Are zombies productive or not?

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ABSTRACT

Increasing productivity at the firm level is important contributor to the overall economic activity. At the same time bank lending is a significant source of financing for firms, especially in continental European countries where non-bank financial intermediation is less developed. However, due to their self-interest, bankers sometimes opt for saving financially weak firms by extending loans or issuing new. We call firms with persistent financial difficulties zombie firms. In this paper we investigate the relationship between zombie firms' loan arrangements and their productivity. In other words, we are interested in how productivity behaves in firms that are financially weak, but still receive loans from the bank. Results show that there is a statistically significant positive link between increasing financing and productivity for healthy firms, while this relationship is non-existent for zombie firms. Since giving loans to financially weak firms means less loans for sound firms, which could use additional funds in a more productive way, our result implies that additional vigilance is warranted for the policy makers.

Keywords: zombie firms, total factor productivity, misallocation, micro level data

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1. Introduction

Bank lending is a significant source of financing for firms. This is especially the case in continental European countries where non-bank financial intermediation is less developed. For overall economic welfare it is important that scarce resource - bank lending - ends up in the best possible hands: there where the marginal impact of the loan is the largest. Economic theory assumes that free market competition will bring financing to the best firms, which promise good returns in the future. However, bankers sometimes opt for saving financially weak firms due to their self-interest (Peek and Rosengren 2005; Sekine, Kobayashi and Saita 2003), but the impact of such throwing good money after bad on firms' productivity are not well researched. This article tackles this important topic by studying the effects of increased bank financing on productivity of financially poor firms, which we call zombie firms. In other words, we are interested in how productivity behaves in firms that are financially weak, but still receive loans from the bank. This relationship is important because of possible effects zombie firms have on the economy.

In the literature there is no consensus about the relationship between bank loans and productivity, because there is only a limited amount of research that focus on the relationship between debt and productivity (e.g. Berger and Bonaccorsi di Patti 2006; Margaritis and Psillaki 2010; Levine and Warusawitharana 2014; Gomis and Khatiwada 2017) and especially on understanding how bank loans can affect productivity (Coricelli et al. 2010). In order to trace the link between bank loans and productivity, we use dataset which includes information on firms' financial statements in Croatia and investigate how firm's leverage affects productivity in zombie and non-zombie firms.

Besides limited literature on the impact of debt financing on firm's productivity, studies on detecting zombie lending in Europe are also relatively rare, although zombie lending is often mentioned in policy discussions and in professional publications. Exception are Albertrazzi and Marchetti (2010) and Schivardi and Sette (2017) who found evidence of zombie lending in Italian economy and Broz and Ridzak (2017) who found evidence of zombie lending in Croatian economy. Hence our study is important for banks and policy makers. Continuing to financially support zombie firms implies that non-zombie firms will have less access to the banks loans due to crowding out. This situation is undesirable for the firms in the aggregate, but also for banks in the longer run, as they invest their scarce resources into subpar debtors,

only to achieve short term gains. In the longer run banks' management risks recording increase in the share of nonperforming loans, if the subpar debtor finally defaults on its payments. In addition to that, this practice might be questioned by the supervisory body or banks' owners.

We study the link between firms' productivity, as measured by total factor productivity (TFP) a 'la Levinsohn and Petrin (2003) and the increase of loan arrangement to poor and healthy firms and find significant positive effect of increased lending on productivity for healthy firms and no effect for zombie firms, implying that dealing with zombie firms might increase overall productivity in the country.

The research is organised in five sections. After the introductory section, following section presents the survey of the related literature. Section 3 presents data and methodology, while the results of the analysis are presented in section 4. Finally, the section 5 concludes.

2. Related literature

Zombie lending refers to a policy where bank extends existing loan or give additional loan to a firm in distress in order to enable firm to repay existing obligation to a bank, thus avoiding or delaying bankruptcy (Peek and Rosengren 2005).[1] Banks have incentives to engage in such activities because of the short term gains: firms will be (temporarily) saved, while banks will not have to report loan as nonperforming, which increases provisions and thus negatively affects bank's earning and capitalisation.[2]

Why one should care whether banks approve loans to healthy firms or to firms in distress (except if this causes potential problem for financial stability and increases systemic risk)?

[1] Zombie lending was most thoroughly investigated in Japan, due to a prolonged recession and stagnation in the '90. Detailed overview of the literature on zombie lending can be found in Broz and Ridzak (2017).

[2] However, it is not always the case that the incentives are related to banks' earnings or that they come from the bank. Sometimes firm in distress fraudulently reports situation in the firm to be more favourable, which leads to less screening and to loan approval (Povel, Singh and Winton 2007); in the expansion phase of the business cycle there might be a large number of applicants, which increases the costs of screenings and leads to some unfavourable loan approvals (Ruckes 2004); as well, in expansion the cost of firm screening rises due to increased number of borrowers unknown to the bank (Dell'Ariccia and Marquez 2006), while loan officers' capacity in screening deteriorate (Berger and Udell 2004).

Such banks' behaviour in loan approval process can slow down the movement of production resources to propulsive activities and hinder the entry of new entrepreneurs to the market. Acemoglu et al. (2013) argue that industrial policy subsidising the R&D or continued operation of incumbents[3] reduces growth and welfare and slows down reallocation, because it deters entry of firms with high innovation capacity. Meza, Pratap and Urrutia (2014) analyse the link between misallocation of resources, TFP and credit conditions and argue that allocation of credit and interest rates across sectors is particularly important in explaining the movements in aggregate TFP. Also, their results suggest that decrease in loan supply is not necessarily harmful to the economy if the existing loans are reallocated optimally.

Besides, increasing productivity at the firm level is important contributor to the overall economic activity (Evans 1992; Klenow and Rodriguez-Clare 1997; Prescott 1998; Caselli 2005). Most research is in fact related to detecting underlying causes of differences in productivity (among others, Hall and Jones 1999; Bloom and Van Reenen 2007; Comin and Hobijn 2010). There is, however, a strand of that literature which claims that productivity can be low because of input misallocation (Restuccia and Rogerson 2013). Since credit misallocation can cause input misallocation (Gilchrist, Sim and Zakrajšek 2013), credit misallocation can be related to the firm's productivity. Hence, rolling over some potentially problematic loans to firms in distress should have a negative impact on productivity both for affected (firms in distress) and non-affected firms. As documented by Peek and Rosengren (2005) and Caballero, Hoshi and Kashyap (2008), affected firms will avoid restructuring and hence the possibility to become more productive, while non-affected firms will have less access to the funds. Adalet McGowan, Andrews and Millot (2017) argue that zombie firms lower the overall productivity growth, limit expansion of healthy firms and create barriers to entry of new firms.

Additionally, Kwon, Narita and Narita (2009) and Ahearne and Shinada (2005) found the negative impact of zombie lending on productivity on the firm level in Japan. Kwon, Narita and Narita (2009) find that zombie lending caused the loss of 37 percent of the actual decline in aggregate productivity growth in the 90' due to inefficient labour resource allocation. Ahearne and Shinada (2005) argue that in the 90', in the non-tradable sectors, less productive firms gained market share while increasing the share of bank lending which was detrimental

[3] Which can sometimes be viewed as similar type of behaviour as zombie lending.

to productive firms. However, zombie firms managed to recover during the first half of 2000 and Fukuda and Nakamura (2011) investigate why they recovered in Japan. They extended the methodology of Caballero, Hoshi and Kashyap (2008) in order to identify zombie firms and argue that restructuring that included reducing the employee count and selling unutilised fixed assets were important factors in the firms' recovery process.

The other strand of the literature on misallocation of (capital) resources argues that distortions that implicitly tax more productive firms and subsidize less productive damage TFP (Hopenhayn, 2014). Restuccia and Rogerson (2008), Moll (2014) and Gopinath et al. (2015) in that context argue that distortions imply taking resources from more to less productive firms, which in our context implies taking loans from more productive firms and giving it to less productive firms. Hence, reallocating capital from less to more productive firms would increase the country's GDP. Busso, Madrigal and Pagés (2012) stress that difficulty in access to capital helps explaining distortions faced by the firms. Literature on the effects of financial frictions on misallocation of resources and productivity show that institutions and policies might also cause productivity losses (Banerjee and Duflo 2005; Midrigan and Xu 2010; D'Erasmo and Boedo 2012).

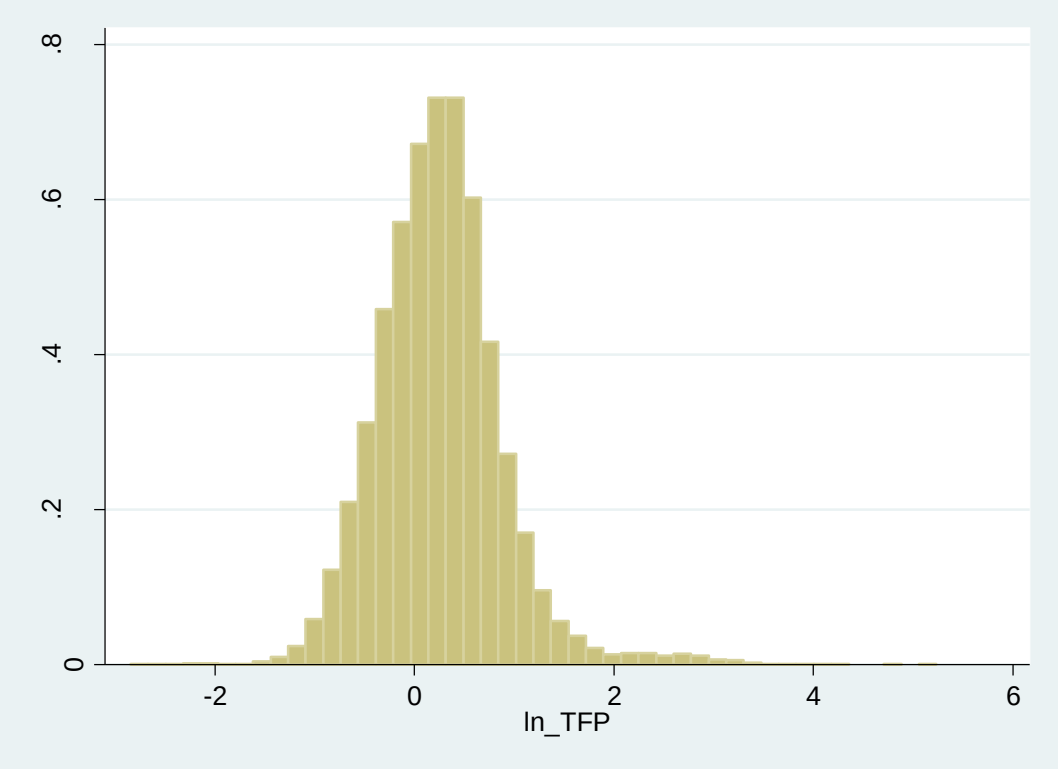
Staal and Brogaard (2011) analyse the relationship between debt and TFP in the Danish manufacturing sector and for most industries find no significant impact of debt on productivity. The finding of no relationship between the increase in debt financing and productivity could be related to the sample of firms, which includes zombie and non-zombie firms. Hence, just measuring the impact of increased debt financing on average firm' productivity might blur the underlying developments. For two sectors where they find positive relationship (chemicals and machinery and equipment), authors argue that banks might give loans only to firms that are performing well. In this article we are investigating separately situations in which banks approve loans to firms that are and are not performing well. Since we are investigating financially weak and healthy firms separately, we expect that the effect of increased financing on productivity differs between these two subsets.

3. Overview of methodology and data

Our empirical strategy to identify the effect of increased financing on firm's productivity is based on two different approaches. The first one is a two-steps approach, where we firstly estimate firms' TFP, and after that, using TFP as a dependent variable, we estimate the effect of increasing firms' financing to their productivity. The second approach is a one-step approach, where we try to identify the effect of increasing financing on firm's productivity jointly with the production function, treating the deviation from this function as a change in productivity.

Productivity, which can be defined as a variation in output that cannot be attributed to variations in production inputs, is calculated following the semi-parametric Levinsohn and Petrin' (2003) extension of the Olley and Pakes' (1996) methodology for calculating productivity. Olley and Pakes (1996) introduced methodology to calculate productivity that allows consistent estimation of the production function coefficients taking into account possible sources of bias: a sample selection and simultaneity biases. Levinsohn and Petrin (2003) suggested the use of intermediate inputs, instead of investments (as in Olley and Pakes 1996), as proxies to control for correlation between inputs and the unobservable firm-specific productivity shocks, i.e. for the simultaneity bias. We used production function with added value as dependent variable. Added value was proxied by sales net of intermediate inputs as suggested by Petrin, Poi and Levinsohn (2004). Labour was proxied by labour costs, capital by capital, reserves and retained earnings. Intermediate inputs were calculated as costs of goods sold, but without labour and amortization costs. All variables were deflated by sectoral deflators obtained from AMECO database and converted to natural logarithms. Total factor productivity was estimated for each Nace Rev 2 subsector separately in order to obtain more precise estimates. Finally, those estimates are used to calculate each firm's TFP. Histogram of natural logarithm of TFP and descriptive statistics is presented in Figure 1.

Figure 1: Histogram of natural logarithm of TFP and descriptive statistics



Variable	min	p5	p50	p95	max	mean	variance	skewness	kurtosis
ln_TFP	-2.850	-0.681	0.233	1.234	5.234	0.253	0.394	0.830	6.181

For the purpose of detecting zombie firms, we use dataset with balance sheet and profit and loss account data of Croatian firms from 2009 until 2015[4]. In total there are 200,228 firm-year observations that have banking relationship. Since our zombie definition depends on the number of years firms meet certain condition, we restrict the dataset only to those firms that sent reports for the whole period. After this operation we have fully balanced panel with 5,718 firms in 7 years or 40,026 firm-years in total.

We define potential zombie firm as a firm which cannot cover 100 percent of its short term financial obligations from earnings before interest, taxes, depreciation and amortisation (EBITDA). In other words, if the ratio of EBITDA and short term financial obligations is less than 1, we consider this firm to be a candidate for a zombie firm. EBITDA is the source from which a firm pays its obligations to banks and ratio of EBITDA to short term obligations smaller than 1 indicates inability to pay its imminent obligations. Various EBITDA ratios are key indicators that are used by rating agencies and financial analysts when assessing the

[4] Due to changes in methodology, we were unable to use data from the earlier period.

financial health of the firm. Our definition is restrictive on purpose, in order to single out firms that stand out (negatively). However, in order to relax the definition of potential zombie firm and to increase robustness of the analysis, we also rely on a definition where a firm cannot cover 70 percent of its short term obligations with EBITDA in order to qualify for a potential zombie firm. Since firms might have financial difficulties only temporarily, we identify zombie firms as firms with persistent financial difficulties. We use 3 consecutive years of EBITDA bellow short term debt (and 70% of short term debt, respectively) as a cut-off for identifying zombie firms. We also test stricter definition, where a firm is a zombie firm if in the whole sample period has financial difficulties.

The main interest of this analysis is to investigate the relationship between zombie firms' loan arrangements, defined as a ratio of total firm's financial obligations over total assets, and their productivity. In other words, we are interested in how TFP behaves in firms that are financially weak, but still receive loans from the bank. In order to investigate this, we separate detected zombie firms and non-zombie firms in two subsamples and conduct separate analysis for these two subsamples. In this way are able to observe not only behaviour of TFP in zombie firms, but also differences in response between zombie and non-zombie firms.

As a result, we have these 6 categories in total that we investigate: z0 (all periods without financial difficulties), z3 (3 and more consequent periods with financial difficulties), z7 (7 consequent periods, which is the whole sample, with financial difficulties), z0 70% (all periods without financial difficulties), z3 70% (unable to cover 70 percent of short term debt in 3 and more consequent periods), z7 70% (unable to cover 70 percent of short term debt in 7 consequent periods, which is the whole sample) and the frequencies are shown in Table 1. The difference between z0 and z0 70% samples is due to different definitions of zombie firms, hence different number of non-zombie firms remains in the sample.

Table 1: Frequency of zombie firms

Zombie	Frequency	n (firms)	% of zombies
z0	32676	4668	
z3	3192	456	9.8
z7	385	55	1.2
z0 70%	34405	4915	
z3 70%	2044	292	5.9
z7 70%	175	25	0.5

Note: the difference between the total number of observations (40,026) and the number of observations presented in this table comes from firms that were in financial difficulties for one or two years. Hence, they are not qualified as zombies, but are not included in completely financially healthy firms either.

As the table above shows, depending on the definition, we have from about 0.5 to about 10 per cent zombie firms in the sample. Ranges from 2 to 9 percent are also found in Adalet McGowan, Andrews and Millot (2017) for European countries.

In order to investigate the relationship between firms' financing arrangements and TFP according to our first approach, after calculating TFP for each firm, we specify the model as:

$$TFP_{it} = \alpha + x'_{it}\beta + D'_{it}\gamma + \delta_t + c_i + u_{it} \quad i = 1,...,N \quad t = 2009,...,2015 \qquad (1)$$

where TFP_{it} is a natural logarithm of firm's total factor productivity, α is the intercept, x'_{it} is a row vector of time-varying explanatory variables that include firm's financing defined as a ratio of total firm's financial obligations over total assets, and export defined as a ratio of income from exports over operating income, β is a column vector of parameters, D'_{it} is a row vector of time-varying dummy variables[5] (with one dummy variable dropped to avoid dummy-variable trap) including size of the firm (small, medium and large), county of firm registration, sector in which firm operates and ownership type (private vs government owned), γ is a column vector of parameters, δ_t are time-specific effects which affect all firms in the same way (with one time dummy dropped), c_i is an individual-specific effect and u_{it} is an idiosyncratic error term. Following results of the Hausman test for all firms, $\chi^2(41) = 384.42$ ($p < 0.05$), we use fixed effects panel models with White robust standard errors clustered by firm that are robust to autocorrelation and between cluster (across firms) heteroskedasticity.

[5] In our models enter size of the firm, county of firm registration, sector in which firm operates and ownership type which change in firms during the observed period.

In the second approach we estimate the relationship between firms' loan arrangements and their productivity jointly with the production function or:

$$y_{it} = \alpha + z'_{it}\omega + x'_{it}\beta + D'_{it}\gamma + \delta_t + c_i + u_{it} \quad i = 1,...,N \quad t = 2009,...,2015 \qquad (2)$$

where y_{it} is natural logarithm of deflated firm's value added, z'_{it} is a row vector of time-varying factors of production variables: natural logarithm of deflated labour costs, natural logarithm of deflated capital, reserves and retained earnings, and natural logarithm of intermediate inputs calculated as deflated costs of goods sold, but without labour and amortization costs, ω is a column vector of parameters. All other terms are the same as in the Equation (1) except the ownership, which does not enter in the row vector D' since by test of exclusion of this variable we cannot reject the null hypothesis that this variable is not significant. First part of equation (2) $z'_{it}\omega$ is traditional production function and TFP is then defined as deviations of observed output from the one predicted by the production function. Here, except production function inputs, we also introduce other variables, namely firms' financing arrangements and share of exports in operating income. As a result, the coefficient with the financing arrangements variable can be interpreted as how much financing of the firm explains error in production function, or in other words productivity. Hausman test (χ^2=769.32, p<0.05) supported fixed effects panel model.

4. Estimation results

After obtaining productivity estimates, we check if there is a systematic difference between zombie and non-zombie firms regarding productivity. Having in mind we cannot use regular *t*-test for testing the difference of mean in productivity of zombie and non-zombie firms due to panel data, where the observations are correlated across time, we use random effects panel model where we regress firm's productivity on the zombie dummy, which is time-invariant variable. Table 2 shows results of these random effects regressions for various zombie definitions. In the first two columns zombies are defined as those firms that are unable to cover their short term debt with EBITDA for 3 and more consecutive years (column 1) and in the whole sample period (column 2). Columns 3 and 4 use criterion where companies are

unable to cover 70% of their short term debt with EBITDA and the same number of years as a cut-off criterion (3 and more and 7 years, respectively). Results show that, across definitions, zombie firms have on average significantly lower productivity, compared to non-zombies. These results indicate that zombie firms have become zombies not because of random shifts in operating conditions due to some shock external to the firm, but because their productivity is lower, i.e. they were unable to compete in the markets.

Table 2: Effect of zombie status on productivity (TFP)

Dependent variable: TFP				
	(1)	(2)	(3)	(4)
z3	-0.128***			
	(-4.54)			
z7		-0.419***		
		(-5.43)		
z3 70%			-0.207***	
			(-5.97)	
z7 70%				-0.348**
				(-3.06)
cons	0.267***	0.267***	0.265***	0.265***
	(31.69)	(32.16)	(32.38)	(32.76)
N	35868	33061	36449	34580
r2_all	0.003	0.005	0.006	0.002
sigma_u	0.568	0.559	0.566	0.560
sigma_e	0.264	0.261	0.262	0.261
Rho	0.823	0.821	0.823	0.821

Note: *t* statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
z3 - zombies are defined as those firms that are unable to cover their short term debt with EBITDA for 3 and more consecutive years. z7 - zombies are defined as those firms that are unable to cover their short term debt with EBITDA in the whole sample period. z3 70% - zombies are defined as those firms that are unable to cover 70 percent of their short term debt with EBITDA for 3 and more consecutive years. z7 70% - zombies are defined as those firms that are unable to cover 70 percent of their short term debt with EBITDA in the whole sample period.

We repeat the same exercise, but this time we use productivity regressions, where we include standard productivity determinants – labour, capital and intermediate inputs, as described in the previous section and dependent variable is value added. Again, the equations are estimated using random effects and samples are the same as in Table 2. Equations corroborate estimation results shown in Table 2 and again show that zombies, however defined, have on average lower productivity than non-zombie firms (Table 3).

Table 3: Effect of zombie status on productivity estimated using productivity equations

Dependent variable: value added				
	(1)	(2)	(3)	(4)
Labour	0.575***	0.563***	0.576***	0.569***
	(168.81)	(159.29)	(170.93)	(164.98)
Capital	0.250***	0.260***	0.250***	0.257***
	(100.49)	(100.06)	(101.85)	(101.54)
Intermediate inputs	0.0886***	0.0844***	0.0859***	0.0832***
	(35.52)	(32.60)	(34.89)	(33.04)
z3	-0.154***			
	(-9.06)			
z7		-0.266***		
		(-5.67)		
z3 70%			-0.178***	
			(-8.59)	
z7 70%				-0.328***
				(-4.79)
Cons	1.213***	1.247***	1.213***	1.238***
	(54.19)	(53.65)	(54.88)	(54.70)
N	35868	33061	36449	34580
r2_all	0.925	0.924	0.925	0.925
sigma_u	0.326	0.329	0.326	0.326
sigma_e	0.231	0.230	0.230	0.229
Rho	0.666	0.672	0.668	0.669

Note: *t* statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

z3 - zombies are defined as those firms that are unable to cover their short term debt with EBITDA for 3 and more consecutive years. z7 - zombies are defined as those firms that are unable to cover their short term debt with EBITDA in the whole sample period. z3 70% - zombies are defined as those firms that are unable to cover 70 percent of their short term debt with EBITDA for 3 and more consecutive years. z7 70% - zombies are defined as those firms that are unable to cover 70 percent of their short term debt with EBITDA in the whole sample period.

Next we test the link between zombie firms and financing. Table 4 presents the results of fixed effects panel models based on specification in Equation (1) and shows only parameters β. Equation specifications are the same across various columns of the table, but we change the samples over estimated regressions.

Table 4: Estimation results – fixed effects panel models

Dependent variable: TFP						
	z0	z3	z7	z0 70%	z3 70%	z7 70%
Financing	0.238***	0.149	0.292	0.244***	0.0930	0.337
	(8.62)	(1.81)	(1.27)	(9.32)	(1.00)	(1.59)
Export	0.0683**	0.168*	0.125	0.0646**	0.219*	0.222***
	(2.69)	(1.97)	(1.03)	(2.58)	(2.34)	(6.30)
General controls	Yes	Yes	Yes	Yes	Yes	Yes
N	32676	3192	385	34405	2044	175
r2_all	0.114	0.101	0.0140	0.126	0.0602	0.113
r2_w	0.0911	0.0663	0.101	0.0909	0.0868	0.288
r2_b	0.118	0.107	0.00834	0.132	0.0587	0.103
sigma_u	0.532	0.641	0.718	0.530	0.664	0.461
sigma_e	0.250	0.272	0.190	0.249	0.266	0.144
Rho	0.819	0.847	0.935	0.819	0.862	0.911

Note: *t* statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

z0 - non-zombie firms. z3 - zombies are defined as those firms that are unable to cover their short term debt with EBITDA for 3 and more consecutive years. z7 - zombies are defined as those firms that are unable to cover their short term debt with EBITDA in the whole sample period. z0 70% - non-zombie firms. z3 70% - zombies are defined as those firms that are unable to cover 70 percent of their short term debt with EBITDA for 3 and more consecutive years. z7 70% - zombies are defined as those firms that are unable to cover 70 percent of their short term debt with EBITDA in the whole sample period. The difference between z0 and z0 70% is due to different definitions of zombie firms, hence different number of non-zombie firms remains in the sample.

Results show that there is a positive relationship between external financing and productivity for non-zombie firms, corroborating positive effects of external financing hypothesis presented in Gomis and Khatiwada (2017). This relationship is non-existent for zombie firms (2nd and 3rd specification). The same results regarding external financing hold for the other zombie definition (where firms are unable to cover at least 70% of their short term debt with EBITDA).

Among other results, it is interesting to note the positive effect of exports on productivity, which holds both for zombie and non-zombie firms with the exception of companies that are zombies in the whole sample, as defined by first zombie definition (EBITDA smaller than short term debt). The result on the link between exports and productivity is contributing to the ongoing discussion on whether exports increase productivity (e.g. Girma, Greenaway and Kneller 2004; Martins and Yang 2009; Loecker 2013).

Having in mind that the significance of financing and export variables on TFP estimates shows that these variables are actually missing from the TFP equation itself, we estimate the

production function with labour, capital and intermediate inputs, as well as with financing and exports, as explanatory variables using fixed effects panel models where the dependent variable is added value, as defined in the Equation (2). Estimation results are presented in Table 5, with samples changing across equations.

Table 5: Estimation results – production function, fixed effects panel models

Dependent variable: value added								
	z_bf	z0	z3	z7	z_bf70%	z0 70%	z3 70%	z7 70%
Labour	0.513***	0.525***	0.612***	0.481***	0.496***	0.509***	0.623***	0.583***
	(49.60)	(50.72)	(19.40)	(5.25)	(44.03)	(44.91)	(17.43)	(7.74)
Capital	0.228***	0.263***	0.134***	0.197**	0.241***	0.276***	0.146***	0.176***
	(39.94)	(42.92)	(8.43)	(3.00)	(39.35)	(42.46)	(7.01)	(5.08)
Intermediate inputs	0.118***	0.116***	0.189***	0.297***	0.111***	0.108***	0.163***	0.169*
	(18.52)	(18.59)	(5.12)	(4.95)	(17.73)	(17.87)	(5.29)	(2.15)
Financing		0.170***	-0.0325	0.173		0.230***	-0.0911	0.193
		(8.51)	(-0.54)	(0.85)		(10.56)	(-1.24)	(1.57)
Export		0.102***	0.150*	0.0814		0.098***	0.216*	0.150**
		(4.79)	(2.08)	(0.84)		(4.27)	(2.36)	(3.46)
General controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	39641	39641	3192	385	34405	34405	2044	175
r2_o	0.919	0.918	0.917	0.956	0.920	0.918	0.919	0.977
r2_w	0.585	0.602	0.580	0.704	0.588	0.605	0.584	0.665
r2_b	0.937	0.935	0.931	0.960	0.937	0.934	0.933	0.981
sigma_u	0.386	0.373	0.408	0.415	0.391	0.378	0.413	0.296
sigma_e	0.233	0.229	0.223	0.160	0.229	0.224	0.229	0.131
rho	0.732	0.727	0.771	0.871	0.744	0.739	0.766	0.837

Note: *t* statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

z_bf – non-zombie firms. z0 - non-zombie firms. z3 - zombies are defined as those firms that are unable to cover their short term debt with EBITDA for 3 and more consecutive years. z7 - zombies are defined as those firms that are unable to cover their short term debt with EBITDA in the whole sample period. z_bf* – non-zombie firms. z0 70% - non-zombie firms. z3 70% - zombies are defined as those firms that are unable to cover 70 percent of their short term debt with EBITDA for 3 and more consecutive years. z7 70% - zombies are defined as those firms that are unable to cover 70 percent of their short term debt with EBITDA in the whole sample period. The difference between z0 and z0 70%, as well as between z_bf and z_bf70% is coming from different definitions for zombie firms, hence different number of non-zombie firms stays in the sample.

Corroborating results obtained earlier, the estimated regressions show there is a positive relationship between external financing and productivity, again only for non-zombie firms. Export contributes significantly positive both to zombie and non-zombie productivity with the exception of long term zombies according to the first definition (fourth column in Table 5).

What could be behind the non-existent link between zombie firm's productivity and financing? The efficiency of free market is based on a fact that market events (in terms of prices and quantities) convey information to the agents in the marketplace. Agents adapt to new circumstances and optimise their behaviour with respect to the new environment. Applied to our analysis, firms that are in financial difficulties would, normally, react by optimizing their production process with respect to new situation in the market. However, if the firm is "blessed" with abundant quantity of important resource (in this case bank loans) its incentive to adapt is limited as it has cushion even when its competitive position is getting weaker. In fact, such firm lives in a dual world, where financing decisions are not made in the market manner, but the products (or services) are sold in competitive markets. It is sort of aid that is received by the firm. However, unlike some firm developmental aid programs that target high growth technologically superior firms (Aghion et al 2012), the selection for aid in this case is based on banks' interests.

There are two main implications of the presented results. First is that zombie firms become zombies not because they are exposed to some random shock to their operating conditions, which decreases their income and makes the debt unsustainable. These firms become zombies because they have on average lower productivity compared to non-zombies. Second implication is related to financing of such zombie firms. Results indicate that adding more credit to such firms will not solve their inherent problem – poor productivity. To solve such problems firms probably need major change in the way they operate. Implications of the results are far reaching and important in the today's economic landscape where many central banks and other government agencies aim to increase credit growth to non-financial corporate sector. If this fresh money ends up in the non-productive firms, we cannot expect sound growth coming from this part of the economy – which should be the working powerhouse or engine of growth of the modern capitalist economy.

Our results show that keeping alive firms that should exit the market might create productivity drag for the whole economy which might in the next step feed in to lower growth rates and what is now being called "secular stagnation". Last, but not least, another lesson of these results is that financing boosting schemes for the non-financial corporate sector should be designed with care, in order to circumvent this problem.

5. Conclusion

In this research we have investigated the link between financing and productivity, with the emphasis on zombie firms. Results show that there is a statistically significant positive link between increasing financing and healthy firms, while this relationship is non-existent for zombie firms. This implies that additional vigilance is warranted for the policy makers. Traditionally, central banks do not have direct mandate to deal with loan distribution. However, as we have shown that there is a positive effect of financing on firm's productivity and non-existent for zombie firms, venturing in to this field might be important, specifically in the period when overall and SME financing is scarce as the banks still struggle with the new regulatory capital and liquidity demands put forth by Basel III.

Except direct firm effects that were researched in this paper, aggregate effects are also important. Giving more loans to financially weak firms means less loans for sound firms, which could use additional funds in a more productive way. In addition to that, this means possible increase in interest rates or lower bank profitability as a result of such misallocation. This makes problem of zombie lending important from wider perspective. More control of banks' management by owners and more role for transaction lending (where firms' financial characteristics are the key to loan being granted) and less role for relationship lending is possible solution for lending to zombie firms.

Finally, a caveat should be mentioned. It does not mean that all situations where bank tries to help a company in distress are necessarily bad. However, if no real change or restructuring is performed at the firm level, investing good money after bad will just make the problem worse, not only for the firm but also for the bank and the economy.

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