

Long Shadows of the Walking Dead on Economic Activity

N. Nergiz Dincer,
Pelin Pektekin,
and Ayça Tekin-Koru

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N. Nergiz Dincer[†], Pelin Pektekin[‡] and Ayça Tekin-Koru[§]

December 2023

Abstract: This paper presents the panorama of zombie firms in the Turkish economy, which are highly inefficient, highly indebted firms that have low or sometimes negative productivity, and provides an analysis of the impact of these firms on economic activity for the period 2012-2015. Our results suggest that the number of zombie firms in Türkiye has increased. The share of these firms in sales and employment has also increased, but at a lower rate. These firms are mainly found in low-technology manufacturing and transportation and distribution services. The paper also shows that healthy firms increase total factor productivity, employment growth, and the investment-to-capital ratio in the economy in a robust manner. The sales of zombie firms have no distorting effect on the economic activity of healthy firms. However, capital sunk into zombie firms has a differential impact on the performance of healthy firms. When the share of zombie capital in a sector increases, the TFP growth of manufacturing firms decreases, while the employment growth of medium-sized service firms increases.

Keywords: zombie firms, productivity, micro data, Türkiye

JEL Codes: D22, D24, E24, C55

* We would like to thank the seminar participants in Turkish Economic Association Conference in 2019, Adana.

[†] Department of Economics, TED University, Ziya Gokalp Bul. No:48, Kolej, Ankara, Turkey. Phone: +90(312)585-0038. E-mail: nergiz.dincer@tedu.edu.tr

[‡] Department of Economics, TED University, Ziya Gokalp Bul. No:48, Kolej, Ankara, Turkey. E-mail: pelin.pektekin@tedu.edu.tr

[§] Department of Economics, TED University, Ziya Gokalp Bul. No:48, Kolej, Ankara, Turkey. Phone: +90(312)585-0034. E-mail: ayca.tekinkoru@tedu.edu.tr

1 Introduction

This paper aims to identify the zombie firms, which are highly inefficient, highly indebted companies that exhibit low or sometimes negative productivity in Turkish economy, and to analyze the effects of zombie firms on economic activity for the period 2012-2015.

The world economy has witnessed a slowdown in productivity growth from its pre-crisis peak of 2.7 percent in 2007 to a trough of 1.5 percent in 2015 (World Bank, 2020). The post-global financial crisis slowdown affected nearly 70 percent of advanced and developing economies. The slowdown has started in advanced economies in the late 1990s whereas in developing countries it has a history of recurring ups and downs. However, the recent setback for developing countries has been the sharpest, lengthiest, and widest - with productivity growth declining from its peak of 6.6 percent in 2007 to a trough of 3.2 percent in 2015. Türkiye is no different because its productivity growth more than halved and slowed down to 2.1 percent in 2013-2018 period (World Bank, 2020).

Several researchers in the economics discipline have attempted to explain the causes and consequences of this weak global productivity growth. In one vein, studies such as Adler, Duval, Furceri, Kılıç-Çelik, Koloskova and Poplawski-Ribeiro (2017) and Gordon (2017) pointed at factors including an ageing workforce and fading ICT boom. In another vein, Andrews, Criscuolo and Gal (2016) focused on rising productivity dispersion across firms while Gopinath, Kalemli-Özcan, Karabarbounis and Villegas-Sanchez (2017) and Decker, Haltiwanger, Jarmin and Miranda (2017) investigated rising capital misallocation and declining business dynamism.

Closely related to resource misallocation and sluggish business dynamism arguments is the rising incidence of zombie firms (Caballero, Hoshi and Kashyap, 2008). A number of recent studies in the economics literature have investigated the causes and consequences of zombie firms.¹ In this newly developing literature the increased prevalence of zombie firms found to seriously endanger and restrict a country's economic growth. When firms that would otherwise exit in a competitive market survive, average productivity dampens and growth opportunities for more productive firms are crowded-out. The zombie problem may arise as a result of structural policy weaknesses, particularly in terms of insolvency regimes. Increased levels of bank forbearance, lengthy monetary stimuli, and the insistence on unreasonable small and medium size enterprise (SME) support measures - all to curb the effects of the global financial crisis- are other possible reasons (McGowan, Andrews and Millot, 2018).

World Bank (2019) and Dincer, Eichengreen and Tekin-Koru (2022) highlight the problems that hinder productivity growth in Turkish economy by decomposing

¹ Ahearne and Shinada (2005), Hoshi (2006), Caballero, Hoshi and Kashyap (2008), Fukuda and Nakamura (2011), Imai (2016) and Goto and Wilbur (2019) for Japan; Tan, Huang and Woo (2016), Dai, Qiao and Song (2019), Liu, Zhang, Zhang and Wang (2019), Zhu, He, Wang, Ye and Liang (2019) for China; Barros, Caires and Pereira (2017) and Gouveia and Osterhold (2018) for Portugal; Urionabarrenetxea, Garcia-Merinoi San-Jose and Retolaza (2018) for Spain; Rodano and Sette (2019) for Italy and finally Andrews and Petroulakis (2017), Storz, Koetter, Setzer and Westphal (2017), McGowan, Andrews and Millot (2018), Hallak, Harasztosi and Schich (2018) for multiple countries.

productivity growth. Both studies draw attention to negative productivity growth among surviving firms -particularly in services sectors. There is also limited evidence on the relatively higher productivity growth rates for the firms exiting the market in the post-2000 period. Their results indicate that some firms with lower productivity continue to survive and may pull down productivity growth. This may suggest the existence of zombie firms in Turkish economy.

The reasons behind the creation of zombie firms in Türkiye is similar to the other countries. Financial support to firms in Türkiye have increased in the aftermath of the global financial crisis to alleviate the short-term hardships in the economy. Increased levels of bank forbearance, low interest rates, and the uncontrolled and non-selective SME support measures contributed in creation of zombie firms in Türkiye similar to the other countries' experiences. This is the main motivation to investigate the zombie incidence and its effects on the Turkish economy.

Our zombie identification strategy is based on utilizing these firms' operating characteristics related to persistent financial weakness. Following Andrews and Petroulakis (2017), we define zombies as firms with an interest coverage (IC) ratio (operating income/interest payments) less than one for three consecutive years. Since the newly established firms are not expected to be profitable, we only use firms that are aged at least ten years in our analysis, which leaves us with years 2012-2015.

The data in this paper comes from the micro datasets of the Annual Industry and Service Statistics database (AISS) and the Foreign Trade Statistics database (FTS) of Türkiye for the period of 2003-2015. Our sample covers the universe of Turkish firms with 20+ employees.

Once we identify the zombie firms, we explore stylized facts regarding zombie firms in Turkish economy in the 2012-2015 period and find that (i) number of zombie firms as well as their share in sales and employment are on rise, (ii) services sectors show higher zombie incidence than manufacturing, (iii) low-tech manufacturing and distribution services have the highest shares of zombies, (iv) productivity of zombie firms is much lower than healthy firms.

Empirics of the paper is based on the estimations analyzing the impact of zombie firms on economic activity. Regression results suggest that non-zombie firms increase total factor productivity (TFP), employment growth and investment to capital ratio in the economy in a robust manner. Sales of the zombie firms do not have a distortionary effect on the non-zombie firms' economic activity. However, the capital sunk into zombie firms has some differential effects on the performance of healthy firms. When the share of zombie capital increases in a sector, the TFP growth of manufacturing firms decreases, while the employment growth of medium-sized service firms increases. In other words, as the capital share of zombie firms gets higher, the TFP growth of non-zombie firms falls as they are deprived of the capital they would otherwise use. Medium-sized service firms, on the other hand, absorb the jobs released by these relatively capital-intensive zombie firms.

To the best of our knowledge, this study is the first one to identify the zombie firms in Türkiye and to offer an analysis of their impact on the Turkish economy. In an environment of deepening productivity problem, increasing financial support provided to firms without checking their financial-standing or production potential coupled with the low interest rate policy, we rigorously document an increase in the number of zombie firms in Turkish economy in the first half of 2010s. The stylized facts presented in this study provide a snapshot of zombie firms in different sectors of the economy and give hints to the policymakers regarding the measures to be taken.

The next section reviews existing literature of zombie firms, business dynamism and resource reallocation. Section 3 explains the key variables and the data by presenting the zombie definition used in this paper along with a description of firm characteristics and the data sources used in the analysis. Section 4 provides descriptive evidence on zombie incidence in Turkish economy. Section 5 describes the empirical methodology used to estimate the effects of zombie firms on economic activity and presents the empirical findings. The final section concludes.

2 Zombies, business dynamism and resource reallocation

The stagnation of the Japanese economy in the 1990s marks the beginning of research on the causes of zombieness (Ahearne and Shinada, 2005; Hoshi, 2006; Caballero et al., 2008; Fukuda and Nakamura, 2011; Imai, 2016; Goto and Wilbur, 2019). These studies point to several institutional rigidities in the Japanese regulatory regime that made troubled firms more likely to survive and job protection in these firms to be more probable. A firm could not lay off workers under the lifetime employment system in Japan. Furthermore, the main bank of a failing firm was required to put together a rescue package.

The Japanese experience is a good starting point, yet the major question remains: Why else do firms become zombies? It is important to answer this question because as pointed out by Andrews and Petroulakis (2017), Storz et al. (2017), McGowan et al. (2018) and Hallak et al. (2018), in the recent decades many economies around the globe have been experiencing a rising trend in the incidence of zombie firms. Structural policy weaknesses such as poorly designed insolvency regimes, bank forbearance, an impaired banking systems and permanency of once crisis-induced small and medium size firm support can contribute to zombie incidence (McGowan et al., 2018). Policymakers may choose to protect troubled firms during recessions to prevent massive layoffs, to mitigate supply chain disruptions and to alleviate the reduction in aggregate demand in the short run. Nevertheless, if these measures are kept long after the crisis is over, then the sustained existence of zombie firms may stand to injure aggregate productivity growth.

Existence of zombie firms has important business dynamism effects in an economy. Hoshi (2006) explains this through a comparison of two economies: one with zombie firms and one without. We will use his example owing to its clarity. In the benchmark economy, there are no zombie firms. The economy is populated by incumbents that are currently in business and potential new entrants. These agents are hit by a productivity shock with common and idiosyncratic components in each time period.

If an incumbent is hit by a large idiosyncratic adverse shock and experiences a decline in its performance, then it exits the market. Likewise, if a potential new entrant is hit by a large idiosyncratic favorable shock, then it enters the market due to advantageous profit prospects. Through exit of the least productive incumbents and entry of the most productive potential entrants in each time period the aggregate productivity increases. This is indeed the building blocks of the Schumpeterian growth paradigm (Aghion and Howitt, 1992).

In the case when an adverse common shock hits this benchmark economy, there will be more exits since more incumbents will become unprofitable. Likewise, entry will be dampened due to reduced profitability prospects for the potential entrants. If the common shock becomes permanent, then the economy moves to a new equilibrium where there are fewer firms in the market.

In this common adverse productivity shock scenario, the simple adjustment mechanism in the benchmark case changes if incumbents are protected by the government. In essence, a market failure is created; firms that otherwise exit the market survive and become zombies. These zombie firms depress the rate of entry because potential entrants as well as healthy incumbents have to compete with them on unequal terms. The problem here is that zombies congest resources for new entrants and healthy firms by holding on to the factors of production that would be released if they exited the market. They may even resort to aggressive pricing practices in goods and labor markets.

The pioneering work of Caballero et al. (2008) offers three channels for low aggregate productivity growth through zombie incidence: (i) zombie firms exhibit low levels of productivity; (ii) zombie firms crowd-out high-productivity activities of healthy firms; (iii) zombie firms create a market failure through dampening the entry of potential successful entrants. Their empirical results show that there is less job turnover in zombie-dominated industries. Furthermore, they report lower investment and employment growth among non-zombie firms.

In short, protection of failing firms may cause some potential entrants not to enter the market and some healthy incumbents to downsize their growth plans. As a result, aggregate productivity declines and an adverse common shock leaves permanent marks on an economy.

3 Key variables and data

3.1 Zombie definition

In the existing literature there seems to be no consensus on the precise definition of zombie firms. There are currently two approaches: In *the first vein*, Ahaerna and Shinada (2005), Hoshi (2016), Caballero et al. (2008), Fukuda and Nakamura (2011) and Imai et al. (2016) use measures that rely on bank protection to identify such firms.

Caballero et al. (2008) construct their measure on the idea that zombie firms are the ones that would have been dead but survive only because they get bank protection. The protection comes in the form of low interest rate loans, so they identify zombies by looking at the difference between the actual interest paid by the firm and hypothetical minimum interest payments that are made by the most creditworthy borrowers. A negative result indicates zombieness since these firms get a more favorable rate than the healthy firms.

Later, two shortcomings of the Caballero et al. (2008) measure were mentioned in Fukuda and Nakamura (2011). Firstly, excellent firms might have been given very favorable rates by their banks. Then, this measure would mistakenly identify these firms as zombies. Second, this measure can fail to identify some of the zombie firms that enjoy evergreening (only interest payments are made during the life of the loan) rather than low interest rates as bank protection. As a result, Fukuda and Nakamura (2011) introduce the profitability criterion to the Caballero et al. (2008) measure to avoid these mistakes. However, Imai (2016) criticizes this new method because temporary declines in profits create the possibility of misidentifying zombies once again. Consequently, he promotes a dynamic approach in zombie identification to overcome all these difficulties. Yet, he acknowledges the data insufficiency problem in these bank protection-based measures and points out the importance of being able to utilize information directly from the financial statements of firms for zombie identification.

Our method for zombie-identification in this paper is motivated by this lack of accessible bank protection data in Türkiye. This data challenge brings us to *the second vein* in the zombie firm literature that predominantly uses financial statement data in zombie identification. Even though Hoshi (2006), Tan et al. (2016) and Imai (2016) augment their analysis by using various financial ratios in the classification of firms as zombies, it is with several OECD (Andrews and Petroulakis, 2017; McGowan et al., 2018; Hallak et al., 2018) and various central bank studies (Bank of England, 2013; Bank of Korea, 2013; Rodano and Sette, 2019) the second branch in the literature started gaining some traction. Rather than utilizing explicit bank protection measures, these studies focus on firms' ability to meet their immediate payments or short-term debts using directly observable financial statement data.

We use the same approach in the case of Türkiye in this paper and utilize operating characteristics of a firm to identify if the firm exhibits persistent financial weakness. In particular, we employ two different definitions of zombie firms as in Andrews and Petroulakis (2017): We define zombies as: (i) firms with an interest coverage (IC) ratio (operating income/interest payments) less than one for three consecutive years or (ii) firms that incur losses -negative profits. While the former measure captures the firms that do not generate enough profits to cover their debt payments and would exit the market under normal circumstances, the latter is a more direct measure of firm profitability and signals firms on the brink of exit. Since the newly-established firms are not expected to be

profitable, we only use firms that are aged at least ten years. We report our results using the first definition for brevity.²

3.2 Firm characteristics

3.2.1 Productivity calculations

We use both labor productivity and TFP as two alternative measures of productivity. Labor productivity is straightforward: log of the ratio of value added to employment. Comparatively, TFP estimations are somewhat more involved.

The assumption that firms optimally choose the level of inputs in production creates the well-known endogeneity problem, i.e., inputs become endogenous because the error term of the estimated production function contains determinants of output that are observable to the firm but not to the analyst. As a result ordinary least squares (OLS) produces inconsistent estimates. To overcome this endogeneity problem, we use the TFP measure³ offered by Akerberg, Caves and Frazer (2015).

Consider the following logarithmically transformed value-added Cobb-Douglas production function:

$$va_{it} = \alpha_k k_{it} + \alpha_l l_{it} + \omega_{it} + \varepsilon_{it} \quad (1)$$

where va_{it} is the log of firm i 's gross output in time t , k_{it} is the log of the capital stock and l_{it} is the log of the quantity of labor. Firm-level productivity is denoted by ω_{it} , while ε_{it} signifies a random error term. Akerberg et al. (2015) use the same ‘‘control function’’ in Levinsohn and Petrin (2003):

$$m_{it} = m(k_{it}, \omega_{it}) \quad (2)$$

where m_{it} is the log of the quantity of intermediate input composed of raw materials and energy consumption. An inverted (2) that is inserted in (1) results in

$$va_{it} = \alpha_k k_{it} + \alpha_l l_{it} + m^{-1}(k_{it}, \omega_{it}) + \varepsilon_{it} = \phi(k_{it}, l_{it}, m_{it}) + \varepsilon_{it} \quad (3)$$

Here, $\phi(k_{it}, l_{it}, m_{it})$ is specified as a third-order polynomial in k_{it}, l_{it} and m_{it} and estimated via OLS. As a result, productivity can be written as

$$\omega_{it}(\alpha_k, \alpha_l) = \hat{\phi}(k_{it}, l_{it}, m_{it}) - \alpha_k k_{it} - \alpha_l l_{it} \quad (4)$$

² Results using the second definition are similar and available upon request.

³ We use revenue TFP (TFPR) rather than physical TFP (TFPQ) due to data limitations. There is no input quantity data at the product level. Estimating TFPQ for a sample of single-product firms is another alternative but that option limits the observations numbers at a great extent.

and an unexpected productivity shock can be expressed as a function of the unknown elasticity parameters $\eta_{it}(\alpha_k, \alpha_l)$ similar to Levinsohn and Petrin (2003). Finally, to identify α_k and α_l the following moment conditions are used:

$$\mathbb{E}[\eta_{it}(\alpha_k, \alpha_l) | k_{it}, l_{it-1}] = 0 \quad (5)$$

By plugging in the newly identified elasticities ($\hat{\alpha}_k$ and $\hat{\alpha}_l$) into (4) firm's productivity at time t is obtained:

$$\hat{\omega}_{it} = \hat{\phi}(k_{it}, l_{it}, m_{it}) - \hat{\alpha}_k k_{it} - \hat{\alpha}_l l_{it} \quad (6)$$

In our estimations, we employ the firm-level *Value-Added*, va_{it} supplied by TurkStat. We use the number of paid employees of firm i in time t as a measure of *Employment*, l_{it} and firm-level *Energy Expenditures* as a proxy for intermediate input use, m_{it} .

Data for *Capital Stock*, k_{it} , is not readily available at the firm-level in Türkiye. Therefore, we construct capital stock values via the Perpetual Inventory Method following Taymaz, Voyvoda and Yılmaz (2008). In the capital stock estimations, we use firm level *Investment Expenditures* on machinery/equipment, buildings and computers and corresponding depreciation rates of 10 percent, 5 percent and 30 percent, respectively.

All values are log-transformed and deflated using 2-digit sector level PPI with the base year of 2003.

3.2.2 Other firm-specific variables

There are three firm-level variables that we use to construct our zombie measures: (i) *Financial Expenditures* are short and long-term borrowing expenses, interest, exchange rate and credit commissions. (ii) and (iii) *Profit Before Tax* and *Loss* are self-explanatory.

Sales is the log of gross sales of the firm. *Large* takes the value of 1 if the number of employees of the firm is greater than 250 and 0 otherwise. *Medium* takes the value of 1 if the number of employees of the firm is between 50 and 249 and 0 otherwise. *Exporter* takes the value of 1 if the firm reports positive export values and 0 otherwise. Finally, *Foreign* is an indicator variable that takes the value of 1 if the firm has any foreign partners and 0 otherwise.

Tables 1a and 1b present definitions/data sources and summary statistics, respectively, for the entire set of variables we use in this paper.

3.3 Data sources

In this paper, we focus on the 2003-2015 period and use two different micro datasets: The Annual Industry and Service Statistics database (AISS) and the Foreign Trade Statistics database (FTS) of Türkiye.

The AISS is based on surveys covering firms in manufacturing as well as services sectors. These surveys were carried out on a yearly basis by TurkStat between 2003-2015. In the recent years, TurkStat started compiling this data from administrative records that are generally completed by obtaining data from governmental sources such as the Revenue Administration and the Social Security Institution. This new database goes back only until 2009 and lacks the detail of the AISS. Furthermore, since we use firms of at least 10 years of age in our zombie identification we have no choice but to use the survey-based data.

The database contains information on a wide array of firm characteristics such as production, employment, wages, investment, taxes, profits, foreign ownership, information on different local units as well as a plethora of different sub-categories of revenue and cost items such as energy expenditures.⁴ Firms are classified under 4-digit NACE Rev2 sectors.

The data for firms with 20+ employees are collected using the full enumeration method while the data for firms with 19 or less employees come from a random sample of firms. In this paper, we use firms with 20+ employees to avoid sampling issues particularly in the micro-scale firms (1-9 employees). At this point, let us note that although firms with 20+ employees compose only 3 percent of the firm population in Türkiye; their sales, output and value added shares in 2015 are 77 percent, 82 percent and 85 percent, respectively.

The FTS covers the entire universe of goods traders in Türkiye as the source of the data is customs declarations. The data are available for the period between 2002-2018 and supplied to the final-user by TurkStat, which uses the administrative records of the Ministry of Trade to compile the data. The database covers cross border trade in goods between Türkiye and other countries. International trade in services is not covered. Among a wealth of information in this database, we only use value of goods exports (f.o.b.) at 12-digit detail for each exporter.

Sample of analysis

Starting from the universe of Turkish firms with 20+ employees, we merge firm level data from the AISS database with the firm-product level export data from the FTS database. Our sample period is dictated by the available years in the AISS, namely 2003-2015. The unit of observation of each cross-section in the merged data is firm. Both the AISS and the FTS databases have a common firm identifier, which makes our merge process consistent and effective.

In this paper, we investigate zombie incidence and its impact on economic activity in Türkiye from 2012 to 2015. Due to the lack of age data in the TurkStat sources we focus on this period and use firms that are in the sample for 10 consecutive years for the reasons

⁴ Note that some of the responses to the sub-categories of AISS survey such as some of the revenue and expenditure items of the firms contain missing data.

outlined in Section 3.1. This leaves us with 81,907 firms among which 3,008 are zombies. The value-added, sales and employment shares of these firms in our sample are 3.6, 4.0 and 5.3 percent, respectively.

4 Stylized facts

4.1 Zombie incidence in Türkiye

Zombie incidence in Türkiye, for manufacturing and services sectors between years 2012-2015, is presented in Figure 1. Panel A indicates the share of zombie firms in all firms in our sample, while Panels B and C show the shares of zombie firms in employment and sales, respectively. There are two conclusions we can draw from Figure 1: (i) The share of zombie firms and their share in economic activity are increasing in both manufacturing and services sectors for the period 2012 to 2015 except for a brief pause in 2014. To be precise, the zombie incidence in manufacturing sector increased from 1.4 percent in 2012 to 1.7 percent in 2015, whereas the share of zombie firms in services sector rose from 2.2 percent in 2012 to 3.0 percent in 2015. (ii) Services sectors in Türkiye show higher zombie incidence compared to manufacturing sectors. This fact is in line with the literature that documents higher zombie incidence in services sector than manufacturing sector. (Hoshi, 2006; Caballero, et al.,2008)

Figure 2 represents the distribution of zombie firms in 2012 and 2015 across broad categories of manufacturing and services sectors. To construct these categories, we use the OECD technology classification for the manufacturing sectors and the WTO services classification for the services sectors (Appendix Tables A1 and A2).

Among manufacturing sectors, low-tech (L-tech) manufacturing where most of the production in Türkiye takes place has the highest share of zombie firms in Turkish economy. Moreover, this share increased from 18.2 percent in 2012 to 19.5 percent in 2015.

The services sectors with the highest share of zombie firms in Turkish economy are distribution services (DIST), tourism (TRSM) and transportation (TRANS) both in 2012 to 2015. While the zombie incidence in TRSM increased 4 percentage points from 2012 to 2015, it showed a 3 percentage points decline in TRANS in these years. Indeed, there can be several reasons for the increased incidence of zombieness in TRSM such as misallocation of resources and increasing financing opportunities for zombie firms.

Stylized Fact 1. *Zombie incidence in Türkiye has stayed relatively stable in Türkiye with the exception of transportation and tourism sectors in Türkiye between 2012-2015.*

4.2 Employment repercussions

In this subsection, we start by examining the share of employment in zombie firms in sectoral detail. Figure 3 shows employment distribution in zombie firms for 2012 and 2015 in broad categories of economic activity. The 45-degree line represents no change in the distribution in 2015 compared to 2012. The points above (below) this line signify an increase (decrease) in the share of a sector in zombie employment from 2012 to 2015. As

expected, high-tech manufacturing has the lowest share of employment in zombie firms. Indeed, in most of the sectors reported in Figure 3, this share stays below 10 percent. The outliers are low-tech manufacturing, transportation and distribution sectors, which exhibit the highest shares in both years.

While the zombie incidence in L-tech manufacturing is 18.2 percent in 2012 (Figure 2), the share of L-tech manufacturing in zombie employment is very high and hovers around 22 percent in the same year (Figure 3). The same gap exists in 2015, as well. This shows that zombie firms in L-tech manufacturing are not very small in terms of employment. In other words, being a small enterprise is not a defining characteristic of zombieness in this sector.

The growth rate of zombie employment in L-tech manufacturing has increased from 22 percent in 2012 to 26 percent in 2015 (Figure 3), whereas the zombie incidence in this sector has not changed much (Figure 2). Put together, this means either a consolidation of employment in L-Tech manufacturing in fewer zombie firms or even larger firms (with higher employment rates) becoming zombies. Considering the fact that this sector encompasses the largest and the most export-intensive manufacturing sectors (food, textiles, apparel, furniture, etc.) of Türkiye, this kind of deterioration is problematic for the economic growth prospects of the country.

Along with a high and unchanging level of zombie incidence, the share of DIST in zombie employment stayed relatively high and stagnant from 2012 to 2015. In other words, the wholesale and retail sector, which absorbs the highest numbers of employees in Türkiye, has the ailment of having around 18 percent of its employees in the zombie firms and harbors 18 percent of zombie firms in Türkiye.

Recall that zombie incidence in TRANS was 12.3 percent and 9.3 percent in 2012 and 2015, respectively (Figure 2). For the same years, the shares of TRANS in zombie employment, are 22 percent and 15 percent, respectively. Very similar to L-tech manufacturing, zombie firms in transportation are large firms as well. Firm size and firm health do not go hand in hand in these years in Türkiye, in other words. Digging deeper in the data, we observe that the largest firms that are zombies in TRANS are indeed state-owned enterprises.

Stylized Fact 2. *Low-tech manufacturing, transportation and distribution services exhibit the highest shares of zombie employment in Türkiye.*

Examined together, we conclude that these sectors in Türkiye host myriad of employees that have to bear the brunt of vulnerabilities that come with being employed in zombie firms. These workers are more likely to be stripped of their labor rights compared to the ones in other sectors. Considering the rampant informality levels in L-tech manufacturing such as textiles or apparel along with land transportation and distribution sectors in Türkiye, these large percentages of zombie employment in these sectors are disquieting.

Next, we examine the sectoral distribution of employment among zombie firms in 2012 and 2015 in two strands: among manufacturers and among services sectors (Table 2).

Among zombie firms in manufacturing, low-tech manufacturers constitute 2/3 of the zombie employment in manufacturing in Türkiye in both years. Considering the increase in the share of zombie firms in low-tech manufacturing in Türkiye from 2012 to 2015, this is yet another alarming finding. Furthermore, while the same share is increasing for medium/low tech (ML-Tech) firms, on a positive note, there is a decline in the share of medium/high tech (MH-tech) firms from 2012 to 2015.

Among zombie firms in services sectors, distribution, transportation, tourism and health services providers display higher levels of employment and thus exhibit higher shares in Table 2. There is a significant decline in this share in TRANS from 33.2 percent to 26.4 percent in just three years from 2012 to 2015. Considering that the zombie incidence in TRANS has declined in this period, this is yet another reflection of employment consolidation in fewer zombie firms in this sector, mainly in state owned enterprises.

Finally, we dissect our data into the more detailed 2-digit sector level in Figure 4, which indeed puts together the information in Figure 3 and Table 2 in bubble graphs, one for 2012 and one for 2015. The size of the bubbles represents the share of the sector in zombie employment in each 2-digit sector. Horizontal axis shows the share of the sector in total employment. The bubbles located in the north-east quadrant of these diagrams represent sectors that absorb a large share of employment in Türkiye and at the same time exhibit higher shares of zombie employment. While Food, Land Transport and Retail were the only three such sectors in 2012, they were joined by Textiles in 2015.

Stylized Fact 3. *While Food Manufacturing, Land Transport and Retail Services had the lion-share of zombie employment in 2012, Textiles joined “the club of the sectors that host the highest shares of zombie employment” in 2015.*

The aforementioned sectors are important sectors in Turkish production and hosts a rather significant share of employment in the country. Put together, the rising incidence of zombieness and increasing employment in the zombie firms have the potential to negatively affect the medium-long term economic growth prospects of the entire country.

Textile is a labor-intensive sector that witnesses increased zombie employment. One of the main reasons behind this trend might be the financial opportunities given to weak companies in low-tech manufacturing sectors by the government. Moreover, in Land Transport the number of zombie firms increased while their employment decreased in 2012-2015 period. Indeed, there can be several reasons for this decrease in employment in land transport such as misallocation of resources and bank credits.

4.3 Productivity repercussions

4.3.1 Variations in productivity across different dimensions

We start by calculating labor productivity and estimating TFP for our entire sample of firms as detailed in Section 3 to be able to examine productivity of zombie firms across various dimensions.

To this effect, Figures 5-7 illustrate kernel density diagrams for visual comparisons. Note that, in the kernel diagrams, sample period is 2012 to 2015 except for the analysis for foreign owned firms for which the 2015 data are not available.

First, we compare zombie and healthy firms in terms of their productivity levels. Figure 5 shows that TFP is significantly different between healthy and zombie firms in manufacturing sector. Among all firms (20+ employees) the healthy firms are more productive. However, in services sector there is no observable difference in the TFP distribution of healthy firms and zombie firms. The same conclusion applies to the lower two panels which illustrate the same distributions for exporters and foreign-owned firms. Figure 6 illustrates the labor productivity comparisons between zombie and healthy firms. Different from TFP comparisons, there is a visible difference between the distributions of labor productivity among zombie and healthy firms. Across all firms, exporters or foreign-owned firms, zombies exhibit lower labor productivity levels.

Stylized Fact 4. *Zombie firms in Türkiye exhibit lower levels of productivity compared to healthy ones.*

Second, we offer a comparison of productivity in terms of firm size, exporter status and foreign-ownership amongst the zombie firms in Figure 7. This time we use TFP for manufacturing and labor productivity for services for brevity. Firm size is defined as small, medium and large in line with Eurostat definitions. Firms with 20-49, 50-249 and 250+ employees are defined as small, medium and large, respectively. The message from Figure 7 is loud and clear:

Stylized Fact 5. *Among zombie firms, larger, export-oriented or foreign-owned ones are more productive than otherwise.*

Moreover, we conduct Kolmogorov-Smirnov tests of the kernel distributions from this section to confirm our visual conclusions. Tables report Kolmogorov-Smirnov test results for zombie firms in manufacturing and service sectors reported in NACE Rev. 2, 2-digit sector detail. Our null hypothesis is that the distributions of healthy and zombie firms are not different from each other. (Appendix Tables A3, A4, A5, A6, A7 and, A8)

5 Empirics

5.1 Empirical design

Zombie firms may harm the economic activity of non-zombie firms and the industry that they are operating in. Following Caballero et al. (2008) and McGowan et al. (2017), we use the following empirical specification to estimate the effect of zombie firms on the economic activity in Türkiye.

$$y_{ist} = \alpha_1 nonZ_{ist} + \alpha_2 Z_{st} + \alpha_3 nonZ_{ist} Z_{st} + \alpha_4 X_{ist} + \varphi_t + \varphi_s + \varepsilon_{ist} \quad (7)$$

where y is the economic activity measured as TFP, employment growth (change in employment over time) or the ratio of investment to capital, $nonZ$ is a dummy that stands for non-zombie firm by taking the value 1 if a firm is not a zombie firm and takes the value 0 if the firm is a zombie firm, Z is the share of zombie firms in industry capital or sales and X represents the matrix for firm controls, in firm i , sector s , time t . Firm size dummies (size is measured by number of employees) *Large* and *Medium* are used as firm controls.

Equation (7) includes time fixed effects and sector fixed effects. Sector fixed effects are both in 2-digits and 4-digits of NACE rev. 2 classification. Only the estimation results with 2-digit sector fixed effects are reported here for brevity. Robust standard errors are clustered at the firm. The model is estimated for the period 2012-2015 in line with zombie identification used in this paper.

In this model, a positive non-zombie dummy coefficient, α_1 , indicates that zombie firms are financially weaker than the healthy firms, while a negative coefficient highlights large subsidies provided to zombie firms. Considering the fact that increasingly large subsidies are extended to zombie firms after 2015, we expect a positive sign for non-zombie dummy coefficient.

Zombie incidence in an economy/sector is expected to reduce the ability of health firms to grow. If this hypothesis holds, the coefficient of the interactions, α_3 , would be negative for the employment growth and investment rate regressions. However, the same coefficient, α_3 , would be positive in productivity regressions if zombie firms increase the entry barriers to market.

5.2 Empirical results

Table 3 presents the results of the estimations that measure the effects of zombie firms on economic activity based on Equation (7). Economic activity is measured as TFP in columns 1-2, employment growth in columns 3-4 and investment to capital ratio in columns 5-6 of Table 3.

In all six specifications, non-zombie dummy is positive and significant indicating that zombie firms are financially weaker than healthy firms. In other words, non-zombie firms increase TFP, employment growth and investment to capital ratio in the economy in a

robust manner. This result confirms our expectation that in our sample period, zombie firms did not receive very large discriminatory subsidies that would increase their spending significantly higher than the healthy firms.

In columns (1), (3) and (5) of Table 3, the share of zombie firms in sales as well as the interaction of non-zombie dummy and the share of zombie firms in sales are included in the estimations. The interaction term is insignificant in column (1) and significantly negative in columns (3) and (5) hinting the possibility that zombie incidence in the sector hurts the growth prospects of healthy firms. However, when marginal effects are checked, it is seen that the size of this effect is insignificant. In other words, in our pooled sample, the zombie incidence is not large enough to trigger adverse productivity, growth and investment outcomes for the healthy firms in Türkiye. In other words, sales of the zombie firms do not have a distortionary effect on the non-zombie firms' performance. This may be due to the fact that the sales of zombie firms are limited as illustrated in Figure 1. Moreover, the advantage of price dampening that they would obtain through the cheaper loans they get may not be enough to affect the economic activity of the non-zombie firms. As our sample period ends in 2015, it is possible that we might be missing the post-2015 period when there were increasingly large subsidies provided to zombie firms.

Estimations with the interaction of non-zombie dummy and the capital sunk in zombie firms are presented in columns (2), (4) and (6) of Table 3. Similar to the sales share regressions, the interaction term has a negative and significant impact on employment growth and investment capital ratio of an average non-zombie firm. This time though, marginal effects in the employment growth is significant. As the capital sunk in zombie firms increase, a healthy firm's employment growth increases in a significant manner. A higher share of machinery and equipment reduces the need for workers in zombie firms and the workers released from these firms are absorbed by the healthy firms.

Next, we turn our attention to different cuts of the data to assess if these effects change in the subsamples of manufacturing vs services (Table 4) and larger firms versus medium firms (Table 5). Non-zombie dummy is positive and significant in all estimations as it is in baseline specification. The marginal effect of the share of zombie firms' sales is insignificant across the board, however, the same cannot be said for the marginal effect of the capital sunk in zombie firms in Tables 4 and 5. The latter in Table 4a, 4b and 5b indicate that when the share of capital sunk in zombie firms increase, it causes a decline in the TFP growth of healthy firms in manufacturing, an increase in the employment growth of healthy firms in services and medium size healthy firms in general.

6 Concluding remarks

In this paper, we identify the zombie firms in Turkish economy and analyze their effects on economic activity for the period 2012-2015. Among firms that are aged at least ten years, we define zombies as firms with an interest coverage ratio less than one for three consecutive years by using micro data sets of TurkStat.

The stylized facts that we derive from the identification of zombie firms are as follows: (i) number of zombie firms as well as their share in sales and employment are on rise, (ii) services sectors show higher zombie incidence than manufacturing, (iii) low-tech manufacturing and distribution services have the highest shares of zombies, (iv) productivity of zombie firms is much lower than healthy firms.

We estimate panel data regressions to analyze the impact of zombie firms on economic activity. Our results suggest that non-zombie firms increase total factor productivity, employment growth and investment to capital ratio in the economy in a robust manner, whereas sales of the zombie firms do not have a distortionary effect on the non-zombie firms' economic activity. However, the capital sunk in zombie firms have some differential effects of the performance of healthy firms. As the zombie share of capital increases in one sector, the TFP growth of manufacturing firms decline, and employment growth of medium size services firms increase. In other words, if the amount of capital in zombie firms get higher, non-zombie firms' TFP growth declines since they are deprived of the capital that they utilize otherwise. Medium term services firms, on the other hand, absorb the employment released from these relatively capital-intensive zombie firms.

A broader and targeted policy design is needed to prevent or reduce lending to zombie firms. Moreover, for the financial system to recognize the credit risk of non-viable borrowers, measures, such as electronic filings, virtual court hearings, as well as out-of-court or hybrid solutions, that would improve the efficiency of insolvency procedures would be helpful (ECB, 2021).

We provide the identification of zombies and the economic impacts of zombies in Turkish economy to draw attention on the congestion of zombies in Turkish economy. Next step would be utilizing a more comprehensive zombie identification strategy along with policy implications.

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Figure 1. Incidence of zombie firms in Türkiye, 2012-2015

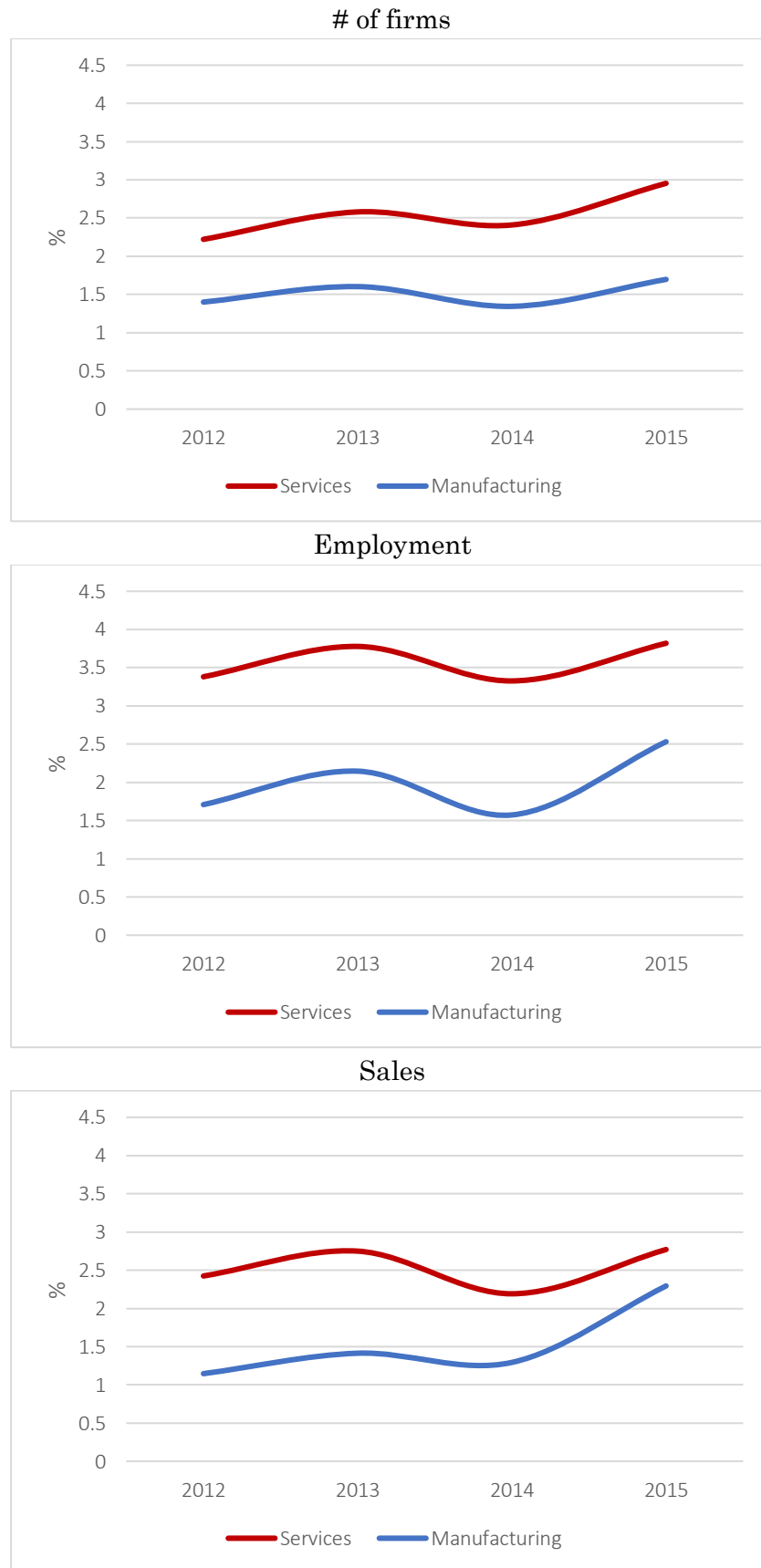
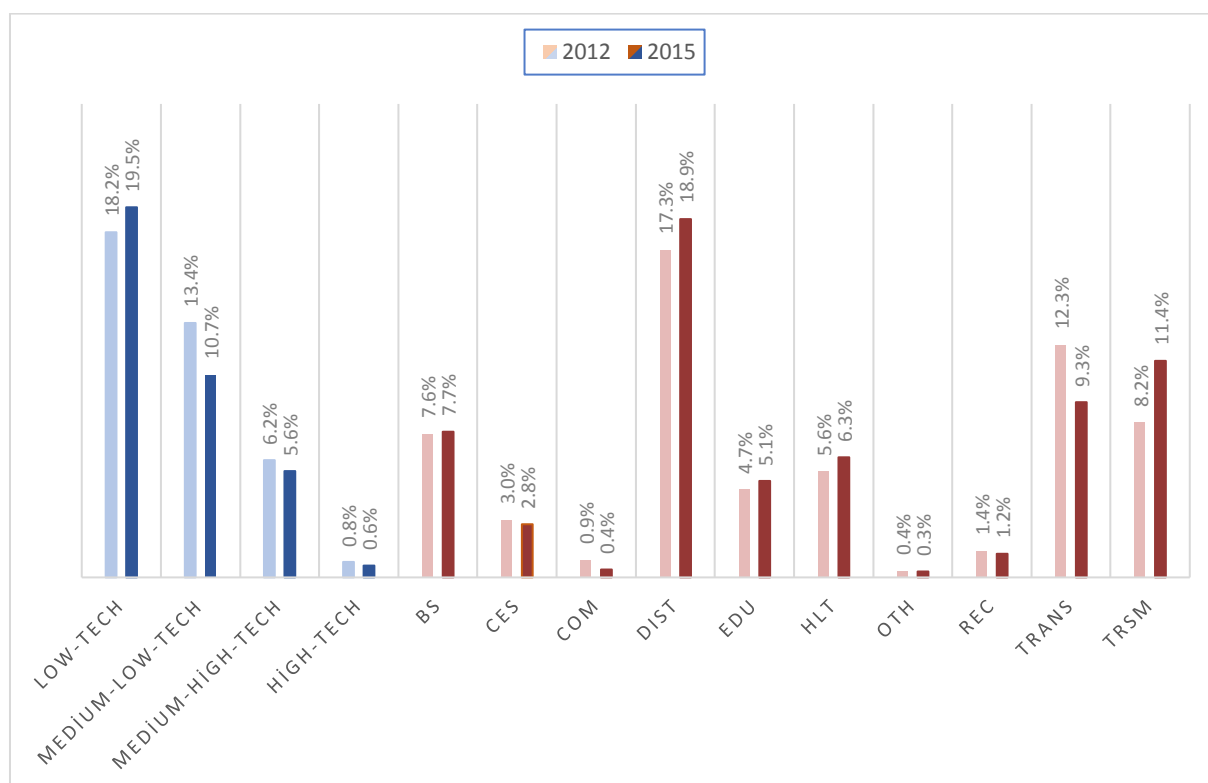
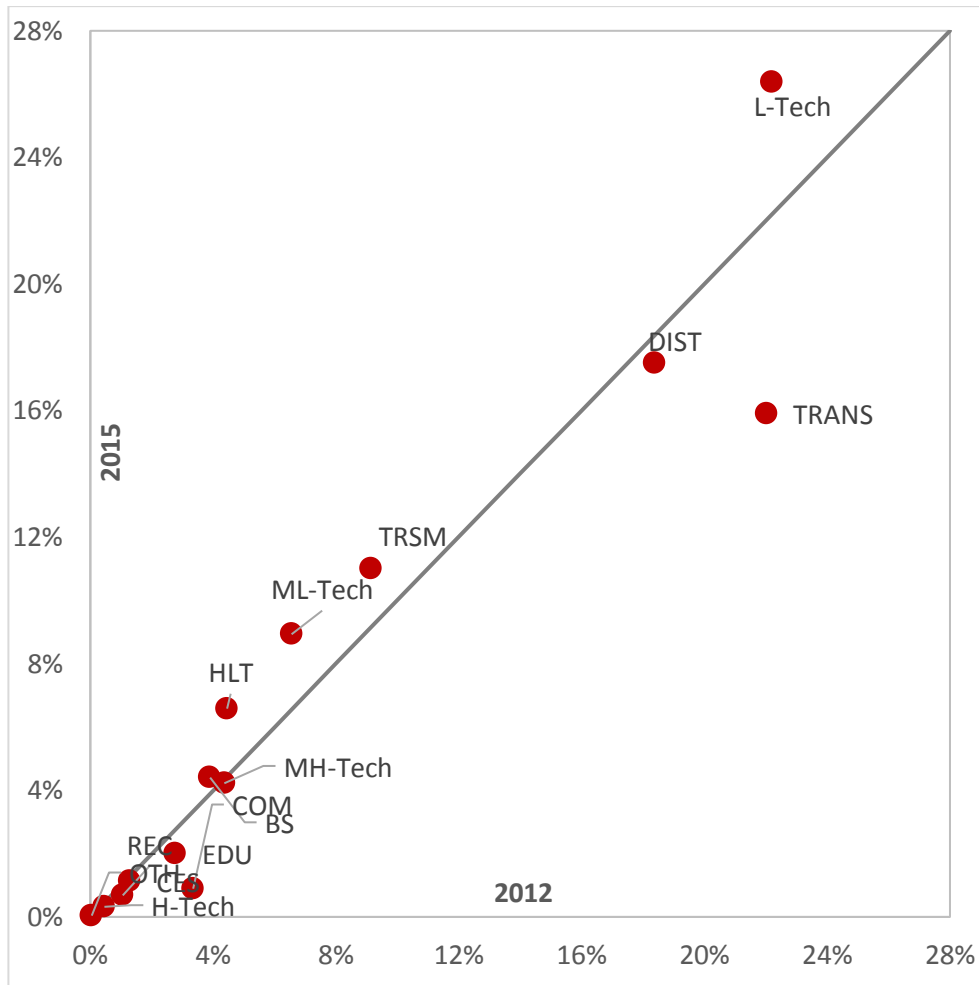


Figure 2. Distribution of zombie firms in 2012 and 2015, broad categories



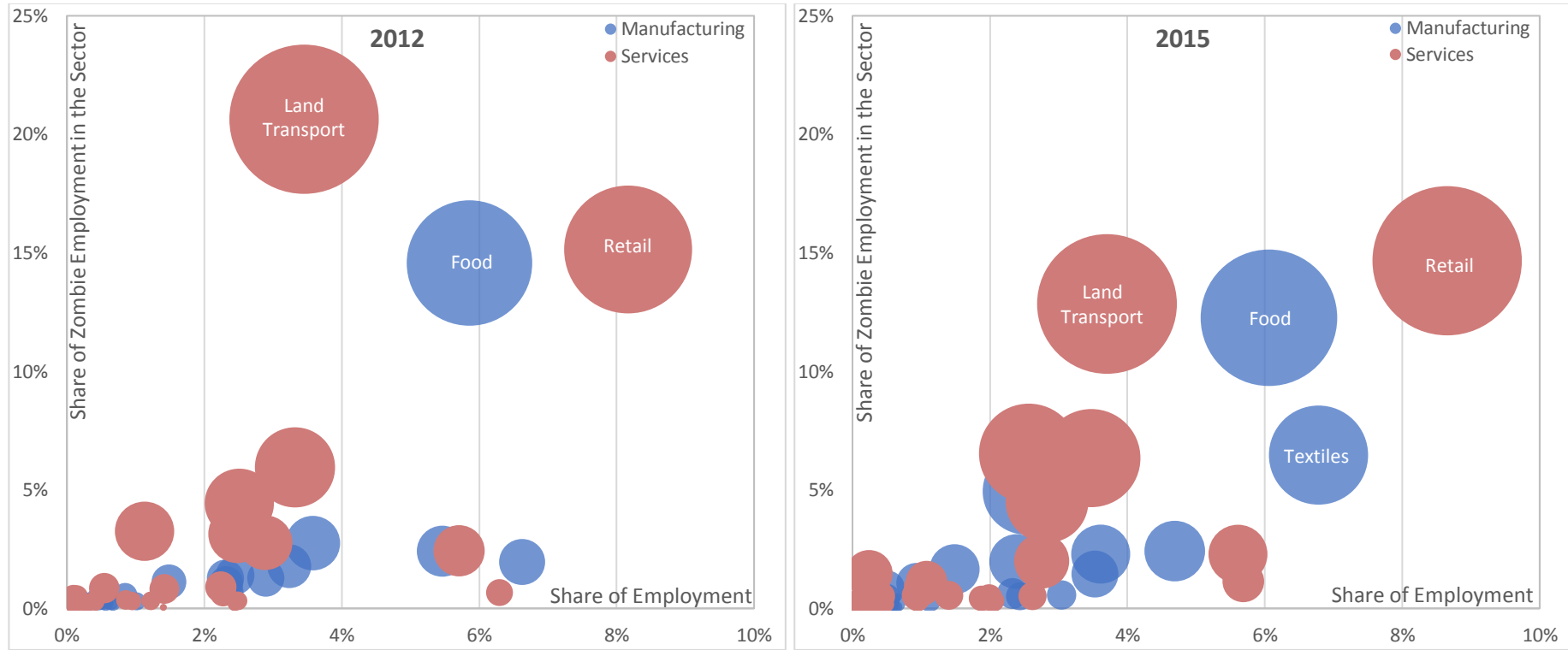
Note: BS: Business Services, CES: Construction and Engineering Services, COM: Communication, DIST: Distribution, EDU: Education, HLT: Health, OTH: Other, REC: Recreational Activities, TRANS: Transportation, TRSM: Tourism

**Figure 3. Employment distribution in zombie firms, broad categories
2012 and 2015**



Note: H-Tech: High Technology; MH-Tech: Medium-High Technology; ML-Tech: Medium-Low Technology; L-Tech: Low Technology; BS: Business Services, CES: Construction and Engineering Services, COM: Communication, DIST: Distribution, EDU: Education, HLT: Health, OTH: Other, REC: Recreational Activities, TRANS: Transportation, TRSM: Tourism

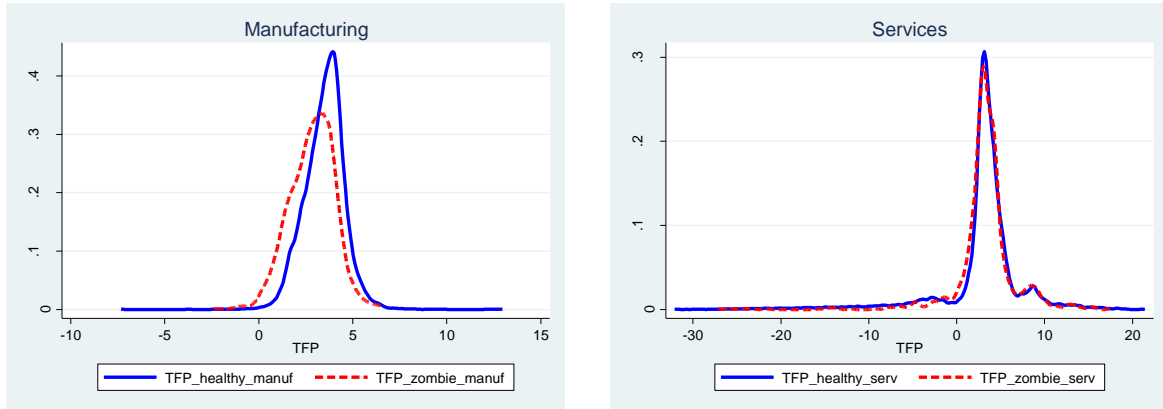
Figure 4. Employment in zombie firms, NACE 2-digit sectors



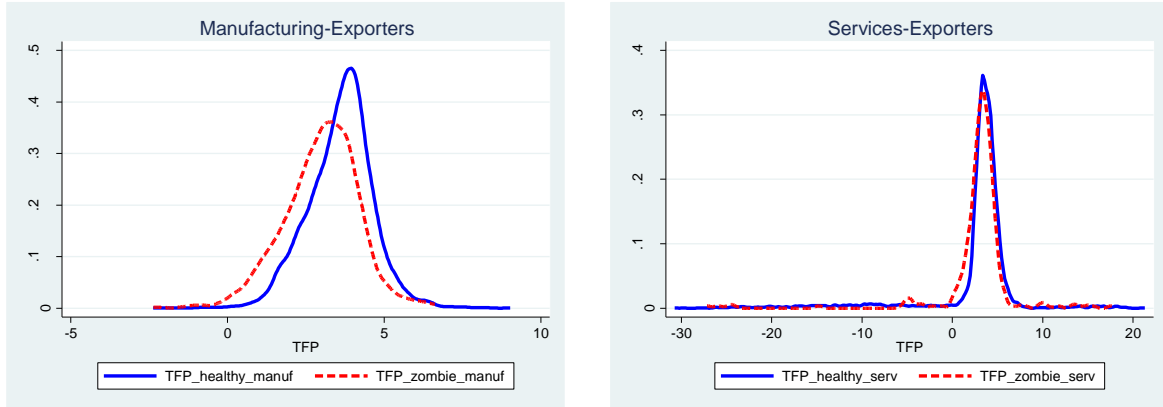
Note: Employment and sector share of zombies with NACE 2-digit sectors. Ratios are zombie firms to all firms in Türkiye. Size of the bubbles represent employment share.

Figure 5. TFP comparisons between zombie and healthy firms

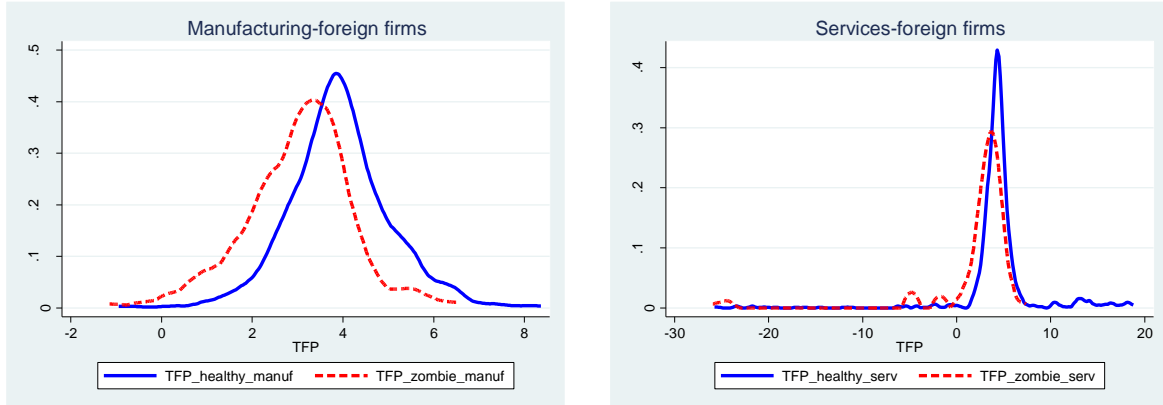
Among all 20+ firms



Among exporters



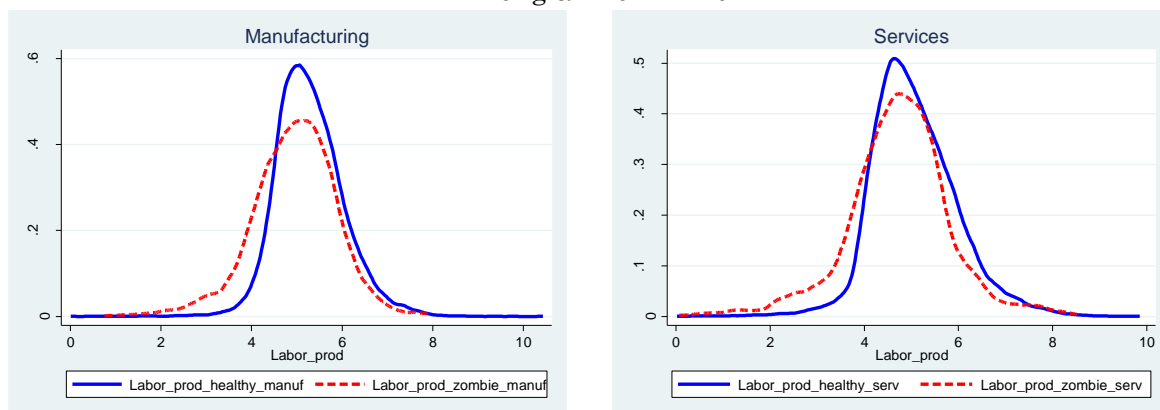
Among foreign owned firms



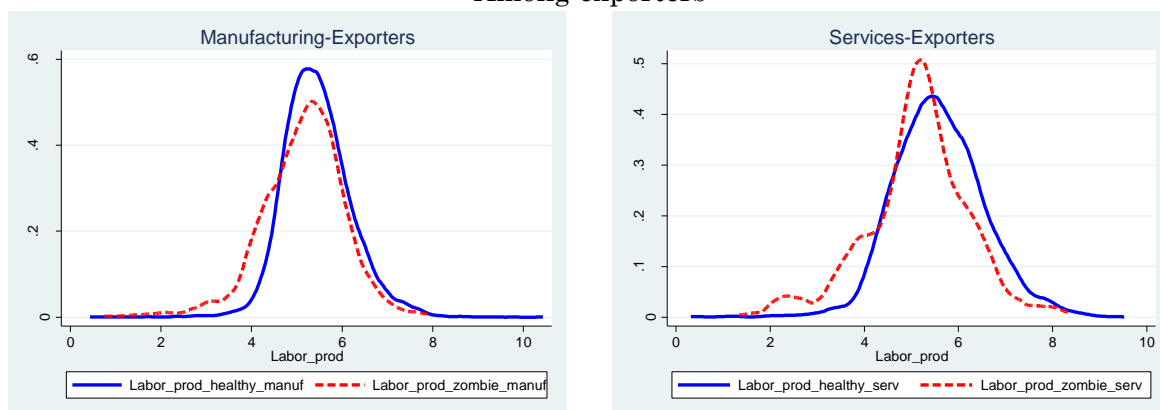
Note: Size and exporting status graphs include zombie and healthy firms in Türkiye for 2012-2015. Foreign-ownership graphs include zombie and healthy firms in Türkiye for 2012-2014 due to unavailability of 2015 data.

Figure 6. Labor productivity comparisons between zombie and healthy firms

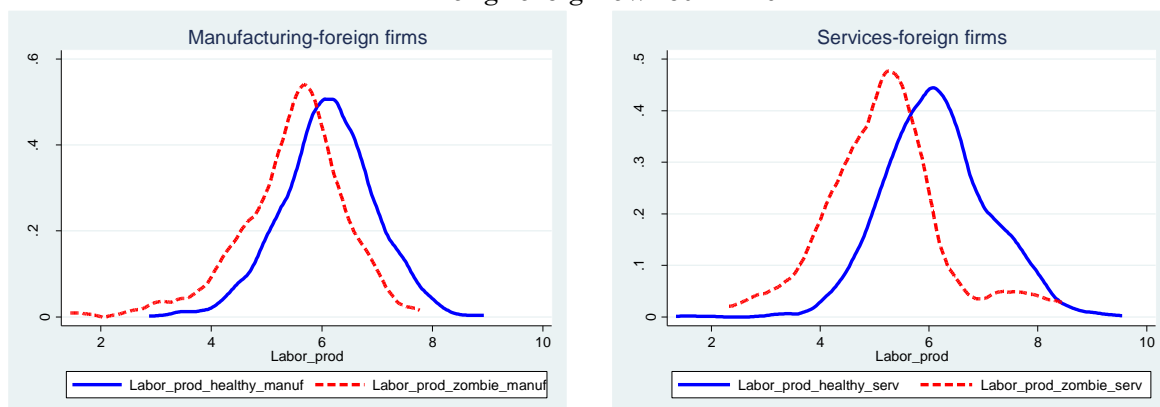
Among all 20+ firms



Among exporters



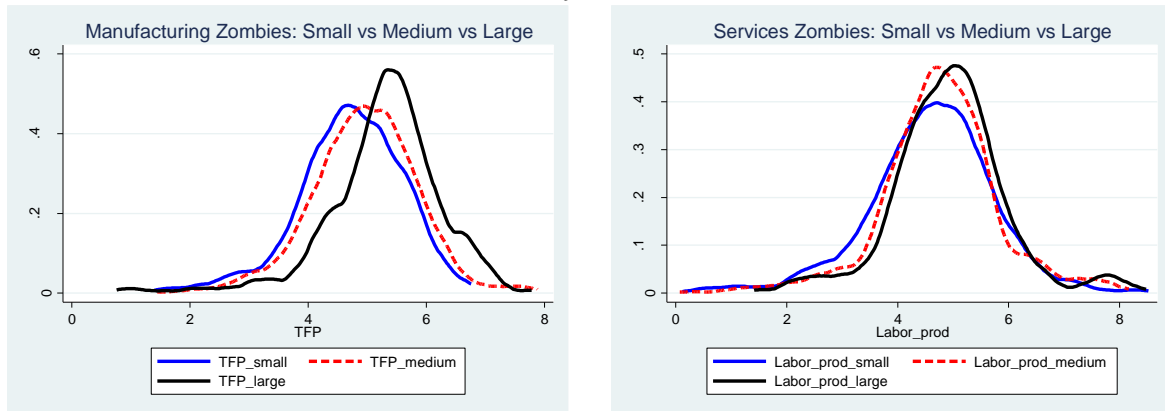
Among foreign owned firms



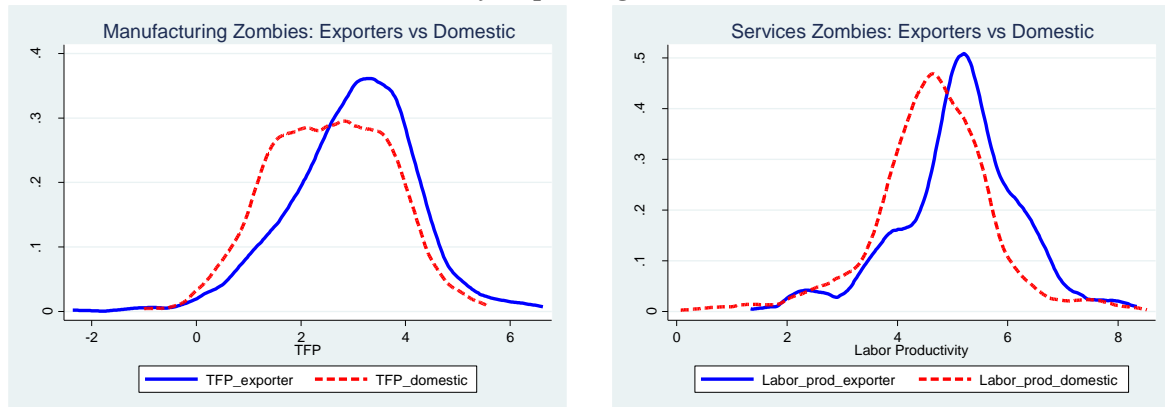
Note: Size and exporting status graphs include zombie and healthy firms in Türkiye for 2012-2015. Foreign-ownership graphs include zombie and healthy firms in Türkiye for 2012-2014 due to unavailability of 2015 data.

Figure 7. TFP and Labor productivity comparisons within zombie firms

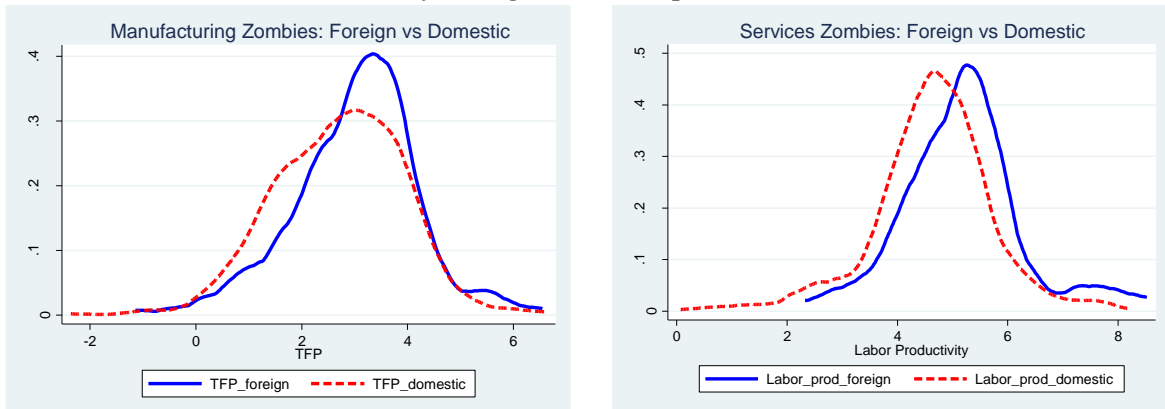
By size



By exporting status



By foreign ownership status



Note: Size and exporting status graphs include zombie firms in Türkiye for 2012-2015. Foreign-ownership graphs include zombie firms in Türkiye for 2012-2014 due to unavailability of 2015 data.

Table 1a. Variable definitions and sources of data

Variable	Definition	Data Source
<i>Value-added</i>	Value-added at factor cost	AISS
<i>Sales</i>	Sales value of firms	AISS
<i>Employment</i>	Number of employments by firms	AISS
<i>Medium</i>	Dummy variable that takes the value 1 if employment is between 100-250 otherwise, it takes the value 0.	AISS
<i>Large</i>	Dummy variable that takes the value 1 if employment is over 250, otherwise, it takes the value 0.	AISS
<i>Financial Expenditures</i>	Financial expenditures of firms	AISS
<i>Profit Before Tax</i>	Profit value of firms before tax payments	AISS
<i>Loss</i>	Loss value of firms	AISS
<i>Exporter Status</i>	Dummy variable that takes the value 1 if the firm is exporter, otherwise it takes the value 0.	FTS
<i>Foreign Status</i>	Dummy variable that takes the value 1 if the firm has a positive foreign share, otherwise it takes the value 0.	AISS
<i>nonZ_{ist}</i>	Dummy variable that takes value 1 if the firm is not zombie otherwise, takes the value 0.	AISS
<i>Z_{st}^{Sales Share}</i>	Sales value of zombie firms divided by sales value of all firms.	AISS
<i>Z_{st}^{Capital Share}</i>	Capital of zombie firms divided by capital of all firms.	AISS-FTS

Note: The Annual Industry and Service Statistics database (AISS) and the Foreign Trade Statistics database (FTS) of Türkiye.

Table 1b. Summary statistics

Variable	Units	Mean	SD	Min	Max
<i>Value-added</i>	Millions (TL)	12	79	-192	6840
<i>Sales</i>	Millions (TL)	71	588	0	42500
<i>Employment</i>		175	600	20	29309
<i>Medium</i>		0.456	0.498	0	1
<i>Large</i>		0.136	0.343	0	1
<i>Financial Expenditures</i>	Millions (TL)	2	26	0	3560
<i>Profit Before Tax</i>	Millions (TL)	4	43	0	4500
<i>Loss</i>	Millions (TL)	0,9	25	0	6020
<i>Exporter Status</i>		0.399	0.489	0	1
<i>Foreign Status</i>		0.039	0.194	0	1
<i>nonZ_{ist}</i>		0.963	0.188	0	1
<i>Z_{st}^{Sales Share}</i>		0.039	0.038	0	0.528
<i>Z_{st}^{Capital Share}</i>		0.065	0.080	0	0.954

Table 2. Sectoral distribution of employment in zombie firms

	2012	2015
	AMONG MANUFACTURING	
Low-Tech	66.5%	66.2%
Medium/Low-Tech	19.7%	22.4%
Medium/High-Tech	13.1%	10.6%
High-Tech	0.7%	0.8%
	AMONG SERVICES	
Business Services	5.9%	7.3%
Construction and Engineering Services	1.9%	1.9%
Communication	5.0%	1.5%
Distribution	27.7%	29.1%
Education	4.2%	3.3%
Health	6.7%	10.9%
Other	0%	0%
Recreational Activities	1.6%	1.1%
Transportation	33.2%	26.4%
Tourism	13.8%	18.3%

Table 3. Effects of Zombie Firms on Economic Activity

Regressions	TFP		EMPLOYMENT GROWTH		INVESTMENT TO CAPITAL RATIO	
	(1)	(2)	(3)	(4)	(5)	(6)
$nonZ_{ist}$	0.212*** (0.030)	0.185*** (0.034)	0.071*** (0.009)	0.058*** (0.009)	0.018*** (0.002)	0.018*** (0.003)
$Z_{st}^{Sales Share}$	-0.038 (0.322)		0.251*** (0.095)		0.077** (0.035)	
$Z_{st}^{Capital Share}$		-0.293 (0.302)		0.089 (0.072)		0.057** (0.026)
$nonZ_{ist} * Z_{st}^{Sales Share}$	-0.115 (0.321)		-0.285*** (0.095)		-0.067* (0.035)	
$nonZ_{ist} * Z_{st}^{Capital Share}$		0.249 (0.304)		-0.084*** (0.009)		-0.049* (0.026)
Observations	80,911	80,911	78,575	78,575	81,907	81,907
# id	22,567	22,567	22,361	22,361	22,808	22,808
Breusch-Pagan Test	53432***	53436***	25***	25***	0.83*	0.82*
Wald test (Chi ²)	103739***	103809***	4757***	4758***	35019***	35026***

Marginal Effects	(1)	(2)	(3)	(4)	(5)	(6)
Sales Share						
$nonZ_{ist} = 0$	-0.038 (0.322)		0.251*** (0.095)		0.077** (0.035)	
$nonZ_{ist} = 1$	-0.153 (0.105)		-0.034 (0.044)		0.010 (0.018)	
Capital Share						
$nonZ_{ist} = 0$		-0.293 (0.302)		0.089 (0.072)		0.057** (0.026)
$nonZ_{ist} = 1$		-0.044 (0.037)		0.063*** (0.023)		0.008 (0.006)

Note: ***, ** and * denote significance at 1, 5 and 10 percent, respectively. All regressions include firm controls, sector and time fixed effects. $nonZ_{ist}$ is the dummy variable that takes the value 1 if the firm is not zombie, $Z_{st}^{Capital Share}$ refer to the share of industry capital sunk in zombie firms, whereas $Z_{st}^{Sales Share}$ represents zombie firms share in sales in the industry. TFP is total factor productivity, employment growth refers to the change in employment and investment to capital ratio is the investment of the firm as a ratio of capital stock of the firm. Robust standard errors are clustered by country, industry and year. Industry refers to 2-digit level detail according to NACE Rev. 2.

Table 4a. Effects of Zombie Firms on Economic Activity-Manufacturing Sample

Regressions	TFP		EMPLOYMENT GROWTH		INVESTMENT TO CAPITAL RATIO	
	(1)	(2)	(3)	(4)	(5)	(6)
$nonZ_{ist}$	0.283*** (0.040)	0.331*** (0.041)	0.099*** (0.013)	0.098*** (0.014)	0.022*** (0.004)	0.020*** (0.004)
$Z_{st}^{Sales Share}$	1.073 (0.735)		0.838*** (0.233)		0.083 (0.085)	
$Z_{st}^{Capital Share}$		1.471** (0.600)		0.684*** (0.205)		0.018 (0.072)
$nonZ_{ist} * Z_{st}^{Sales Share}$	-0.993 (0.745)		-0.832*** (0.233)		-0.832*** (0.233)	
$nonZ_{ist} * Z_{st}^{Capital Share}$		-1.847*** (0.600)		-0.643*** (0.203)		-0.021 (0.070)
Observations	39,031	39,031	38,872	38,872	40,027	40,027
# id	10,969	10,969	11,079	11,079	11,222	11,222
Breusch-Pagan Test	28221***	28235***	10***	10***	20***	20***
Wald test (Chi ²)	16499***	16529***	2173***	2170***	462***	461***

Marginal Effects	(1)	(2)	(3)	(4)	(5)	(6)
	Sales Share					
$nonZ_{ist} = 0$	1.073 (0.735)		0.838*** (0.233)		0.083 (0.085)	
$nonZ_{ist} = 1$	0.080 (0.158)		0.005 (0.076)		0.017 (0.035)	
	Capital Share					
$nonZ_{ist} = 0$		1.471** (0.600)		0.684*** (0.205)		0.018 (0.072)
$nonZ_{ist} = 1$		-0.0376*** (0.124)		0.041 (0.413)		-0.003 (0.029)

Note: ***, ** and * denote significance at 1, 5 and 10 percent, respectively. All regressions include firm controls, sector and time fixed effects. $nonZ_{ist}$ is the dummy variable that takes the value 1 if the firm is not zombie, $Z_{st}^{Capital Share}$ refer to the share of industry capital sunk in zombie firms, whereas $Z_{st}^{Sales Share}$ represents zombie firms share in sales in the industry. TFP is total factor productivity, employment growth refers to the change in employment and investment to capital ratio is the investment of the firm as a ratio of capital stock of the firm. Robust standard errors are clustered by country, industry and year. Industry refers to 2-digit level detail according to NACE Rev. 2.

Table 4b. Effects of Zombie Firms on Economic Activity-Services Sample

Regressions	TFP		EMPLOYMENT GROWTH		INVESTMENT TO CAPITAL RATIO	
	(1)	(2)	(3)	(4)	(5)	(6)
$nonZ_{ist}$	31.191** (14.745)	37.377*** (9.327)	31.191** (14.745)	0.040*** (0.012)	0.013*** (0.003)	0.014*** (0.004)
$Z_{st}^{Sales Share}$	-266.324 (239.819)		0.107 (0.109)		0.053 (0.040)	
$Z_{st}^{Capital Share}$		-34.195 (67.905)		0.003 (0.080)		0.042 (0.030)
$nonZ_{ist} * Z_{st}^{Sales Share}$	130.162 (231.269)		-0.134 (0.112)		-0.042 (0.040)	
$nonZ_{ist} * Z_{st}^{Capital Share}$		30.500 (66.798)		0.065 (0.081)		-0.036 (0.029)
Observations	41,880	41,880	39,703	39,703	41,880	41,880
# id	12,227	12,227	11,858	11,858	12,227	12,227
Breusch-Pagan Test	22711***	22719***	39***	39***	8***	7***
Wald test (Chi ²)	3535***	3533***	2511***	2517***	19993***	19994***

Marginal Effects	(1)	(2)	(3)	(4)	(5)	(6)
Sales Share						
$nonZ_{ist} = 0$	-266.324 (239.819)		0.107 (0.109)		0.053 (0.040)	
$nonZ_{ist} = 1$	-136.162 (100.620)		-0.027 (0.052)		0.010 (0.021)	
Capital Share						
$nonZ_{ist} = 0$		-34.195 (67.905)		0.003 (0.080)		0.042 (0.030)
$nonZ_{ist} = 1$		-3.694 (10.094)		0.068*** (0.024)		0.007 (0.007)

Note: ***, ** and * denote significance at 1, 5 and 10 percent, respectively. All regressions include firm controls, sector and time fixed effects. $nonZ_{ist}$ is the dummy variable that takes the value 1 if the firm is not zombie, $Z_{st}^{Capital Share}$ refer to the share of industry capital sunk in zombie firms, whereas $Z_{st}^{Sales Share}$ represents zombie firms share in sales in the industry. TFP is total factor productivity, employment growth refers to the change in employment and investment to capital ratio is the investment of the firm as a ratio of capital stock of the firm. Robust standard errors are clustered by country, industry and year. Industry refers to 2-digit level detail according to NACE Rev. 2.

Table 5a. Effects of Zombie Firms on Economic Activity-Large Firms Sample

	TFP		EMPLOYMENT GROWTH		INVESTMENT TO CAPITAL RATIO	
Regressions	(1)	(2)	(3)	(4)	(5)	(6)
$nonZ_{ist}$	0.190*** (0.046)	0.150*** (0.043)	0.056*** (0.021)	0.049** (0.021)	0.018*** (0.006)	0.025*** (0.006)
$Z_{st}^{Sales Share}$	-0.343 (0.456)		0.259 (0.221)		0.100 (0.066)	
$Z_{st}^{Capital Share}$		-0.686** (0.283)		0.217 (0.141)		0.148*** (0.141)
$nonZ_{ist} * Z_{st}^{Sales Share}$	0.507 (0.472)		-0.346 (0.222)		-0.115* (0.063)	
$nonZ_{ist} * Z_{st}^{Capital Share}$		0.724** (0.287)		-0.148 (0.143)		-0.145*** (0.043)
Observations	11,056	11,056	10,880	10,880	11,137	11,137
# id	3,590	3,590	3,561	3,561	3,617	3,617
Breusch-Pagan Test	6859***	6859***	0.28	0.32	29***	30***
Wald test (Chi ²)	134328***	134366***	322***	325***	232***	241***
Marginal Effects	(1)	(2)	(3)	(4)	(5)	(6)
	Sales Share					
$nonZ_{ist} = 0$	-0.343 (0.456)		0.259 (0.221)		0.100 (0.066)	
$nonZ_{ist} = 1$	0.164 (0.245)		-0.087 (0.129)		-0.015 (0.042)	
	Capital Share					
$nonZ_{ist} = 0$	-0.686** (0.283)		0.217 (0.141)		0.148*** (0.141)	
$nonZ_{ist} = 1$	0.038 (0.068)		0.069 (0.036)		0.003 (0.012)	

Note: ***, ** and * denote significance at 1, 5 and 10 percent, respectively. All regressions include firm controls, sector and time fixed effects. $nonZ_{ist}$ is the dummy variable that takes the value 1 if the firm is not zombie, $Z_{st}^{Capital Share}$ refer to the share of industry capital sunk in zombie firms, whereas $Z_{st}^{Sales Share}$ represents zombie firms share in sales in the industry. TFP is total factor productivity, employment growth refers to the change in employment and investment to capital ratio is the investment of the firm as a ratio of capital stock of the firm. Robust standard errors are clustered by country, industry and year. Industry refers to 2-digit level detail according to NACE Rev. 2.

Table 5b. Effects of Zombie Firms on Economic Activity-Medium Firms Sample

Regressions	TFP		EMPLOYMENT GROWTH		INVESTMENT TO CAPITAL RATIO	
	(1)	(2)	(3)	(4)	(5)	(6)
$nonZ_{ist}$	0.237*** (0.035)	0.181*** (0.031)	0.083*** (0.013)	0.059*** (0.011)	0.017*** (0.004)	0.016*** (0.004)
$Z_{st}^{Sales Share}$	0.557 (0.471)		0.309* (0.175)		0.058 (0.056)	
$Z_{st}^{Capital Share}$		-0.300 (0.252)		0.050 (0.092)		0.029 (0.030)
$nonZ_{ist} * Z_{st}^{Sales Share}$	-0.636 (0.467)		-0.439** (0.172)		-0.047 (0.054)	
$nonZ_{ist} * Z_{st}^{Capital Share}$		0.273 (0.253)		0.008 (0.092)		-0.023 (0.030)
Observations	69,855	69,855	67,695	67,695	70,770	70,770
# id	20,296	20,296	20,056	20,056	20,523	20,523
Breusch-Pagan Test	16888***	16891***	14***	13***	4**	4**
Wald test (Chi ²)	268331***	268353***	1084***	1080***	484***	484***

Marginal Effects	(1)	(2)	(3)	(4)	(5)	(6)
Sales Share						
$nonZ_{ist} = 0$	0.557 (0.471)		0.309* (0.175)		0.058 (0.056)	
$nonZ_{ist} = 1$	-0.079 (0.177)		-0.130* (0.070)		0.011 (0.026)	
Capital Share						
$nonZ_{ist} = 0$		-0.300 (0.252)		0.050 (0.092)		0.029 (0.030)
$nonZ_{ist} = 1$		-0.028 (0.063)		0.058** (0.025)		0.005 (0.009)

Note: ***, ** and * denote significance at 1, 5 and 10 percent, respectively. All regressions include firm controls, sector and time fixed effects. $nonZ_{ist}$ is the dummy variable that takes the value 1 if the firm is not zombie, $Z_{st}^{Capital Share}$ refer to the share of industry capital sunk in zombie firms, whereas $Z_{st}^{Sales Share}$ represents zombie firms share in sales in the industry. TFP is total factor productivity, employment growth refers to the change in employment and investment to capital ratio is the investment of the firm as a ratio of capital stock of the firm. Robust standard errors are clustered by country, industry and year. Industry refers to 2-digit level detail according to NACE Rev. 2

Data Appendix

Table A1. NACE 2-digit sectoral codes for manufacturing

NACE2 Code	Technology Classification	Name of Sector
10	Low-Tech	Food Products
11	Low-Tech	Beverages
12	Low-Tech	Tobacco Products
13	Low-Tech	Textiles
14	Low-Tech	Apparel
15	Low-Tech	Leather and Related Products
16	Low-Tech	Wood and Cork Products
17	Low-Tech	Paper and Paper Products
18	Low-Tech	Printing and reproduction of recorded media
19	Medium/Low-Tech	Coke and refined petroleum products
20	Medium/High-Tech	Chemical and Chemical Products
21	High-Tech	Basic pharmaceutical products
22	Medium/Low-Tech	Rubber and Plastic Products
23	Medium/Low-Tech	Other non-metallic mineral products
24	Medium/Low-Tech	Basic metals
25	Medium/Low-Tech	Fabricated metal products
26	High-Tech	Computer, electronic and optical products
27	Medium/High-Tech	Electrical equipment
28	Medium/High-Tech	Machinery and equipment n.e.c.
29	Medium/High-Tech	Motor vehicles, trailers and semi-trailers
30	Medium/High-Tech	Other Transport Equipment
31	Low-Tech	Furniture
42	Low-Tech	Other Manufacturing

Table A2. NACE 2-digit sectoral codes for services

NACE2 Code	Broad Services Classification	Name of Sector
41	CES Constr. and Eng. Ser.	Construction of buildings
42	CES Constr. and Eng. Ser.	Civil engineering
43	CES Constr. and Eng. Ser.	Specialized construction activities
45	DIST Distribution	Wholesale and retail of motor vehicles and motorcycles
46	DIST Distribution	Wholesale, except of motor vehicles and motorcycles
47	DIST Distribution	Retail, except of motor vehicles and motorcycles
49	TRANS Transportation	Land transport and transport via pipelines
50	TRANS Transportation	Water transport
51	TRANS Transportation	Air transport
52	TRANS Transportation	Warehousing and support activities for transportation
53	COM Communication	Postal and courier actives
55	TRSM Tourism	Accommodation
56	TRSM Tourism	Food and beverage service activities
58	OTH Other	Publishing activities,
59	COM Communication	Motion picture, video and television program, etc.
61	COM Communication	Telecommunications
62	BS Business Services	Computer programing, consultancy and related act.
63	BS Business Services	Information service activities
68	BS Business Services	Real estate activities
69	BS Business Services	Legal and accounting activities
70	BS Business Services	Activities of head offices; management consultancy
71	BS Business Services	Architectural and engineering activities
72	BS Business Services	Scientific research and development
73	BS Business Services	Advertising and market research
74	BS Business Services	Other professional, scientific and technical activities
75	BS Business Services	Veterinary activities
77	BS Business Services	Rental and leasing activities
78	BS Business Services	Employment activities
79	TRSM Tourism	Travel agency, tour operator services and related act.
80	BS Business Services	Security and investigation activities
81	BS Business Services	Services to buildings and landscape activities
82	BS Business Services	Office admin., office support and other business act.
85	EDU Education	Education
86	HLT Health	Human health activities
87	HLT Health	Residential care activities
88	HLT Health	Social work activities without accommodation
90	REC Recreational Activities	Creative, arts and entertainment activities
91	REC Recreational Activities	Libraries, archives, museums and other cultural act.
92	REC Recreational Activities	Gambling and betting activities
93	REC Recreational Activities	Sports and amusement and recreation activities
95	BS Business Services	Repair of computers and personal and household goods
96	OTH Other	Other personal service activities

Table A3. Kolmogorov-Smirnov results: Zombie vs healthy manufacturing firms

TOTAL FACTOR PRODUCTIVITY									
Sector	All Firms			Exporters			Foreign-Owned		
	# Obs	# Zombie	Test Stat	# Obs	# Zombie	Test Stat	# Obs	# Zombie	Test Stat
All	40027	1188	0.237***	25092	785	0.239***	1603	140	0.359***
10	4489	169	0.316	2007	106	0.275***	199	31	0.260
11	214	30	0.555	130	12	0.506*	25	4	0.762
12	41	0	-	41	0	-	18	0	-
13	5131	142	0.294***	2973	87	0.274***	75	1	0.865
14	5252	100	0.314***	2932	57	0.356***	66	0	-
15	914	11	0.347	588	8	0.278	4	0	-
16	587	16	0.266	321	10	0.221	5	0	-
17	981	30	0.248	738	24	0.181	57	3	0.370
18	541	18	0.251	299	15	0.294	5	2	0.667
19	81	2	0.987	64	2	1.000	6	1	1.000
20	1071	38	0.262	925	31	0.318**	164	12	0.489*
21	278	16	0.247	212	16	0.242	55	8	0.534
22	2650	84	0.200**	1976	73	0.234***	153	21	0.514***
23	3468	157	0.233***	1444	60	0.227**	103	8	0.280
24	1476	81	0.257***	1152	63	0.274***	57	12	0.289
25	3605	73	0.163	2396	53	0.188	128	6	0.363
26	340	9	0.429	264	9	0.440	24	1	0.652
27	1563	38	0.244	1188	29	0.309	94	9	0.397
28	2994	43	0.213	2379	29	0.167	89	2	0.851
29	1656	40	0.440***	1306	33	0.482***	104	14	0.745***
30	299	22	0.907	205	16	0.885	22	0	-
31	1573	38	0.330***	912	26	0.307	12	1	0.727
32	823	31	0.380***	650	26	0.393***	37	4	0.424

Note: ***, ** and * denote significance at 1, 5 and 10 percent, respectively. Corrected p-values are reported. For sample sizes smaller than 50, p-values may suffer from approximation bias.

Table A3 reports Kolmogorov-Smirnov test results for zombie and healthy firms in manufacturing sectors reported in NACE Rev. 2, 2-digit sector detail. For the manufacturing sector as a whole, the null hypothesis of distribution equality is rejected. In sectoral detail, among 23 manufacturing sectors, in 8 of them, healthy firms are significantly more productive than zombie firms. Among manufacturing exporters, in 10 of the sectors, there is a significant productivity difference between zombies and healthy firms. Moreover, in Sectors 22 (Rubber and plastic products) and 29 (Motor vehicles), distribution differs in all firms, exporters and foreign owned firms.

Table A4. Kolmogorov-Smirnov results: Zombie vs healthy manufacturing firms

TOTAL FACTOR PRODUCTIVITY									
Sector	Small			Medium			Large		
	# Obs	# Zombie	Test Stat	# Obs	# Zombie	Test Stat	# Obs	# Zombie	Test Stat
All	15651	408	0.246***	18946	563	0.247***	5430	217	0.340***
10	1854	49	0.307***	1948	78	0.370***	687	42	0.357
11	74	12	0.672***	99	14	0.586***	41	4	0.344
12	4	0	-	12	0	-	25	0	-
13	1650	39	0.325***	2492	72	0.344***	989	31	0.377***
14	2264	45	0.237	2296	42	0.473***	692	13	0.210
15	440	5	0.515	428	5	0.481	46	1	0.822
16	296	5	0.645	244	2	0.541	47	9	0.202
17	383	6	0.738**	450	14	0.380	148	10	0.286
18	277	10	0.265	234	7	0.628*	30	1	0.897
19	43	1	0.976	34	1	1.000	4	0	-
20	413	22	0.244	510	13	0.367	148	3	0.600
21	62	1	0.967	125	11	0.264	91	4	0.253
22	1109	21	0.247	1254	54	0.270***	287	9	0.321
23	1147	64	0.259***	1883	75	0.253***	438	18	0.284
24	467	21	0.436***	707	41	0.1193	302	19	0.457***
25	1512	27	0.236	1763	45	0.129	330	1	0.7175
26	124	4	0.723	168	5	0.359	48	0	-
27	593	17	0.139	740	10	0.502	230	11	0.435
28	1350	18	0.301	1430	19	0.242	214	6	0.798***
29	519	8	0.276	771	14	0.495**	366	18	0.623***
30	105	8	-	139	9	0.846	55	5	-
31	548	12	0.428	860	12	0.306	165	12	0.304
32	417	11	0.294	359	20	0.458***	47	0	-

Note: ***, ** and * denote significance at 1, 5 and 10 percent, respectively. Corrected p-values are reported. For sample sizes smaller than 50, p-values may suffer from approximation bias. Small-size firms have 20-49 employees, medium-size firms have 50-249 employees and large-size firms have 250+ employees.

Table A4 shows Kolmogorov-Smirnov test results for the comparison between zombie and healthy manufacturing firms by size. For manufacturing as a whole and Sector 13 (Textiles) results are significant in all three size categories. In other words, healthy firms are more productive than zombie firms. In Sector 29 (Motor vehicles), distribution differs medium and large size firms not differ in small size. On the other hand, for sector 24 (Basic metals) distribution differs for small and large size firms but not differ for medium size. Moreover, in sectors 11 (Beverages) and 23 (Other non-metallic) distribution is differ for small and medium size firms while large size is not.

Table A5. Kolmogorov-Smirnov results: Zombie vs healthy services firms

LABOR PRODUCTIVITY									
Sector	All Firms			Exporters			Foreign-Owned		
	# Obs	# Zombie	Test Stat	# Obs	# Zombie	Test Stat	# Obs	# Zombie	Test Stat
All	41880	1820	0.139***	7645	301	0.192***	1610	110	0.476***
41	2029	30	0.330**	216	3	0.643	1	0	-
42	1306	169	0.255	260	2	0.756	17	0	-
43	1527	20	0.147	384	5	0.443	19	3	0.750
45	2388	80	0.209**	470	11	0.3648	78	2	0.882
46	8749	224	0.147***	4387	133	0.180***	621	20	0.609***
47	5689	247	0.334***	758	47	0.418***	131	22	0.635***
49	2493	186	0.310***	259	21	0.247	58	4	0.722
50	400	39	0.220	73	7	0.184	20	0	-
51	61	17	0.321	52	14	0.376	10	2	0.625
52	1148	34	0.262	126	6	0.392	85	0	-
53	120	1	0.647	7	0	-	16	0	-
55	2620	200	0.209***	77	9	-	81	8	0.408
56	2211	96	0.322***	52	6	0.551	26	3	0.913
58	221	12	0.426	40	2	0.632	16	0	-
59	81	6	0.413	10	3	0.571	2	0	-
61	97	10	0.490	49	5	0.318	17	1	0.688
62	428	23	0.589***	98	3	0.916	43	0	-
63	82	12	0.2071	8	1	1.000	12	0	-
68	207	9	0.596**	5	1	1.000	17	1	1.000
69	162	2	0.538	0	0	-	10	1	1.000
70	391	33	0.176	12	0	-	33	6	0.389
71	529	7	0.222	47	1	0.652	62	0	-
73	330	14	0.335	26	2	0.458	87	9	0.680***
74	45	1	0.955	2	0	-	0	0	-
77	103	6	0.576	9	0	-	10	0	-
78	102	4	0.469	2	0	-	8	0	-
79	321	14	0.264	27	0	-	15	2	0.308
80	694	20	0.157	5	3	1.000	12	3	1.000
81	1624	21	0.311	31	0	-	13	1	0.917
82	419	22	0.3370	39	1	0.895	32	6	0.346
85	2918	157	0.247***	10	1	0.556	10	0	-
86	1610	204	0.173***	52	7	0.400	36	12	0.750***
88	190	4	0.610	0	0	-	0	0	-
90	34	5	0.414	8	0	-	0	0	-
93	170	18	0.235	13	2	0.909	4	0	-
95	192	11	0.823***	17	4	0.769	5	4	0.500
96	123	8	0.379	2	0	-	0	0	-

Note: ***, ** and * denote significance at 1, 5 and 10 percent, respectively. Corrected p-values are reported. For sample sizes smaller than 50, p-values may suffer from approximation bias. Sectors with less than 30 observations (72, 75, 87, 91 and 92) are not reported.

Table A6. Kolmogorov-Smirnov results: Zombie vs healthy services firms

LABOR PRODUCTIVITY									
Sector	Small			Medium			Large		
	# Obs	# Zombie	Test Stat	# Obs	# Zombie	Test Stat	# Obs	# Zombie	Test Stat
All	17641	757	0.187***	18473	734	0.126***	5766	329	0.091
41	658	16	0.446**	1071	13	0.257	300	1	1.000
42	264	4	0.565	733	15	0.156	309	2	0.723
43	542	6	0.582	857	8	0.223	128	6	0.273
45	1122	44	0.185	1177	32	0.249	89	4	0.574
46	4726	118	0.166**	3505	90	0.144	518	16	0.381
47	2753	121	0.375***	2215	64	0.402***	721	62	0.267***
49	1091	73	0.336***	1094	87	0.294***	208	26	0.433***
50	237	29	0.258	145	8	0.252	18	2	0.500
51	17	9	0.3333	10	3	0.333	34	5	0.766
52	520	16	0.244	491	13	0.323	137	5	0.689
53	41	0	-	36	1	0.743	43	0	-
55	847	52	0.248**	1235	105	0.247***	548	43	0.399***
56	1050	34	0.452***	954	36	0.364***	207	26	0.170
58	121	4	0.547	63	5	0.482***	37	3	0.794
59	40	3	0.622	28	1	1.000	13	2	0.818
61	24	1	0.522	40	0	-	33	9	0.292
62	119	6	0.701*	229	14	0.522**	80	3	0.883
63	18	4	0.607	47	1	0.826	17	7	0.329
68	87	5	0.605	106	3	0.599	14	1	0.769
69	84	1	0.506	53	1	0.634	25	0	-
70	185	19	0.135	164	13	0.349	42	1	0.610
71	275	4	0.290	195	0	-	59	2	0.500
73	112	5	0.4542	159	8	0.464	59	1	0.879
74	34	1	0.970	11	0	-	0	0	-
77	31	2	0.724	56	4	0.596	16	0	-
78	27	1	0.654	31	2	0.552	44	1	0.814
79	161	13	0.220	126	1	0.568	34	0	-
80	67	4	0.250	309	9	0.398	318	7	0.400
81	243	0	-	705	10	0.317	676	11	0.466
82	171	6	0.549	154	6	0.574	94	10	0.269
85	1003	60	0.372***	1492	75	0.272***	423	22	0.337
86	459	73	0.309***	767	86	0.199**	384	45	0.116
88	163	4	0.605	24	0	-	3	0	-
90	18	4	0.286	13	1	0.667	3	0	-
93	70	1	0.507	85	14	0.262	15	3	0.500
95	147	5	0.894	33	4	0.759	12	2	0.600
96	82	7	0.335	40	1	0.718	1	0	-

Note: ***, ** and * denote significance at 1, 5 and 10 percent, respectively. Corrected p-values are reported. For sample sizes smaller than 50, p-values may suffer from approximation bias. Small-size firms have 20-49 employees, medium-size firms have 50-249 employees and large-size firms have 250+ employees. Sectors with less than 30 observations (72, 75, 87, 91 and 92) are not reported.

Table A7. Kolmogorov-Smirnov results: Among manufacturing zombies

TOTAL FACTOR PRODUCTIVITY						
Sector	Exporter vs Non-Exporter			Foreign vs Domestic		
	# Obs	# Zombie	Test Stat	# Obs	# Zombie	Test Stat
All	25092	785	0.196***	1603	140	0.151*
10	2007	106	0.184	199	31	0.335
11	130	12	0.278	25	4	0.483
13	2973	87	0.252	75	1	0.520
14	2932	57	0.167	66	0	-
15	588	8	0.375	4	0	-
16	321	10	0.533	5	0	-
17	728	24	0.708	57	3	0.882
18	299	15	0.667	5	2	0.546
19	64	2	-	5	2	1.000
20	925	31	0.313	164	12	0.363
21	212	16	-	55	8	0.375
22	1976	73	0.253	153	21	0.191
23	1444	60	0.283**	103	8	0.599*
24	1152	63	0.135	57	12	0.530*
25	2396	53	0.359	128	6	0.419
26	264	9	-	24	1	0.667
27	1188	29	0.280	94	9	0.418
28	2379	29	0.616**	89	2	0.741
29	1306	33	0.229	205	14	0.195
31	912	26	0.423	12	1	0.815
32	650	26	0.346	37	4	0.515

Note: ***, ** and * denote significance at 1, 5 and 10 percent, respectively. Corrected p-values are reported. For sample sizes smaller than 50, p-values may suffer from approximation bias. Sectors 12 and 30 are not reported due to all-through non-convergence of the test statistic.

Tables A5 and A6 present Kolmogorov-Smirnov test results of comparisons between zombie and healthy firms in services sector where productivity is measured as labor productivity. Table A5 shows that among all firms, exporters and foreign-owned firms, distribution for these zombie and healthy firms are significantly different from each other in services sector. In Sectors 46 and 47 (distribution sectors) distributions differ between zombie and healthy firms.

Tables A7 shows the results of domestic versus exporter and domestic versus foreign owned manufacturing firms within zombie firms. In total, the distribution within zombie firms are significantly different with each other where productivity is measured as TFP. For instance, NACE 2-digit sectoral code 23 (Rubber and Plastic Products) both differ in exporter and foreign-owned zombie firms.

Table A8. Kolmogorov-Smirnov results: Among services zombies

LABOR PRODUCTIVITY						
Sector	Exporter vs Non-Exporter			Foreign vs Domestic		
	# Obs	# Zombie	Test Stat	# Obs	# Zombie	Test Stat
All	7645	301	0.305***	1610	110	0.470***
41	216	3	0.407	1	0	-
42	260	2	0.316	17	0	-
43	384	5	0.400	19	3	0.333
45	470	470	0.466	78	2	0.651
46	4387	133	0.358	621	20	0.283
47	758	47	0.187	131	22	0.237
49	259	21	0.472	58	4	0.608
50	73	7	0.357	20	0	-
51	52	14	0.500	10	2	0.500
52	126	6	0.417	85	0	-
55	77	9	0.397	81	8	0.407
56	52	6	0.867***	26	3	0.508
58	40	2	0.500	16	0	-
59	10	3	0.667	2	0	-
61	49	5	0.400	17	1	0.500
62	98	3	0.400	43	0	-
63	8	1	0.909	12	0	-
68	5	1	0.500	17	1	-
69	0	0	-	10	1	1.000
70	12	0	-	33	6	0.438
71	47	1	1.000	62	0	-
73	26	2	0.500	87	9	-
79	27	0	-	15	2	0.875
80	5	3	1.000	12	3	1.000
81	31	0	-	13	1	0.824
82	39	1	0.619	32	6	0.667
85	10	1	0.968	10	0	-
86	52	7	0.432	36	12	0.317
93	13	2	0.750	4	0	-
95	17	4	0.571	5	4	0.425

Note: ***, ** and * denote significance at 1, 5 and 10 percent, respectively. Corrected p-values are reported. For sample sizes smaller than 50, p-values may suffer from approximation bias. Sectors 53, 72, 74-78, 87-92 and 96 are not reported due to all-through non-convergence of the test statistic.

Moreover, Table A8 reports the Kolmogorov-Smirnov results among zombie firms in services sector. In total, the distribution of exporter and non-exporter zombie firms and, foreign owned and domestic zombie firms are significantly different from each other. On the other hand, only tourism sector (NACE 2-digit sectoral code 56) test result is significant in exporter versus non-exporter zombie firms.