public guarantees systems (Rodrigues et al., 2016; Farinha and Félix, 2015), and in fostering the development of alternative financing options, in particular in the context of supranational initiatives, such as the so-called Capital Markets Union in the EU. Future research could provide evidence on the effects of zombies separately on tangible and intangible investment, as our preliminary evidence suggests that the effect is asymmetric.

Overall, and while the knowledge of the consequences of zombie congestion is important, effective policy action hinges on a deeper understanding of the nature of zombie firms and how they interact with existing institutional features. Are these zombies inherently unviable? Or do they become zombies ex-post due to bad shocks or due to a regulatory setting that does not enable them to grow and strive? While there is evidence that ex-ante heterogeneity across firms is a key determinant of ex-post growth (e.g. Pugsley et al., 2017), it is important to better understand what those ex-ante factors are and what drives zombie dynamics. Moreover, in particular as the margin of improvement in exit

and restructuring barriers decreases, one needs to better understand what can be done to further foster the exit of zombies, the growth of viable incumbents and the entry of dynamic firms, key to boost employment and productivity (e.g. Haltiwanger et al., 2013). The evidence shows that there are additional policy complementarities, beyond the ones related to bank health, that need to be promptly addressed. For instance, ensuring a fit for purpose regulatory environment is an important challenge for policy makers, as product market distortions and administrative barriers to entry are also positively associated with higher zombie congestion and lower exit (Adalet McGowan et al., 2017b/c; Monteiro et al., 2017; Aghion et al., 2017). The increased market concentration, detrimental for investment of the laggards, is being potentiated by existing regulations, that therefore need to be adapted and enhanced (Gutierrez and Phillipon, 2017a/b). There is also scope for improvements in human capital, namely at managerial level, an in firm-level governance, as they are key to potentiate technological diffusion and unlock firm-level growth (Bloom et al., 2012; Pellegrino and Zingales, 2017; Queiró, 2018).

Concerning aggregate dynamics, while zombie congestion and intrasectoral reallocation are (increasingly) important, there are other dynamics that concur to explain the productivity slowdown. On top of the more classical discussions on cross-sectorial misallocation, there are also changing dynamics at the other end of the zombie productivity spectrum, i.e. the very high growth firms (the so-called gazelles). They are not only becoming rarer but also less productive (e.g. Pugsley et al., 2017). To different degrees, all these elements, taken together, explain the country level developments, A successful policy agenda must tackle these challenges in a coherent and encompassing manner.

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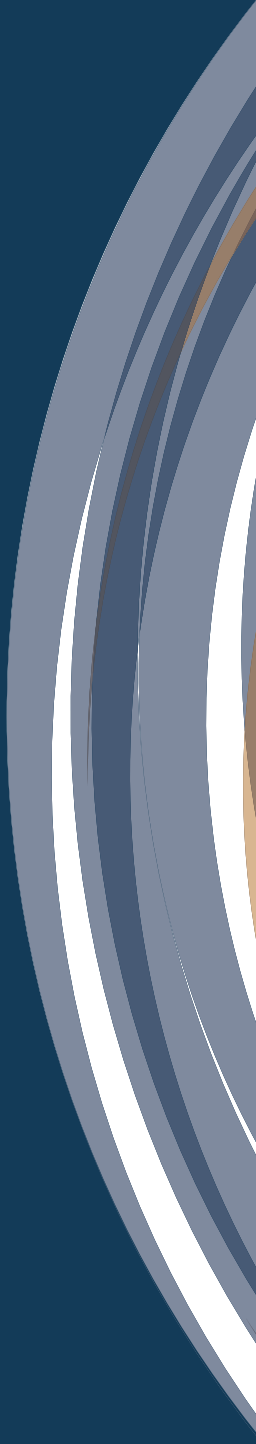

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