# Rethinking the Cleansing Effect of Recessions*

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**Abstract**

Do recessions cleanse the economy of its least productive firms? Using comprehensive administrative data on Portuguese firms from 2004 to 2023, we study exit selection over the business cycle. We document two main findings. First, low-productivity firms are more likely to exit during growth slowdowns, but we find no evidence of cleansing during recessions. Second, low-productivity firms are more likely to become zombies during recessions rather than exit. As a result, the cleansing and zombie effects operate in opposite directions in downturns, weakening the selection at the exit margin. We develop a model with endogenous entry, exit, and zombie firms that matches these empirical patterns and quantifies their implications for aggregate TFP growth. We show that zombie congestion during recessions dampens productivity-enhancing reallocation and lowers aggregate TFP.

JEL: D22, E32, L25, G21.

Keywords: firm exit; business cycle; zombie firms; cleansing effect of recessions.

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# 1 Introduction

Do recessions cleanse the economy of its least productive firms? According to Schumpeter (1942), higher firm exit in recessions allows resources to be reallocated towards more productive firms. More recently, this silver lining view of recessions has been echoed in Caballero and Hammour (1994), who show that downturns induce the destruction of older, less advanced technology. However, there is no consensus on this question. Several theoretical contributions have found that accounting for additional factors, such as financial or information frictions, recessions may actually reduced or reversed the cleansing effect (Barlevy (2003); Ouyang (2009); Osotimehin and Pappadà (2017)). In this paper, we address this research question from an empirical and theoretical perspective as we study the patterns of exit selection over the business cycle. We first perform an empirical analysis of the cleansing effect of recessions, and we then introduce a model of endogenous firm entry and exit and zombie firms to better understand the impact of the cleansing effect of recessions on aggregate TFP.

Our empirical analysis is based on a comprehensive firm-level data set from Portugal over the period 2004-2023, obtained from combining two administrative sources. The data set, which covers the universe of incorporated firms, is an ideal setting to study the relation between firm exit and productivity. First, firm exit exclude businesses that disappear due to mergers and acquisitions. Second, the dataset provides information on hours worked, which allows a more precise computation of the firm-level total factor productivity (TFP). Finally, Portugal has experienced over the period three different recessions, which allow us to asses how exit patterns may evolve with the nature of the recession.

We estimate how firm-level TFP affects the firm exit and study how this relationship varies over the business cycle. Following a specification similar to Foster et al. (2016), we capture the intensity of the cleansing effect by estimating how the impact of TFP on exit increases with the severity of economic slowdowns, which we define as negative regional GDP growth. We then assess whether the cleansing effect is strengthened during recessions. Consistent with previous findings, we show that higher TFP is associated with a lower probability of exit. More importantly, we find evidence of a positive cleansing effect: the negative relationship between productivity and exit becomes stronger during economic slowdowns, meaning that less productive firms are more likely to exit in these periods. However, contrary to the Schumperterian intuition, we find that the intensity of the cleansing effect is lower during recessions. This weaker cleansing effect is found in all three recessions in our sample—the Great Recession (2008-2009), the Sovereign Debt Crisis (2011-2013), and the Covid period (2020-2021).

To better understand this weaker cleansing effect during recessions, we start by exploring the variation across firms of different age and size and estimate the same regression separately for each group of firms. We find that the cleansing effect associated with slowdowns holds across all age and size groups. The reduced intensity of cleansing during recessions is especially salient for small firms whereas large firms do not display this pattern. Large firms how a similar intensity of cleansing during and outside of recessions. The results by firm age are quite similar. We find that the gap between intensity of cleansing during and outside recessions is higher for young firms than for middle-aged firms. Old firms show no significant difference in the intensity of cleansing during recessions. Taken together, the pooled and group estimates imply that lower aggregate demand or productivity are not the only source behind the recession. In particular, the fact that the reduced intensity is found for young and small firms points to several sources of shocks or frictions, to which these firms are most exposed to, such as financial and information frictions and is line with theoretical results in Osotimehin and Pappadà (2017) and Ouyang (2009).

We explore another possible explanation. Low productivity firms could survive during recessions if they are offered more lenient financing conditions. In fact, banks have an incentive to keep firms alive instead of letting them default. This mechanism, referred to as zombie firms, is challenging to measure directly. Zombie firms are commonly defined as highly-leveraged firms with returns on assets below the risk-free rate for three years or more. We use the same definition and, in line with the literature, we restrict the group of zombies to firms 5 years and older to avoid mislabeling as zombie young firms with high growth potential. We show that low productivity firms are more likely to become a zombie, and that this transition of low productivity firms into the zombie state is more frequent during recessions. This result suggests that low productive firms survive the recession because of more favorable financing conditions. As low productive firms turn into zombie firms in recession rather than exit, the zombie effect works in the opposite direction than the cleansing effect. The selection at the exit margin is therefore blurred during recessions, leading to a dampened cleansing.

We then build a model of firm dynamics with endogenous entry and exit and zombie firms able to reproduce our empirical findings. In our model, there is a random draw on a variable that determines whether incumbent firms receive a subsidy or not. This draw is not related to firm productivity and is purely transitory. Firms that do not receive the subsidy stay in the market as long as their continuation value is positive and exit otherwise. Instead, for firms that receive the zombie subsidy, the zombie and exit decisions depend on the period profits. The rationale behind this assumption is that firms drawing a zombie subsidy may stay in the market even though their continuation value is negative, as long as their profit losses are not too large. In that case, these

firms become zombie rather than exit. We therefore introduce a threshold on profit losses defined as a fraction of the operational fixed cost. The tolerance for profit losses allows these firms with negative continuation value to remain in the market rather than exit. This tolerance could also be interpreted as the maximum amount of profit losses for which a financial intermediary is willing to provide support to a firm, turning it into a zombie firm. We calibrate the model using simulated data, and show that the model is able to reproduce the cleansing and zombie effect of recessions. We then compute aggregate TFP and compare the baseline economy to counterfactuals where we either shut down zombie firms or increase their incidence. Our results show that there is a silver lining effect of slowdowns: as the selection at the exit margin improves, this generate a lower fall in aggregate TFP. However, with respect to an economy without zombies, aggregate TFP is on average lower and experiences larger falls during slowdowns in our baseline economy, where low productivity firms turn into zombies rather than exit.

Our paper contributes to the empirical literature examining the relationship between firm exit and productivity over the business cycles, with early contributions include Lee and Mukoyama (2015). A growing body of work emphasizes the importance of financial frictions in shaping the cleansing effect of recessions. For example, Eslava et al. (2010) show that credit-constrained Columbian firms experience a higher exit rates increases during recessions. Closest to our work is Foster et al. (2016) who show that, in the US manufacturing sector, the cleansing effect weakened during the Great Recession and highlight the financial origins of that recession. Consistent with their findings, we document a reduced cleansing intensity during recession. Our contribution is two-fold. First, we find that in our data the reduced cleansing effect holds across different recessions and is not specific to the Great Recession. Second, we show show that the cleansing effect holds once delayed exit of zombie firms is accounted for. Our results imply that the delayed impact of the recession are important to consider and could explain results found in other countries.

The paper is organized as follows. Section 2 describes our data and Section 3 introduces our empirical strategy to measure the cleansing effect of recessions. In Section 4, we build a simple model of firm dynamics with endogenous entry and exit and zombie firms. In Section 5, we calibrate the model and report our quantitative results on the implications of the zombie and cleansing effect of recessions on aggregate TFP.

# 2 Data

## 2.1 Data Description

### Data Sources: SCIE

For the empirical analysis, our main data source is Integrated Business Accounts System (Sistema de Contas Integradas das Empresas, SCIE) which provides a broad range of economic and financial information for the universe of non-financial firms operating in Portugal. This administrative dataset is collected through an integrated online system, called Simplified Business Information (Informacao Empresarial Simplificada, IES), which allows to declare the information required by different government institutions on a single procedure for the whole population of non-financial firms. The SCIE is compiled and delivered by Portuguese Statistical Office (Instituto Nacional de Estatística, INE).

The SCIE provides yearly information for about 400,000 firms (1.3 million firms including self employment enterprises which we don't include in our analysis) for the period 2004-2021 and attributes a unique identifier to each firm which allows us to follow the firms over time in a panel format. It includes detailed balance sheet and income statement information of the firms which provides a wide range of knowledge regarding the firms. Some of the available information includes income and expenses (Labor Cost, Sales, Profit, Cost of the goods sold, interest payments...), balance sheet (Tangible-Intangible Value of Assets, Financial Investment, Equity, Dividends), Investment (Software, Patents, Industrial Property, Land), derived information (Value Added, Gross-Fixed Capital Formation).

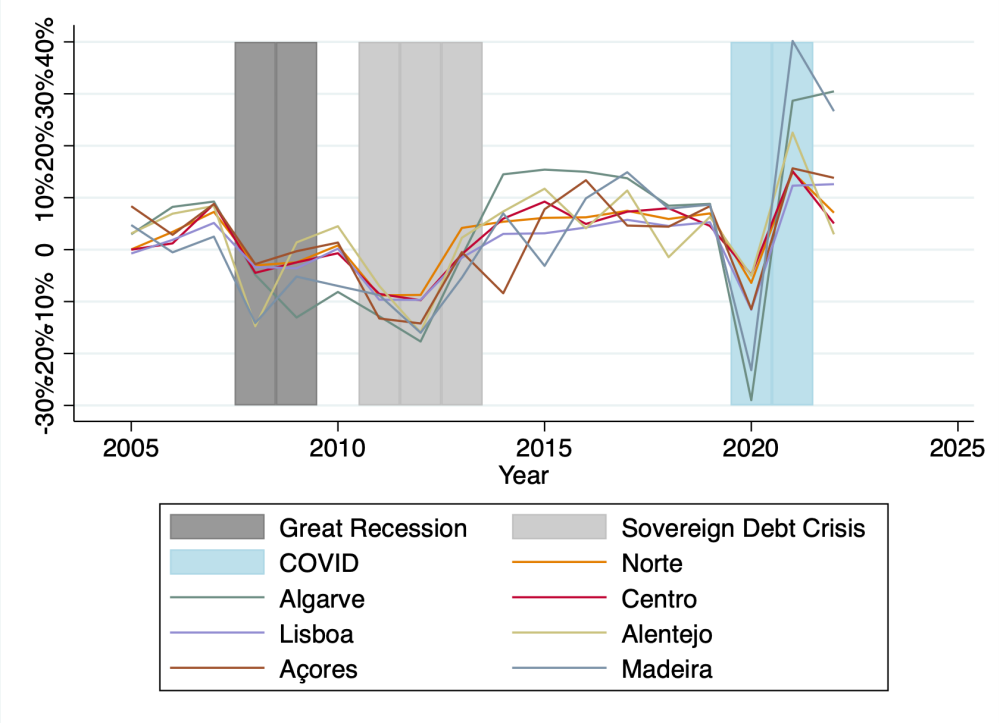
### Data Sources: QP

Our second data source is the employee-employer matched data Quadros de Pessoal (QP) which is collected by Ministry of Labour, Solidarity and Social Security and also delivered by Portuguese Statistical Office (Instituto Nacional de Estatística, INE). The QP covers all universe of private firms with at least one wage earner. This administrative data covers the period 1980-2021 and currently includes around 350,000 firms and more than 3 million employees. When we use the QP data for our analysis, we only consider the period after 2004 which is the starting year of the SCIE.

The QP data contains detailed information on the workers of the firms (gender, age, education, skill level, occupational category, tenure, last date of promotion, wages, hours worked, bargaining, contract type) and some information at the firm level (Age, location, industry, employment,

sales, ownership structure, and legal setting). Firms and employees are attributed to a unique identifier which allows us to follow them over time and match this data with the SCIE. When the information given by the SCIE is not enough for the analysis, we match the two data sets and use the sample of around 250,000 firms which are included in both datasets. For example, age of the firm is not provided in the SCIE and extracted from the QP.

Figure 1: Real GDP Growth by Region.




Note: GR refers to the Great Recessions (2008-2009), SD to the Sovereign Debt Crisis (2011-2013) and COVID to the pandemic (2020-2021).

## Variables

All nominal variables are converted into real ones using 2015 base year consumer price index provided by OECD. Our main interest is in exit dummy variable provided with the SCIE by Portuguese Statistical Office (INE). Exit dummy for a given year t is recorded as one if the firm announces legal death between the period t, t+1 and disappears from the data. For the firm size categorization, we categorize the firms with number of paid employees. Small firms are the firms which has less than 10 employees, middle size firms are the firms which has less than 50 employees and big firms are the firms with more than 50 employees. For industry classification,

most recent classification, CAE Revision 3 (Portuguese Classification of Economic Activities) is used. We consider the level 1 industry classification in which industries are categorized into 17 (non-financial sectors).

There are seven regions in Portuguese level 2 classification and we measure region specific real GDP as total value added of the firms in that region. Our slowdown variable is negative real GDP growth from year t to t+1 and also region specific. The information about the age and total working hours to calculate TFP of the firms comes from QP data. Lastly, following the standard literature, the Great Recession dummy consider the years 2008 and 2009 whereas Sovereign Debt dummy considers the years 2011, 2011 and 2013 as the crisis period associated with them. Covid dummy considers the years 2020 and 2021 as the crisis period.

Table 1: Descriptive Statistics.

| | |
|---|---|
| Entry rate | 0.0034 |
| Exit rate | 0.0106 |
| Age | 14.48 |
| Employment | 13.48 |
| Real Revenues | 1,708,429 |
| Observations | 3,199,500 |

Table 1 reports the main descriptive statistics of our database, including the average age and size of the firms - both in terms of revenue and employment - as well as the real wages and the number of observations left for the analysis after firms with missing data is removed. Figure 1 shows the real GDP growth in the seven regions of Portugal. A negative GDP growth will indicate a "slowdown" period in our baseline analysis. Note that the Great Recession of 2008-2009, the Sovereign Debt Crisis of 2011-2013 and Covid of 2020-2021 are the only periods where the GDP growth is negative across all Portuguese regions.

**TFP Measure**

We measure TFP at the establishment level by constructing an index in a manner similar to that used in Syverson (2011). The TFP index is given by:

$$\ln TFP = \ln Q_{it} - \alpha_k K_{it} - \alpha_l L_{it} - \alpha_m M_{it}$$

where - $Q_{it}$ is real revenues at industry level - $K_{it}$ real capital level calculated with perpetual inventory method at industry level - $L_{it}$ is the number of working hours - $M_{it}$ real cost of interme-

diary input at industry level - Output elasticities $\alpha_{k,l,m}$ are cost shares of total cost of producing where - $TC = rK$+ wage sum + intermediary input cost

For the $TFP$ variable in the regressions, we use log deviation of the firm-level productivity from its' industry-year mean in year $t$. We imply this when we refer to TFP throughout the paper. Extreme cases when the measure $TFP$ is bigger than 2 or smaller than -2 (which represents less than 1% of the data) are dropped from the data.

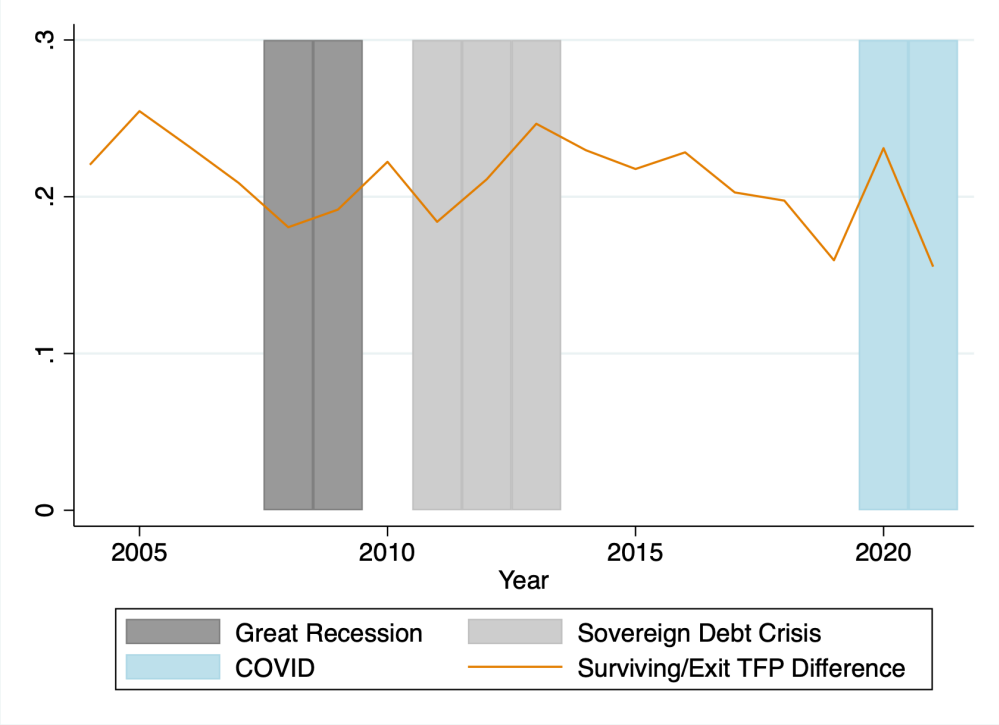
Table 2: Exit rates in Slowdowns vs Recessions.

| | (1) Firm Exit | (2) Firm Exit |
|---|---|---|
| Slowdown | 0.0129*** | 0.0127*** |
| | (3.86) | (3.79) |
| Recession × Slowdown | -0.00992** | |
| | (-2.45) | |
| Great Recession × Slowdown | | -0.0139* |
| | | (-1.79) |
| Sovereign Debt × Slowdown | | 0.00854 |
| | | (1.04) |
| Covid × Slowdown | | -0.0122*** |
| | | (-3.08) |
| Firm size class FE | Yes | Yes |
| Region FE | Yes | Yes |
| Year FE | | |
| Industry FE | Yes | Yes |
| Observations | 3028714 | 3028714 |

What happens to firm exit rates along the business cycle? Table 2 shows that exit rates are countercyclical, as they increase in slowdowns. Note that the countercyclical behavior of firm exit rates is not driven by large changes during episodes of recessions. As shown in the second column of Table 2, the firm exit rate slightly decreases during the Great Recession and the Covid recession, while it increases during the Sovereign Debt crisis, even though this increase is not statistically significant.

Before introducing our baseline specification to measure the cleansing effect of recessions, we compute the average productivity difference between surviving and exiting firms. A cleansing effect of recessions should imply an increase during recessions, as exiting firms should be less productive than surviving firms, and further so in a recession.

Figure 2: Surviving vs Exit Productivity.




Note: GR refers to the Great Recessions (2008-2009), SD to the Sovereign Debt Crisis (2011-2013) and COVID to the pandemic (2020-2021). TFP difference is the average yearly TFP (defined above) difference between surviving and exiting firms.

Figure 2 shows the average TFP difference between surviving and exiting firms over time. The productivity difference starts to increase during the Great Recession and the Sovereign Debt Crisis. It also increases at the beginning of the Covid period. We explore the cleansing effect in more detail in the next section.

# 3 Empirical Strategy

Hopenhayn (1992) and Hopenhayn and Rogerson (1993) establish the relationship between productivity and firm exit through heterogeneous productivity, demand and cost structures. In these models, firm exit is more likely when the productivity is low. Firstly, our empirical strategy links the measure productivity and firm exit as built in the standard literature. On top of the relationship between firm exit and productivity, we follow Foster et al. (2016) to analyze how this relationship changes along the business cycles, especially during the crisis periods which is our particular interest here.

## 3.1 Baseline specification

For our baseline specification, we estimate the following regression:

$$Exit_{i,j,s,t+1} = \beta_1 TFP_{i,j,s,t} + \gamma_1 Slowdown_{s,t+1} + \beta_2 (TFP_{i,j,s,t} \times Slowdown_{s,t+1}) \delta_s + \delta_j + \delta_{size} + \delta_{t+1} + u_{i,j,s,t+1} \quad (1)$$

where $i$ stands for the firm, $j$ for the industry, $s$ for the region and $t$ stands for the year. $Exit_{i,j,s,t+1}$ dummy is equal to one if the firm announces legal death between period t to t+1 and zero otherwise. $TFP_{i,j,s,t}$ is the deviation of the firm-level labor productivity in industry j from its' industry-year mean in year t, $Slowdown_{s,t+1}$ is the negative GDP growth of the region where the firm is located as explained above. $\delta_i$, $\delta_j$, $\delta_{size}$, $\delta_{t+1}$ are respectively firm, industry, firm size classification and time fixed effects. It is worth to note that we do not consider national variation in the cycle but only regional variation because we control for year fixed effects.

Traditional random effects probit and unconditional fixed effects logit models do not achieve anything in terms of endogeneity as they are prone to the incidental parameters bias in our case (low T). Therefore, to estimate the regression, we use the linear probability model to better deal with correlated individual effects and heterogeneity bias through fixed effects estimation and better interpret the coefficients despite the standard drawbacks of linear models for binary dependent variables. The standard errors are clustered at the firm level. The coefficient $\beta_1$ reflects how much the probability to exit changes when TFP of a firm is higher by one unit. Following the standard literature, $\beta_1$ is expected to be negative. Our primary coefficient of interest is $\beta_2$ to measure aggregate cleansing effect of cycles. The coefficient $\beta_2$ reflects the change on the relationship between TFP and exit in bad times compared to good times. A negative $\beta_2$ implies average the productivity difference between the surviving firms and exiting firms is higher in bad times compared to good times, and therefore crisis are cleansing.

## 3.2 The Cleansing Effect of Recessions

Portugal experienced two major economic crisis during the last two decades. The first one is the worldwide Great Recession which largely impacted the Portuguese economy in the years 2008 and 2009. The second one is sovereign debt crisis which forced Portugal to apply bail-out programs in 2011, 2012 and 2013. Our next analysis aims to answer the natural question if the cleansing effect differs during these two fundamentally different crisis periods and if it depends on the source of the crisis.

To examine the cleansing effect during these two different crisis periods, as in Foster et al.

(2016), we extend our baseline specification and run the following regression:

$$Exit_{i,j,s,t+1} = \beta_1 TFP_{i,j,s,t} + \gamma_1 Slowdown_{s,t+1} + \beta_2(TFP_{i,j,s,t} \times Slowdown_{s,t+1}) + \beta_3(TFP_{i,j,s,t} \times Recession_{t+1}) + \gamma_2(Slowdown_{s,t+1} \times Recession_{t+1}) + \beta_4(TFP_{i,j,s,t} \times Slowdown_{s,t+1} \times Recession_{t+1}) + \delta_s + \delta_j + \delta_{size} + \delta_{t+1} + u_{i,j,s,t+1} \quad (2)$$

where *Recession* is a dummy indicating Great Recession (2008-2009), or the Sovereign Debt crisis (2011-2013), or the COVID period (2020-2021).

We run the same model as explained in the baseline specification except the added double and triple interaction terms. The coefficient of triple interaction term, $\gamma_2$, reflects how the cleansing effect of bad times changes during the Great Recession and Sovereign Debt crisis periods. A negative $\beta_4$ implies that there is a higher cleansing during the specific crisis period whereas a positive $\beta_4$ either implies there is less cleansing or no cleansing at all. Moreover, $\beta_2 + \beta_4$ gives the overall cleansing effect of the specific crisis period.

Table 3: The Cleansing Effect of Recessions.

| | (1) Firm Exit | (2) Firm Exit |
|---|---|---|
| TFP | -0.00645*** | -0.00881*** |
| | (-16.83) | (-20.01) |
| Slowdown | 0.00430 | 0.0100* |
| | (1.32) | (2.31) |
| TFP × Slowdown | -0.0187*** | -0.0595*** |
| | (-5.28) | (-4.58) |
| Recession × Slowdown | | -0.00874 |
| | | (-1.91) |
| Recession × TFP | | 0.00291*** |
| | | (5.39) |
| Recession × TFP × Slowdown | | 0.0432*** |
| | | (3.97) |
| Firm size class FE | Yes | Yes |
| Region FE | Yes | Yes |
| Year FE | Yes | Yes |
| Industry FE | Yes | Yes |
| Observations | 2976075 | 2976075 |

Table 3 reports the results of our baseline specification (2) in column (1) and (2) respectively.

The first column shows that firm exit is negatively related to firm productivity, and tends to increase during crisis periods. Moreover, a low firm-level productivity further increases the probability of exit during slowdowns, suggesting that there is a cleansing effect during crisis periods. The second column of Table 3 reports the results of the regression including a dummy for the three episodes of Recessions mentioned above. The goal of the extended specification in (2) is to explore whether the negative coefficient for the interaction term ($TFP \times Slowdown$) is driven by an enhanced cleansing effect during episodes of recessions. The results in the second column of Table 3 show that this is not the case. The interaction term $Recession \times TFP \times Slowdown$ is positive and significant, suggesting a dampened effect of recessions on cleansing.[1]

This result holds true when we use separate dummies for each episode of Recessions. Table A2 in Appendix A.2 shows that there is a dampened effect on cleansing across all episodes of recessions, with a slightly larger effect for COVID and Great Recession than the Sovereign Debt recession. In Appendix B we report several robustness tests, including firm-level controls such as firm debt, or the firm average level of $TFP$ rather than $TFP_t$. Since recessions are times of heightened uncertainty in the financial markets, we replace the dummy $Recession$ with indicators of volatility in the Financial Markets or increased financial tightening (see Figure A1). The results in Tables B.3 and B.4 support the main results: while the selection of firms based on their productivity is stronger during Slowdowns, this cleansing effect is dampened during times of higher volatility of financial markets or tightened credit conditions.

We then explore the cleansing effect of recession across two different dimensions: firm age and size. First, we split our sample in three groups of firm age: young (below 3 years of age), middle-age (between 3 and 29) and old firms (above 30 years).[2] Table 4 reports the results of the main regression for these age groups. Interestingly, we find that there is a selection of firms based on their productivity across all age groups, with a stronger cleansing effect for young firms. Also, there is a dampened effect of recessions for all age groups, but relatively stronger for young firms. This dampened effect fades away for older firms, for which the coefficient of the interaction term $Recession \times TFP \times Slowdown$ is positive but not significant anymore. This suggests that the cleansing effect is similar across Slowdowns and Recession for old firms, whereas young low productivity firms are more likely to exit during Slowdowns and survive during Recessions.

Second, we split our sample into three groups of firm size: small (less than 3 employees),

[1] This result is consistent with an alternative simpler specification which takes into account $Recession$ and $Slowdown$ separately. Table A1 in Appendix A.1 shows that the interaction term of $TFP \times Recession$ and $TFP \times Slowdown$ are both negative but the only the latter is significant suggesting that there is cleansing during slowdowns rather than during recessions.

[2] The split is assigned in order to have a similar number of firms in the young and old group. Having different thresholds slightly changes the results.

Table 4: The cleansing effect during slowdowns and recessions - Firm Age.

| | **Young Firms** | | **Middle-Age Firms** | | **Old Firms** | |
|---|---|---|---|---|---|---|
| | Firm Exit | Firm Exit | Firm Exit | Firm Exit | Firm Exit | Firm Exit |
| TFP | -0.00680*** | -0.0107*** | -0.00616*** | -0.00819*** | -0.00639*** | -0.00711*** |
| | (-18.72) | (-12.59) | (-43.32) | (-25.31) | (-18.96) | (-9.00) |
| Slowdown | 0.00475 | 0.0111 | 0.00412** | 0.00868** | 0.00408 | 0.0127 |
| | (0.78) | (1.05) | (2.04) | (2.34) | (0.85) | (1.34) |
| TFP × Slowdown | -0.0189*** | -0.0877*** | -0.0192*** | -0.0537*** | -0.0130*** | -0.0241* |
| | (-4.08) | (-6.60) | (-11.44) | (-10.45) | (-3.53) | (-1.81) |
| Recession × Slowdown | | -0.0130 | | -0.00672 | | -0.0122 |
| | | (-0.99) | | (-1.49) | | (-1.10) |
| Recession × TFP | | 0.00459*** | | 0.00253*** | | 0.000992 |
| | | (4.49) | | (6.59) | | (1.08) |
| Recession × TFP × Slowdown | | 0.0761*** | | 0.0364*** | | 0.0107 |
| | | (5.27) | | (6.67) | | (0.78) |
| Firm size class FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Region FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 400214 | 400214 | 2259749 | 2259749 | 316100 | 316100 |

Note: Young firms are firms with age below 3 years, middle-age firms refers to firms with age between 3-29 years, old firms refers to firms with age above 30 years.

middle-size (between 3 and 20 employees), and large firms (above 20 employees). The results reported in Table 5 provide a similar picture as the analysis across different age groups. There is a cleansing effect across all size groups, with a dampening effect of recessions that fades away for larger firms. For those firms, recessions are as cleansing as periods of economic slowdowns, because there is not a significant different impact of a recession on the selection of firms based on their productivity.

Summing up, the empirical evidence suggests a few facts about the cleansing effect of recessions. First, the selection of firms is negatively correlated with firm *TFP* and this selection is stronger during bad times. Second, the cleansing effect is less intensive during recessions than in slowdowns. Third, this finding is stronger for young and small firms. Why are recessions less cleansing than slowdowns? Per se, this result is not entirely new. Foster et al. (2016) find that there has been no cleansing effect during the Great Recession in the U.S. They argue that the stronger financial constraints faced by firms during the Great Recession might have induced

Table 5: The cleansing effect during slowdowns and recessions - Firm Size.

| | **Small Firms** | | **Middle-Size Firms** | | **Large Firms** | |
|---|---|---|---|---|---|---|
| | Firm Exit | Firm Exit | Firm Exit | Firm Exit | Firm Exit | Firm Exit |
| TFP | -0.00781*** | -0.0116*** | -0.00566*** | -0.00728*** | -0.00490*** | -0.00549*** |
| | (-32.77) | (-19.98) | (-37.09) | (-21.22) | (-9.82) | (-5.67) |
| Slowdown | -0.00301 | 0.00312 | 0.00722*** | 0.0118*** | 0.00750 | 0.0121 |
| | (-0.79) | (0.44) | (3.28) | (2.93) | (1.37) | (1.26) |
| TFP × Slowdown | -0.0162*** | -0.0762*** | -0.0197*** | -0.0499*** | -0.0231*** | -0.0386** |
| | (-5.95) | (-8.39) | (-10.82) | (-9.08) | (-3.89) | (-2.39) |
| Recession × Slowdown | | -0.0117 | | -0.00667 | | -0.00665 |
| | | (-1.37) | | (-1.36) | | (-0.57) |
| Recession × TFP | | 0.00510*** | | 0.00179*** | | 0.000296 |
| | | (7.58) | | (4.39) | | (0.25) |
| Recession × TFP × Slowdown | | 0.0603*** | | 0.0337*** | | 0.0199 |
| | | (6.31) | | (5.77) | | (1.14) |
| Region FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 772363 | 772363 | 1910190 | 1910190 | 293510 | 293510 |

Note: Small firms are firms with less than 3 employees, middle-size firms refers to firms with 3-20 employees, large firms refer to firms with more than 20 employees.

the exit of high productivity firms exposed to credit constraints, thus blurring the selection of firms. Our findings extend the results in Foster et al. (2016) as we show that there is a systematic dampened cleansing during recessions, regardless of the nature of the recessions.

The objective of the next section is to understand which factors lead to a less intensive selection based on productivity during recessions. We will therefore focus on the mechanisms that prevent the exit of firms of firms with poor fundamentals, which survive as zombie firms.

## 3.3 Zombie firms

### Descriptive statistics

What determines the missing selection of low productivity firms during recessions? In this section, we explore how zombie firms interfere with the selection of firms at the exit margin and induce a less intense cleansing effect during recessions. A zombie firm is typically identified as

a firm that is receiving access to credit markets despite not being profitable. As such, it is kept alive by the financial intermediaries (e.g. banks) in the hope of a future recovery. This produces a credit misallocation, as credit is allocated to incumbent non-profitable firms whereas high productive investments might not be implemented because of lack of credit. In this paper, we explore a relatively new approach as we focus on the business cycle dimension of zombie firms and study the consequences of this phenomenon on the selection of firms over the business cycle.

Following the existing literature, we define a firm as zombie when the following three conditions hold. First, when the return on assets is lower than the Euribor interest rate (which represents the risk-free interest rate for a bank) at least for three consecutive years. Second, when the leverage (the ratio of debt over assets) is higher than the industry-median leverage of exiting firms. Third, the firm is older than 5 years. Firms fulfilling these three conditions are therefore highly indebted incumbents with returns on their asset below the risk-free rate. Table 6 reports stylized facts about zombie firms in comparison to non-zombie firms.

Table 6: Descriptive Statistics Zombie vs Non-Zombie.

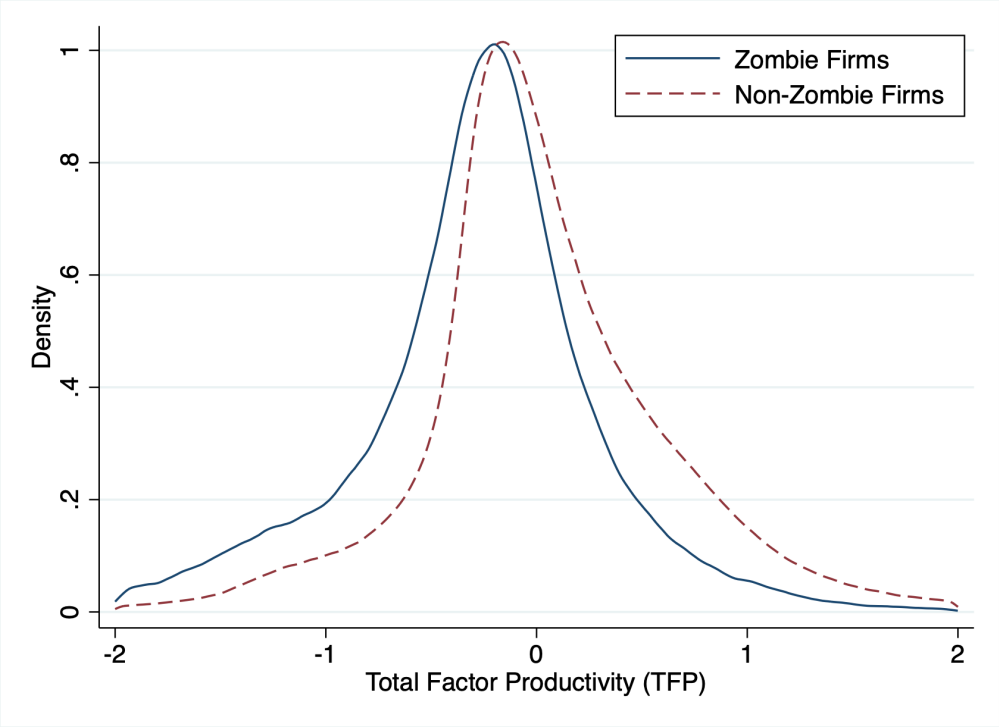
| Average | Non-Zombie | Zombie |
|---|---|---|
| Age | 14.29 | 17.16 |
| Employment | 13.72 | 10.14 |
| Real Revenues | 1,762,633 | 945,702 |
| TFP | 0.028 | -0.273 |
| Share | 0.929 | 0.071 |

Notes: Age is defined in years, real revenues is yearly revenues in euro (2015 based), and *TFP* is defined as log-deviation from industry mean.

As expected, zombie firms are on average smaller than non-zombie firms, pay lower wages and have lower revenues. Not surprisingly, zombie firms are also less productive than non zombie firms. As shown in Figure 3, the distribution of TFP of zombie firms is substantially shifted towards the left with respect to non-zombie firms.

As mentioned above, the objective in this section is to explore the zombie phenomenon along the business cycle. First, we regress the zombie rate over slowdowns and recessions, using the same controls as the previous regression of exit rate over slowdowns and recessions. The results in the first column of Table 7 show that there are more zombie firms in bad times, and there is not a significant amplification or dampening effect during recessions. In this respect, the cyclicality of the zombie rate is qualitatively close to the cyclicality of the exit rate reported in Table 2. When we use a separate dummy for each episode of recessions (see the second column of Table 7), we

Figure 3: Zombie firms - TFP distribution.




Note: Kernel density estimation. *TFP* is defined as log-deviation from industry mean.

find that the zombie rate was lower during the Great Recession and the Covid pandemic, when both the exit rate and the zombie rate decreased. The Sovereign Debt crisis instead is different as we find a statistically significant increase in the zombie rate. To sum up, such as for the exit rate, the zombie rate is therefore countercyclical.

### The zombie effect of recessions

At each period, firms belong to three possible states: either they are active ($A$), zombie ($Z$), or exit ($E$). First, we study in more detail the selection of firms into the zombie state according to their productivity, as we use the same econometric specification as equation (2) where we replace firm exit with the firm zombie definition provided above. Second, we compute the transition matrix across the three states of firms over the business cycle.

The first column in Table 8 clearly establishes that low TFP firms are more likely to be zombie, and this is further true during bad times (slowdowns). When we add a dummy for the three episodes of recessions in Portugal, we find that low productivity firms are more likely to be zombies in recessions rather than slowdown (the interaction term $Recession \times TFP \times Slowdown$

Table 7: Zombie rates in Slowdowns vs Recessions.

| | (1) Zombie | (2) Zombie |
|---|---|---|
| Slowdown | 0.0316*** | 0.0256*** |
| | (3.22) | (2.65) |
| Recession × Slowdown | -0.0163 | |
| | (-1.61) | |
| Great Recession × Slowdown | | -0.00587 |
| | | (-0.36) |
| Sovereign Debt × Slowdown | | 0.252*** |
| | | (11.57) |
| Covid × Slowdown | | -0.0636*** |
| | | (-5.97) |
| Firm size class FE | Yes | Yes |
| Region FE | Yes | Yes |
| Year FE | Yes | Yes |
| Industry FE | Yes | Yes |
| Observations | 3028714 | 3028714 |

is negative and significant).

In this respect, the cleansing and the zombie effect of recessions work in opposite directions. While firm selection at the exit margin is stronger during slowdowns and dampened in recessions, the zombie effect among low productivity firms is dampened in slowdown and stronger in recessions. This suggests that low productivity firms become zombie rather than exit during recessions. In turn, this could provide an explanation for the blurred selection at the exit margin during recessions.

We now turn to the transition dynamics across the three states of firms - active ($A$), zombie ($Z$), or exit ($E$) - over the business cycle. In the top panel of Table 9, we report the transition matrix over the entire period of analysis. About 96% of firms that are active at time $t$ are active in the next period as well ($A_{t+1}$), whereas about 3% of them become zombie ($Z_{t+1}$) and 1% of them exit the market ($E_{t+1}$). When looking at firms that are zombie at time $t$, there is about 24% of them that recovers and becomes active in the next period, whereas 73% of them remains zombie and about 3% of them exits the market. Not surprisingly, the exit rate is higher among zombie firms, suggesting that the selection into exit operates through the zombie state: firms might first become zombie and exit in subsequent periods.

Table 8: The zombie effect of recessions.

| | (1) Zombie | (2) Zombie |
|---|---|---|
| TFP | -0.0584*** | -0.0459*** |
| | (-16.55) | (-7.66) |
| Slowdown | 0.00904 | 0.0199 |
| | (0.38) | (0.55) |
| TFP × Slowdown | -0.0965*** | 0.102* |
| | (-5.07) | (2.03) |
| Recession × Slowdown | | -0.0158 |
| | | (-0.50) |
| Recession × TFP | | -0.0170*** |
| | | (-6.74) |
| Recession × TFP × Slowdown | | -0.198** |
| | | (-3.41) |
| Firm size class FE | Yes | Yes |
| Region FE | Yes | Yes |
| Year FE | Yes | Yes |
| Industry FE | Yes | Yes |
| Observations | 2976075 | 2976075 |

The last three columns of Table 9 report the average firm-level *TFP* of firms at time $t$, expressed in log-deviations from the industry mean as in the baseline specification of equation (2). As one might expect, there is a ranking in terms of productivity with respect to the transition to next period state. First, zombie firms at time $t$ are on average less productive than active firms, which is consistent with the results of Table 8. Moreover, there is a clear ranking in terms of productivity with respect to next period state: on average, zombie firms that recover and become active next period are relatively more productive (-.1780) than those that remain zombie (-.2685) or exit (-.3763) in the following period. This selection effect is instead blurred for active firms: while those that stay active in the next period are more productive (.0493), those exiting are on average relatively more productive (-.1670) than those becoming zombie (-.1986). The transition dynamics reported in Figure 9 highlight two key facts: i) there is some delayed exit associated with the zombie state, ii) active firms that move into the zombie state are less productive than those exiting.

In the panels *Recession* and *Slowdown (no recession)*, we compute the transition matrix and

Table 9: Transition dynamics.

| | ***Status*** | | | ***TFP*** | | |
|---|---|---|---|---|---|---|
| | $A_{t+1}$ | $Z_{t+1}$ | $E_{t+1}$ | $A_{t+1}$ | $Z_{t+1}$ | $E_{t+1}$ |
| ***All years*** | | | | | | |
| $A_t$ | .9572 | .0318 | .0109 | .0493 | -.1986 | -.1670 |
| $Z_t$ | .2388 | .7296 | .0316 | -.1780 | -.2685 | -.3763 |
| ***Recession*** | | | | | | |
| $A_t$ | .9482 | .0384 | .0134 | .0613 | -.1953 | -.1373 |
| $Z_t$ | .2019 | .7613 | .0368 | -.1166 | -.2478 | -.3501 |
| ***Slowdown (no recession)*** | | | | | | |
| $A_t$ | .9501 | .0364 | .0136 | .0296 | -.1799 | -.2378 |
| $Z_t$ | .1786 | .7928 | .0286 | -.2055 | -.2613 | -.4322 |

Notes: *TFP* refers to the average firm-level *TFP* expressed in log-deviations from the industry mean.

average firm productivity when considering recession or slowdown years, as in the baseline specification of equation (2). First, we note that firms - whether they are active or zombie at time $t$ - are more likely to exit or become zombie both in recession and slowdown, in line with the results of Table 2 and Table 7 respectively. Second, and more importantly, firm productivity clearly determines the selection of firms into their state in the next period during slowdown: whether they are active or zombie at time $t$, firms that exit at time $t+1$ are on average less productive (-.2378 and -.4322) than those being zombie at time $t+1$ (-.1799 and -.2613) or active at time $t+1$ (.0296 and -.2055). This pattern is different during recessions: active firms that turn into zombie firms in the next period are on average less productive (-.1953) than those that exit (-.1373). In contrast to what happens during slowdowns, low productivity firms become zombie rather than exit in recessions, and this shift into the zombie state may explain the dampened effect of recession found in our baseline regression - see Table 3.[3]

[3]In Appendix C.2, we run a counterfactual to test whether the zombie state of low productivity firms contributes to the dampened cleansing effect of recessions.

# 4 Model

In this section, we build a simple model of firm dynamics with endogenous entry and exit *à la* Restuccia and Rogerson (2008), without capital and without distortions. We extend the model by considering time-varying firm-level and aggregate productivity, and zombie firms. The objective of this model is to provide a framework able to reproduce both the cleansing and the zombie effect of recessions highlighted in Section 3.

## 4.1 Environment

The economy is constituted of workers, supplying inelastically their labor, of mass $N_s$. The production function is

$$y = sZn^{\gamma} \tag{3}$$

The idiosyncratic productivity is persistent and follows the law of motion $f(s'|s)$. The aggregate productivity component $Z$ follows the law of motion $h(Z'|Z)$. The corresponding cdf are denoted $F$ and $H$.

There is an unlimited mass of potential entrants. Entrants draw their productivity from the distribution $g(s)$ and pay an entry cost $c_e$ $w/Z$. This implies that the entry costs is denominated in terms of a specific good produced with constant returns to scale. As in Bilbiie et al. (2012), this specification ensures that wages and entry are pro-cyclical.

The timing for incumbents is the following: they observe $s$ and $Z$, are subject to fixed operating costs $c_f$ and decide to stay or exit. The exit decision is therefore purely endogenous as we do not include exogenous death shocks. If they stay, incumbents produce and pay wages. Potential entrants observe the value of the aggregate shock $Z$ before paying the entry cost, i.e. before deciding to enter or not, but they do not know their own productivity $s$. With this timing assumption for $Z$, the solution strategy is the same as in Hopenhayn and Rogerson (ADD REFS). Once potential entrants decide to pay the entry cost and enter, they observe $s$ and can immediately exit if they wish to.

The incumbent firm value function is

$$W(s, Z) = \pi(s, Z) + \beta E_{s,Z} \max \left[ W(s', Z'), 0 \right], \tag{4}$$

where $\beta = \frac{1}{1+r}$ and $\pi(s, Z) = \max_n \left( sZn^{\gamma} - wn - c_f \right)$. The labor decision is $n(s, Z) = \left( \frac{\gamma sZ}{w} \right)^{1/(1-\gamma)}$ where $E_{s,Z}(.) \equiv E(.|s, Z)$ denotes the expectation taken with respect to future values of s and Z,

conditional on their current values. Let $x(s, Z)$ be the optimal exit decision, with $x(s, Z) = 1$ if $W(s, Z) < 0$: firms exit when their continuation value turns negative.

The entrants' value function is:

$$W_e(Z) = \int_s \max\left[W(s, Z), 0\right] g(s) ds \tag{5}$$

and firms choose to enter as long as the value of entry is larger than the entry cost $c_e$ $w/Z$.

## 4.2 Zombie firms

We introduce zombie firms in a simple manner. In every period, there is a random draw on a variable $\delta = [0, 1]$ that determines whether incumbent firms receive a subsidy ($\delta = 1$) or not ($\delta = 0$). This draw is not related to firm productivity and is purely transitory.

For firms that do not receive the subsidy ($\delta = 0$), the exit decision is unchanged as firms with $W(s, Z) < 0$ exit, and firms with $W(s, Z) \geq 0$ remain active. Instead, for firms that receive the subsidy ($\delta = 1$), the zombie and exit decisions depend on the period profits $\pi(s, Z)$.

The rationale behind this assumption is that firms drawing a zombie subsidy may stay in the market even though their continuation value is negative, as long as their profit losses are not too large. In that case, these firms become zombie rather than exit. We therefore introduce a threshold on profit losses defined as a fraction $\tau$ of the operational fixed cost $c_f$. We define $\tau$ as the tolerance for profit losses that allows these firms with negative continuation value to remain in the market rather than exit. This tolerance $\tau c_f$ could also be interpreted as the maximum amount of profit losses for which a financial intermediary is willing to provide support to a firm, turning it into a zombie firm. Under this condition, firms with $\delta = 1$:

$$\begin{cases} \text{Exit}, & \text{if } W(s, Z) < 0 \quad \text{and} \quad \pi(s, Z) < -\tau c_f, \\ \text{Zombie}, & \text{if } W(s, Z) < 0 \quad \text{and} \quad \pi(s, Z) \geq -\tau c_f, \\ \text{Active}, & \text{if } W(s, Z) \geq 0. \end{cases} \tag{6}$$

At this stage, both the probability to draw a zombie subsidy $p$ and the tolerance to profit losses $\tau$ are constant. When it comes to the calibration of the model (Section 5), we then provide a specification for these variables assuming that they are pro-cyclical. This implies that the number of firms drawing a zombie subsidy is higher in booms than in recessions, whereas the tolerance for profit losses is higher in bad times. This would be equivalent to have a financial sector that provides fewer but more generous subsidies in recessions, covering larger profit losses.

## 4.3 The evolution of the productivity distribution

The actual firm productivity distribution is endogenous because of the exit and entry decisions. Let $m_e$ denote the mass of entrants and $\mu$ the measure of idiosyncratic productivity over $s$ before production (right after endogenous and exogenous exit takes place). The law of motion of the endogenous distribution of $s$ is given by

$$\mu(s') = \int_s (1 - x(s', Z'))(1 - \lambda) f(s'|s)\mu(s)ds + m_e(1 - x(s', Z'))(1 - \lambda)g(s')$$

where $m_e$ is the mass of entrants. This expression gives the productivity distribution for next period for a given current distribution $\mu(s)$ and for a given $Z'$. It implicitly depends on the history of $Z$. Note that the distribution $\mu$ is a measure and does not sum to one.

The evolution of the joint distribution of the idiosyncratic ($s$) and aggregate productivity ($Z$) is

$$\phi(s', Z') = \int_s \int_Z \left[(1 - x(s', Z'))(1 - \lambda) f(s'|s) + m_e(1 - x(s', Z'))(1 - \lambda)g(s')\right] h(Z'|Z)\phi(s, Z)dZds$$

and we use the stationary distribution as initial condition.

## 4.4 Model solution

There are two key conditions for solving the model. First, the free entry condition

$$W_e(Z) = E_s \max\left[W(s, Z), 0\right] = c_e \frac{w}{Z}$$

Given the timing assumption that $Z$ is known before paying the entry cost, this solves for $w(Z)$. Second, the labor market clearing condition

$$N_s(Z) = \int_s n(s, Z)\mu(s)ds.$$

We solve the model and simulate our economy for 10000 firms over 100 periods. As we explain in more detail in the next Section, we calibrate our model using the simulated data to match the empirical moments computed above.

# 5 Quantitative results

In this Section, we first establish the calibration strategy of the model, as we pick some parameters directly from the literature and calibrate others based on moments from simulated data. We show the selection of firms into the active, zombie and exit states under the baseline calibration, and run regressions on simulated data to highlight the ability of the model to reproduce the cleansing and zombie effect of recessions observed in the empirical analysis.

Then, we compute the aggregate TFP in our economy and compare the main outcome in the baseline calibration and counterfactual economies where we either shut down zombie firms or increase the tolerance for profit losses. Finally, we perform a decomposition of aggregate TFP growth under the baseline and counterfactual economies to highlight the role of zombie firms on aggregate productivity growth in slowdowns and recessions.

## 5.1 Calibration

We assume that the idiosyncratic firm productivity $s$ takes 1000 values, and the grid for productivity $s$ covers +/- 3 standard deviation, defined as $\sigma_s = \sigma_{\varepsilon s}/\sqrt{(1-\rho_s^2)}$. We assume an AR process with Markov chain for the idiosyncratic firm productivity $s$ as $\ln s_t = \rho_s \ln s_{t-1} + \varepsilon_t$, with $\varepsilon_t$ following a Normal $(0, \sigma_{\varepsilon s}^2)$.

The transition probability from grid point $s_j$ to $s_k$ is given by

$$
\begin{aligned}
T_{jk} &= Prob[\ln s_k - \tfrac{1}{2}(\ln s_k - \ln s_{k-1}) \leq \rho_s \ln s_j + \varepsilon \leq \ln s_k + \tfrac{1}{2}(\ln s_{k+1} - \ln s_k)] \\
T_{jk} &= Prob[\ln s_k - \tfrac{1}{2}(\ln s_k - \ln s_{k-1}) - \rho_s \ln s_j \leq \varepsilon \leq \ln s_k + \tfrac{1}{2}(\ln s_{k+1} - \ln s_k) - \rho_s \ln s_j] \\
T_{jk} &= F(\ln s_k + \tfrac{1}{2}(\ln s_{k+1} - \ln s_k) - \rho_s \ln s_j) - F(\ln s_k - \tfrac{1}{2}(\ln s_k - \ln s_{k-1}) - \rho_s \ln s_j)
\end{aligned}
$$

For first and last grid points

$$T_{j1} = Prob(\varepsilon \leq \ln s_k + \frac{1}{2}(\ln s_{k+1} - \ln s_k) - \rho_s \ln s_j)$$

$$T_{jn} = Prob(\varepsilon \geq \ln s_k - \frac{1}{2}(\ln s_k - \ln s_{k-1}) - \rho_s \ln s_j)$$

For aggregate productivity $Z$, we assume that it takes 5 values, and we define the two levels below the mean($Z$) as periods of recessions. We instead define growth and slowdown as the difference between $Z_t$ and $Z_{t-1}$. The grid for aggregate productivity $Z$ covers +/- 3 standard deviation, defined as $\sigma_Z = \sigma_{\varepsilon Z}/\sqrt{(1-\rho_Z^2)}$. We assume an AR process with Markov chain for

aggregate productivity $Z$ as $\ln Z_t = \rho_Z \ln Z_{t-1} + \varepsilon_t$, with $\varepsilon_t$ following a Normal $(0, \sigma^2_{\varepsilon Z})$. For the transition matrix, we apply the same method as for the idiosyncratic productivity.

We report in Table 10 our baseline calibration, and in Table 11 the simulated and empirical moments. Following the literature, we set the discount factor $\beta = 0.96$, and labor share $\gamma = 0.57$. We then match directly the parameters about the AR process of the idiosyncratic and aggregate productivity using our simulated data. Finally, we need to set up four parameters about firm dynamics: i) the fixed operational cost $c_f$, ii) the entry cost $c_e$, iii) the zombie profit tolerance $\tau(Z)$, and iv) the probability to draw a zombie subsidy $p(Z)$. The objective is to match the average exit and zombie rate, as well as their cyclicality, based upon the empirical evidence reported in Tables 2 and 7.

As mentioned above, the tolerance for profit losses is a larger in bad states of aggregate productivity $Z$, and constant when $Z$ is equal to its mean value or above:

$$\begin{cases} \tau(Z) = 0.75 - 0.5 * [Z - mean(Z)], & \text{if } Z < mean(Z), \\ \tau(Z) = 0.75, & \text{if } Z \geq mean(Z). \end{cases}$$

About the probability to draw a zombie subsidy $p(Z)$, we simply define two levels with a lower probability to draw a zombie subsidy in bad times:

$$\begin{cases} p(Z) = 0.80, & \text{if } Z \leq mean(Z), \\ p(Z) = 0.85, & \text{if } Z > mean(Z). \end{cases}$$

The baseline calibration of this simple model provides average exit and zombie rates in our simulated data close to their empirical counterpart (see Table 11). About the cyclicality of the exit and zombie rate, we run two regressions on our simulated data to check how both move in slowdown (when $Z_t < Z_{t-1}$), and recession (when $Z_t < mean(Z)$).

We report the results of these regressions in Table 12. The first column shows that firm exit tend increase in slowdown whereas exit is dampened in recessions, in line with the empirical findings of Table 2. The second column of Table 12 shows that zombie rates also increase in slowdown and there is not a significant increase or decrease in recession, which is what we also find in the data (see Table 7). To sum up, the model is therefore able to replicate the cyclicality of the exit and zombie rates observed in the data.

In Figure 4, we provide an illustration of the exit and zombie rules described in equation (6), for any level of aggregate productivity $Z$. The figure reports the profits of firms (solid lines), the tolerance for profit losses $-\tau c_f$ (dots), and the levels of idiosyncratic productivity $s$ for which the

Table 10: Calibration.

| Description | Parameter | Value |
|---|---|---|
| ***1. Preferences (directly)*** | | |
| Discount factor | $\beta$ | 0.96 |
| Risk-free interest rate | $r = 1/\beta - 1$ | 0.0417 |
| ***2. Production (directly)*** | | |
| Labor share | $\gamma$ | 0.57 |
| ***3. Shocks (matched)*** | | |
| Firm-level TFP, autocorrelation | $\rho_s$ | 0.90 |
| Firm-level TFP, standard deviation | $\sigma_{\varepsilon s}$ | 0.13 |
| Aggregate TFP, autocorrelation | $\rho_Z$ | 0.90 |
| Aggregate TFP, standard deviation | $\sigma_{\varepsilon Z}$ | 0.03 |
| ***4. Firm dynamics (matched)*** | | |
| Per-period fixed operational cost | $c_f$ | 0.04 |
| Entry cost | $c_e$ | 0.10 |
| Zombie profit tolerance | $\tau(Z)$ | [0.75-0.84] |
| Probability to draw a zombie subsidy | $p(Z)$ | [0.80-0.85] |

Table 11: Simulated and empirical moments.

| | Data | Model |
|---|---|---|
| ***Shocks*** | | |
| Firm-level TFP, autocorrelation | 0.92 | 0.90 |
| Firm-level TFP, standard deviation | 0.32 | 0.31 |
| Aggregate TFP, autocorrelation | 0.90 | 0.79 |
| Aggregate TFP, standard deviation | 0.10 | 0.11 |
| ***Firm dynamics*** | | |
| Average exit rate | 0.0200 | 0.0255 |
| Average zombie rate | 0.0721 | 0.0772 |

Table 12: Exit and zombie rates in Slowdowns vs Recessions - Simulated data.

| | (1) Firm Exit | (2) Zombie |
|---|---|---|
| Slowdown | 0.0343*** | 0.0337*** |
| | (5.69) | (3.30) |
| Recession × Slowdown | -0.0452*** | 0.0175 |
| | (-4.04) | (0.93) |
| Observations | 194175 | 194175 |

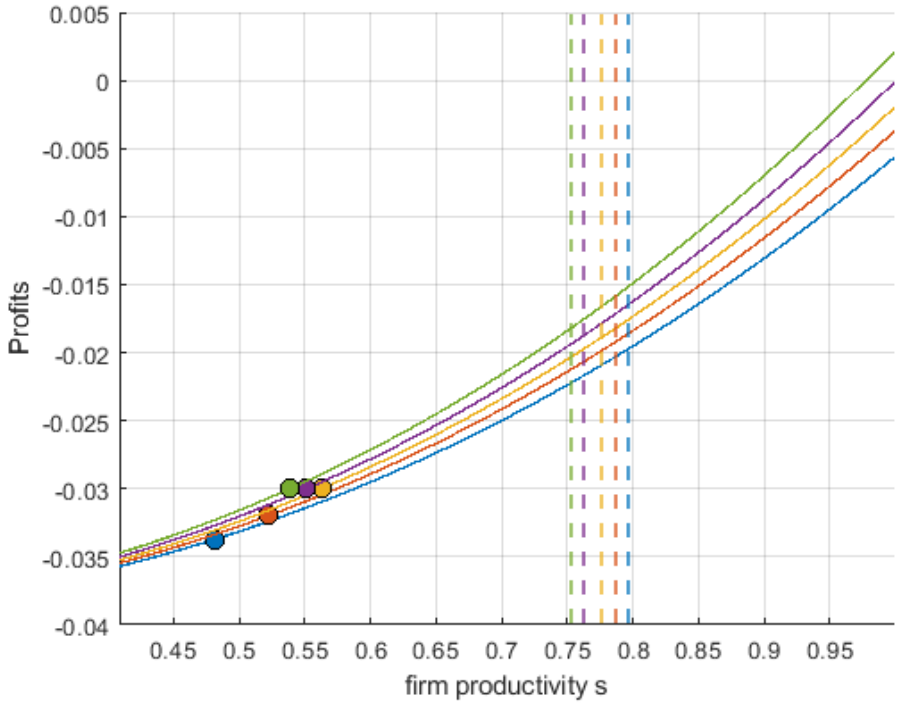
continuation value of the firm $W(s, Z) = 0$ (vertical hashed lines).

Let us first focus on firms that do not draw a zombie subsidy ($\delta = 0$). For these firms, if their idiosyncratic productivity $s$ is above the hashed vertical line, the continuation value is positive and they are active, otherwise they exit.

Instead, the exit decision is different for firms that draw a zombie subsidy ($\delta = 1$). These firms exit if they have large profit losses: their idiosyncratic productivity $s$ is such that profits are below the dots in Figure 4. If their profit losses are limited, that is profits are above $-\tau c_f$, they become zombie even though their continuation value is negative. Finally, just like firms with ($\delta = 0$), if the firm value is positive they remain active despite the negative profits in the period.

During recessions (in this case when $Z = 1$ or $Z = 2$), firm continuation values fall, thus the exit thresholds moves to the right (vertical hashed lines). However, firms that draw a zombie subsidy ($\delta = 1$) become zombie rather than exit. The same mechanism works for firms with lower productivity. In recessions, profits fall for any idiosyncratic productivity $s$, but the tolerance to profit losses $\tau(Z)$ is larger, thus pushing down the exit threshold for these firms. As a result low productivity firms that should have exit become zombie instead.

Figure 4: Zombie and exit thresholds.




Note: The green color refers to $Z = 5$, purple to $Z = 4$, yellow to $Z = 3$, orange to $Z = 2$, and blue to $Z = 1$. Solid lines report the profits, the dots refers to the tolerance $-\tau c_f$, and the vertical hashed lines to the level of $s$ for which the continuation value of the firm $W(s, Z) = 0$.

## 5.2 The cleansing and zombie effect of recessions

We now use our simulated data to evaluate the performance of the model to reproduce the cleansing and the zombie effect of recessions observed in the data, respectively Table 3 and Table 8.

We first compute the total factor productivity at the firm-level as $ln(s) + ln(Z)$ and we define $TFP$ as the deviation of firm-level total factor productivity with respect to the mean over the period. Our goal is to run regressions using the closest specification as possible as the one described in equation (2).

Table 13: The Cleansing Effect of Recessions - Simulated data.

| | (1)<br>Firm Exit | (2)<br>Firm Exit |
|---|---|---|
| TFP | -0.1156*** | -0.1119*** |
| | (-100.88) | (-87.93) |
| Slowdown | 0.0128*** | 0.0127*** |
| | (2.69) | (2.39) |
| TFP × Slowdown | -0.0333*** | -0.0398*** |
| | (-1.99) | (-2.12) |
| Recession × Slowdown | | -0.0000 |
| | | (0.00) |
| Recession × TFP | | -0.0223*** |
| | | (7.28) |
| Recession × TFP × Slowdown | | 0.1326*** |
| | | (3.03) |
| Observations | 186240 | 186240 |

The first column of Table 13 shows that low productivity firms have a higher probability to exit and that this selection is fostered during a slowdown. In this respect, the regression on simulated data reproduces our empirical results. Most interestingly, the second column shows that the fostered selection of firms happens during slowdowns rather than recession, as the sign of the triple interaction $Recession \times TFP \times Slowdown$ is positive and significant. The model is therefore able to replicate the dampening effect of recessions on the selection of firms, that we observed in the data. In other words, there is no cleansing effect during recessions in our simulated data. As a comparison, we run the same regression on simulated data in a counterfactual economy where we shut down zombie firms – either by putting $\tau(Z) = 0$ or $p(Z) = 0$. In an economy without zombie firms, there is no dampening of the cleansing effect during recessions (see Table A10 in Appendix D).

We then replace exit by zombie and run the same regression. The results of our regression on simulated data in Table 14 are consistent with the empirical results of Table 8. As we observe in the data, low productivity firms are more likely to become zombie and this is further true in a slowdown. However, low productivity firms turn into zombie firms mostly when the slowdown brings the economy into a recession. The triple interaction $Recession \times TFP \times Slowdown$ is indeed negative and significant, showing that the cleansing and the zombie effect of recessions work in opposite direction. In the model, low productivity firms that draw a zombie subsidy ($\delta = 1$) become zombie firms in a recession instead of exit. As a result, this blurs the selection at the exit margin and dampens the cleansing effect of recessions.

Table 14: The zombie effect of recessions - Simulated data.

| | (1)<br>Zombie | (2)<br>Zombie |
|---|---|---|
| TFP | -0.4350*** | -0.4244*** |
| | (-237.09) | (-207.57) |
| Slowdown | 0.0379*** | 0.0321*** |
| | (5.05) | (3.58) |
| TFP × Slowdown | -0.1374*** | -0.0364 |
| | (-5.39) | (-1.21) |
| Recession × Slowdown | | 0.0195 |
| | | (1.18) |
| Recession × TFP | | -0.0510*** |
| | | (-10.28) |
| Recession × TFP × Slowdown | | -0.1407** |
| | | (-2.33) |
| Observations | 194175 | 194175 |

## 5.3 Aggregate TFP

In order to delve more into the consequences of a dampened cleansing effect of recessions in the presence of zombie firms, we compute the aggregate total factor productivity in our baseline economy, and in counterfactual economies where we shut down zombie firms or increase their incidence.

We define aggregate TFP as the weighted sum of firm-level total factor productivity at time $t$:

$$aggTFP_t = \sum_i \theta_{i,t} TFP_{i,t},$$

where $\theta_{i,t} = \frac{n_{i,t}}{N_{S,t}}$ is the labor share of active firms at time $t$. We report in Table 15 aggregate TFP, firm-level output and labor, as well as the exit and zombie rates. Specification [i] refers to our baseline calibration, whereas in specification [ii] and [iii] we shut down zombie firms by putting for all $Z$, $\tau_Z = 0$ and $p_Z = 0$ respectively. We then explore the opposite case, that is economies with high tolerance for profit losses (specification [iv]), and an economy where all firms draw a zombie subsidy in every period (specification [v]).

Table 15: The aggregate implications of zombie firms.

| | **Baseline** | **No zombie tol.** | **No zombie sub.** | **High zombie tol.** | **High zombie sub.** |
|---|---|---|---|---|---|
| Parameter change | - | $\tau_Z = 0$ | $p_Z = 0$ | $\tau_b = 7.5$ | $p_Z = 1$ |
| | [i] | [ii] | [iii] | [iv] | [v] |
| ***Aggregate TFP*** | | | | | |
| Average | 0.347 | 0.399 | 0.399 | 0.338 | 0.301 |
| Volatility | 0.120 | 0.121 | 0.121 | 0.119 | 0.120 |
| ***Firm-level output*** | | | | | |
| Average | 0.146 | 0.167 | 0.167 | 0.142 | 0.132 |
| Volatility | 0.011 | 0.012 | 0.012 | 0.010 | 0.011 |
| ***Firm-level labor*** | | | | | |
| Average | 0.022 | 0.026 | 0.026 | 0.022 | 0.020 |
| Volatility | 0.002 | 0.003 | 0.003 | 0.002 | 0.002 |
| ***Exit rate*** | 0.0255 | 0.0476 | 0.0476 | 0.0225 | 0.0098 |
| ***Zombie rate*** | 0.0769 | 0.0000 | 0.0000 | 0.1031 | 0.1338 |

Notes: For each specification [i-v], we simulate 10,000 stochastic processes and their associated responses over 100 periods (years), using the baseline shock structure.

The results in Table 15 provide a quantitative assessment of the impact of zombie firms on the cleansing effect of recession. The shift of low productivity firms into the zombie state does not only induce a dampened cleansing effect of recessions but also reduces aggregate TFP. Indeed, aggregate TFP is on average larger in the no-zombie economies than in our baseline economy. The larger is the tolerance to profit losses (specification [iv]) or the higher is the number of firms that draw a zombie subsidy (specification [v]), the higher is the zombie rate and the lower is aggregate TFP. Similar results hold true for the firm-level labor and output: on average firm size

tend to be smaller in economies where the incidence of zombie firms is larger and it increases in recessions.[4]

Finally, to better grasp the effect of blurred selection at the exit margin in the presence of zombie firms, we decompose the changes in aggregate TFP, following Foster et al. (2001):

$$\Delta aggTFP_t = \underbrace{\sum_{i\in C} \theta_{i,t-1}\,\Delta TFP_{it} + \sum_{i\in C} \Delta\theta_{it}\,(TFP_{i,t-1} - aggTFP_{t-1}) + \sum_{i\in C} \Delta\theta_{it}\,\Delta TFP_{it}}_{\text{Intensive}}$$
$$+ \underbrace{\sum_{i\in E} \theta_{it}\,(TFP_{it} - aggTFP_{t-1})}_{\text{Entry}} - \underbrace{\sum_{i\in X} \theta_{i,t-1}\,(TFP_{i,t-1} - aggTFP_{t-1})}_{\text{Exit}},$$

where the *Intensive* term refers to all changes in aggregate TFP that occurs among incumbent continuing firms, either because of changes in their $TFP$, or labor share $\theta_{i,t}$, or both. At the extensive margin, the *Entry* and *Exit* terms refers to changes in aggregate TFP induced by the entry and exit of firms at time $t$. Note that, as long as exiting firms are less productive than aggregate productivity at time $t-1$, the contribution of *Exit* to aggregate productivity growth is positive. In turn, the stronger is the selection of low productivity firms at the exit margin, the larger is the growth of aggregate TFP.

Table 16: Aggregate TFP growth decomposition.

| | **Baseline** | **No zombie tol.** | **No zombie sub.** | **High zombie tol.** | **High zombie sub.** |
|---|---|---|---|---|---|
| Parameter change | - | $\tau_Z = 0$ | $p_Z = 0$ | $\tau_b = 7.5$ | $p_Z = 1$ |
| | [i] | [ii] | [iii] | [iv] | [v] |
| | | | ***Growth*** **($Z_t > Z_{t-1}$)** | | |
| $\Delta aggTFP$ | 0.0953 | 0.0984 | 0.0976 | 0.0940 | 0.0936 |
| Intensive | 0.0770 | 0.0754 | 0.0750 | 0.0759 | 0.0787 |
| Entry | 0.0142 | 0.0151 | 0.0147 | 0.0144 | 0.0131 |
| Exit (-) | 0.0041 | 0.0079 | 0.0078 | 0.0037 | 0.0017 |
| | | | ***Slowdown*** **($Z_t < Z_{t-1}$)** | | |
| $\Delta aggTFP$ | -0.0912 | -0.0791 | -0.0835 | -0.0904 | -0.0938 |
| Intensive | -0.0997 | -0.0917 | -0.0969 | -0.0991 | -0.1001 |
| Entry | 0.0034 | 0.0028 | 0.0029 | 0.0042 | 0.0044 |
| Exit (-) | 0.0051 | 0.0098 | 0.0105 | 0.0045 | 0.0020 |

[4] In Appendix D, we report in Table A11 two additional counterfactuals where we keep constant the tolerance for profit losses, and the probability to draw a zombie subsidy.

In Table 16, we report the decomposition of changes in aggregate TFP when the economy is growing ($Z_t > Z_{t-1}$) or in a slowdown ($Z_t < Z_{t-1}$), in our baseline and counterfactual economies. First, we note that a big fraction of changes in aggregate TFP occur at the intensive margin. Also, when the economy is growing, both the intensive and the extensive margin (both entry and exit) contribute to the growth of aggregate TFP.

The picture is slightly different during slowdowns. Aggregate TFP falls in a slowdown and this is mostly due to a negative intensive margin, as the $TFP$ of continuing firms shrinks. This fall in aggregate TFP is only partly compensated by changes at the extensive margin, both entry and exit. Entrant firms are indeed relatively more productive, and the exit of firms with relatively low $TFP$ also pushes up aggregate TFP. However, these positive changes are dominated by the fall at the intensive margin.

Our focus is thus on *Exit*: when positive, the larger is this factor, the smaller is the fall in aggregate TFP. In short, the results in the bottom panel of Table 16 show that the *Exit* term captures the silver lining effect of slowdowns: as the selection at the exit margin improves, this generate a lower fall in aggregate TFP. The contribution of *Exit* to changes in aggregate TFP is larger in the absence of zombie firms (specification [ii] and [iii]). As a result, this limits the fall in aggregate TFP with respect to the baseline economy and the counterfactual economies where we increase instead the incidence of zombie firms (specification [iv] and [v]).[5] These findings are consistent with the results in Table 15: in an economy where low productivity firms turn into zombies rather than exit, aggregate TFP is on average lower and experiences larger falls during slowdowns.

[5] In Appendix D, we report in Table A12 two additional counterfactuals where we keep constant the tolerance for profit losses, and the probability to draw a zombie subsidy.

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# APPENDIX

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# A Alternative specifications

## A.1 Cleansing in recessions

Table A1: Cleansing in recessions.

| | (1) Firm Exit | (2) Firm Exit (no covid) | Firm Exit |
|---|---|---|---|
| TFP | -0.00611*** | -0.00611*** | -0.00645*** |
| | (-42.64) | (-42.61) | (-51.44) |
| Recession | 0.00229*** | 0.00517*** | |
| | (19.13) | (35.36) | |
| Recession × TFP | -0.000237 | -0.00189*** | |
| | (-1.00) | (-6.57) | |
| Slowdown | | | 0.0340*** |
| | | | (44.23) |
| TFP × Slowdown | | | -0.0180*** |
| | | | (-12.21) |
| Firm size class FE | Yes | Yes | Yes |
| Region FE | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes |
| Observations | 3144209 | 2790357 | 2976075 |

Note: *TFP* is the deviation of the firm-level TFP from its' industry-year mean in year t. *Crisis* is the negative GDP growth of the region where the firm is located. *Recession* is a dummy indicating the Great Recession (2008-2009), the Sovereign Debt Crisis (2012-2013) and Covid (2020-2021). The model includes firm, firm size and year fixed effects. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. t values in the parenthesis.

## A.2 The cleansing effect across different recessions

Table A2: The cleansing effect across different recessions.

| | (1) Firm Exit | (2) Firm Exit | (3) Firm Exit |
|---|---|---|---|
| TFP | -0.00645*** | -0.00881*** | -0.00881*** |
| | (-16.83) | (-20.01) | (-20.05) |
| Slowdown | 0.00430 | 0.0100* | 0.00977* |
| | (1.32) | (2.31) | (2.28) |
| TFP × Slowdown | -0.0187*** | -0.0595*** | -0.0595*** |
| | (-5.28) | (-4.58) | (-4.58) |
| Recession × Slowdown | | -0.00874 | |
| | | (-1.91) | |
| Recession × TFP | | 0.00291*** | |
| | | (5.39) | |
| Recession × TFP × Slowdown | | 0.0432*** | |
| | | (3.97) | |
| Great Recession × Slowdown | | | -0.00996** |
| | | | (-2.80) |
| Sovereign Debt × Slowdown | | | 0.00920 |
| | | | (1.75) |
| Covid × Slowdown | | | -0.0102* |
| | | | (-2.10) |
| Great Recession × TFP | | | 0.00210 |
| | | | (1.31) |
| Sovereign Debt × TFP | | | 0.00177** |
| | | | (3.27) |
| Covid × TFP | | | 0.00661*** |
| | | | (21.16) |
| Great Recession × TFP × Slowdown | | | 0.0496** |
| | | | (3.53) |
| Sovereign Debt × TFP × Slowdown | | | 0.0321* |
| | | | (2.16) |
| Covid × TFP × Slowdown | | | 0.0607*** |
| | | | (4.65) |

Note: TFP is the deviation of the firm-level TFP from its' industry-year mean in year t. Crisis is the negative GDP growth of the region where the firm is located. GR, SD and COV are dummies indicating the Great Recession (2008-2009), the Sovereign Debt Crisis (2012-2013) and Covid (2020-2021). The model includes firm, firm size and year fixed effects. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. t values in the parenthesis.

# B Robustness

## B.1 Firm level debt

Table A3: The cleansing effect during slowdowns vs recessions with firm debt.

| | (1)<br>Firm Exit | (2)<br>Firm Exit |
|---|---|---|
| TFP | -0.00552*** | -0.00621*** |
| | (-39.19) | (-18.65) |
| Slowdown | 0.00276 | 0.0106*** |
| | (1.47) | (3.06) |
| TFP × Slowdown | -0.0183*** | -0.0326*** |
| | (-11.82) | (-6.37) |
| Fin | 0.00000199 | 0.00000199 |
| | (1.57) | (1.57) |
| Recession × Slowdown | | -0.0120*** |
| | | (-2.90) |
| Recession × TFP | | 0.000551 |
| | | (1.41) |
| Recession × TFP × Slowdown | | 0.0166*** |
| | | (3.09) |
| Firm size class FE | Yes | Yes |
| Region FE | Yes | Yes |
| Year FE | Yes | Yes |
| Industry FE | Yes | Yes |
| Observations | 2045253 | 2045253 |

Note: *Fin* refers to the ratio of current liabilities over current assets (data 2010-2023). *TFP* is the deviation of the firm-level TFP from its' industry-year mean in year t. *Crisis* is the negative GDP growth of the region where the firm is located. *Recession* is a dummy indicating the Great Recession (2008-2009), the Sovereign Debt Crisis (2012-2013) and Covid (2020-2021). The model includes firm, firm size and year fixed effects. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. t values in the parenthesis.

Table A4: The cleansing effect during slowdowns vs recessions with firm debt: Young Firms.

| | (1) Firm Exit | (2) Firm Exit |
|---|---|---|
| TFP | -0.00529*** | -0.00530*** |
| | (-12.91) | (-5.46) |
| Slowdown | 0.00493 | 0.0116 |
| | (0.78) | (1.06) |
| TFP × Slowdown | -0.0147*** | -0.0200 |
| | (-2.99) | (-1.37) |
| Fin | 6.38e-08 | 6.36e-08 |
| | (0.29) | (0.29) |
| Recession × Slowdown | | -0.0107 |
| | | (-0.80) |
| Recession × TFP | | -0.000524 |
| | | (-0.45) |
| Recession × TFP × Slowdown | | 0.00935 |
| | | (0.60) |
| Firm size class FE | Yes | Yes |
| Region FE | Yes | Yes |
| Year FE | Yes | Yes |
| Industry FE | Yes | Yes |
| Observations | 258343 | 258343 |

Note: *Fin* refers to the ratio of current liabilities over current assets (data 2010-2023). *TFP* is the deviation of the firm-level TFP from its' industry-year mean in year t. *Crisis* is the negative GDP growth of the region where the firm is located. *Recession* is a dummy indicating the Great Recession (2008-2009), the Sovereign Debt Crisis (2012-2013) and Covid (2020-2021). The model includes firm, firm size and year fixed effects. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. t values in the parenthesis.

Table A5: The cleansing effect during slowdowns vs recessions with firm debt: Small Firms.

| | (1) Firm Exit | (2) Firm Exit |
|---|---|---|
| TFP | -0.00609*** | -0.00674*** |
| | (-23.61) | (-11.00) |
| Slowdown | -0.00261 | 0.00805 |
| | (-0.66) | (1.12) |
| TFP × Slowdown | -0.0159*** | -0.0262*** |
| | (-5.60) | (-2.79) |
| Fin | 0.00000162 | 0.00000162 |
| | (1.14) | (1.13) |
| Recession × Slowdown | | -0.0169* |
| | | (-1.93) |
| Recession × TFP | | 0.000746 |
| | | (1.04) |
| Recession × TFP × Slowdown | | 0.0110 |
| | | (1.11) |
| Firm size class FE | Yes | Yes |
| Region FE | Yes | Yes |
| Year FE | Yes | Yes |
| Industry FE | Yes | Yes |
| Observations | 537237 | 537237 |

Note: *Fin* refers to the ratio of current liabilities over current assets (data 2010-2023). *TFP* is the deviation of the firm-level TFP from its' industry-year mean in year t. *Crisis* is the negative GDP growth of the region where the firm is located. *Recession* is a dummy indicating the Great Recession (2008-2009), the Sovereign Debt Crisis (2012-2013) and Covid (2020-2021). The model includes firm, firm size and year fixed effects. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. t values in the parenthesis.

## B.2 Average level of TFP

Table A6: The cleansing effect during slowdowns and recessions - avg firm-level TFP.

| | (1) Firm Exit | (2) Firm Exit |
|---|---|---|
| avgTFP | -0.00577*** | -0.00851*** |
| | (-11.08) | (-13.63) |
| Slowdown | 0.00603 | 0.0123** |
| | (1.87) | (2.99) |
| avgTFP × Slowdown | -0.0180*** | -0.0648*** |
| | (-4.77) | (-3.84) |
| Recession × Slowdown | | -0.00951* |
| | | (-2.02) |
| Recession × avgTFP | | 0.00343*** |
| | | (4.47) |
| Recession × avgTFP × Slowdown | | 0.0496** |
| | | (3.38) |
| Firm size class FE | Yes | Yes |
| Region FE | Yes | Yes |
| Year FE | Yes | Yes |
| Industry FE | Yes | Yes |
| Observations | 3018252 | 3018252 |

Note: *TFP* is the deviation of the firm-level TFP from its' industry-year mean in year t. *Crisis* is the negative GDP growth of the region where the firm is located. *Recession* is a dummy indicating the Great Recession (2008-2009), the Sovereign Debt Crisis (2012-2013) and Covid (2020-2021). The model includes firm, firm size and year fixed effects. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. t values in the parenthesis.

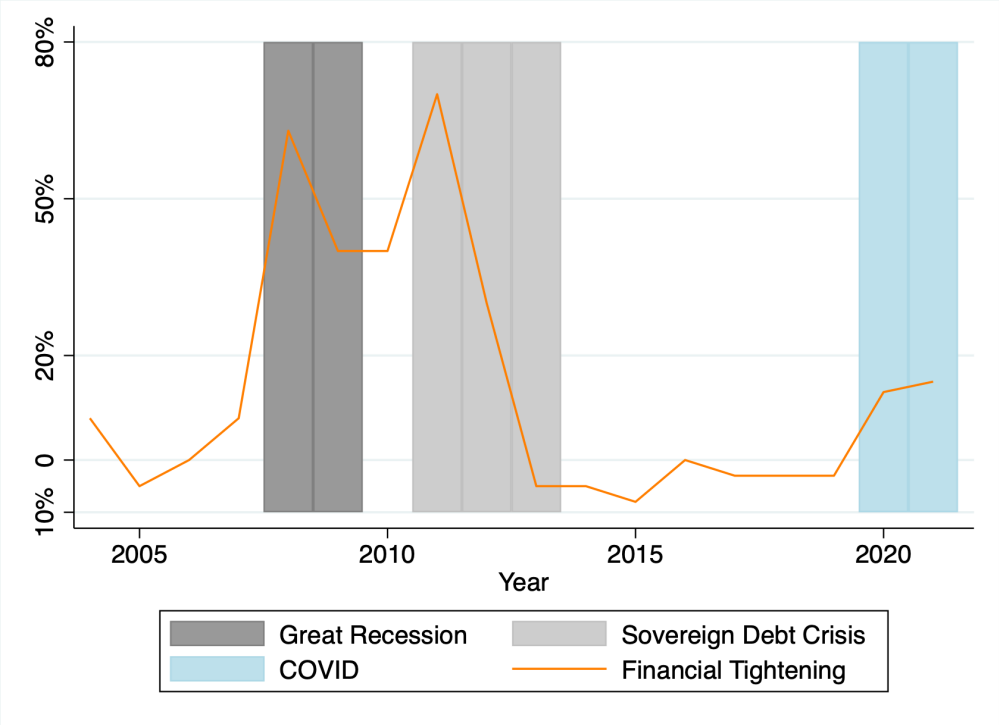
## B.3 Cleansing Effect of Volatility of Financial Markets

Table A7: Cleansing Effect of Volatility of Financial Markets.

| | (1) Firm Exit | (2) Firm Exit |
|---|---|---|
| TFP | -0.00645*** | -0.00724*** |
| | (-51.61) | (-48.03) |
| Slowdown | 0.00430** | 0.00860*** |
| | (2.37) | (3.50) |
| TFP × Slowdown | -0.0187*** | -0.0319*** |
| | (-12.71) | (-16.10) |
| Volatility_fm × Slowdown | | -0.00490*** |
| | | (-2.80) |
| Volatility_fm × TFP | | 0.000606*** |
| | | (4.51) |
| Volatility_fm × TFP × Slowdown | | 0.0200*** |
| | | (10.73) |
| Firm size class FE | Yes | Yes |
| Region FE | Yes | Yes |
| Year FE | Yes | Yes |
| Industry FE | Yes | Yes |
| Observations | 2976075 | 2976075 |

## B.4 Financial tightening and recessions

Figure A1: Financial tightening and recessions.




Note: GR refers to the Great Recessions (2008-2009), SD to the Sovereign Debt Crisis (2011-2013) and COVID to the pandemic (2020-2021).

Table A8: Cleansing Effect of Financial Tightening.

| | (1) Firm Exit | (2) Firm Exit |
|---|---|---|
| TFP | -0.00645*** | -0.00576*** |
| | (-51.61) | (-33.96) |
| Slowdown | 0.00430** | 0.00701*** |
| | (2.37) | (2.98) |
| TFP × Slowdown | -0.0187*** | -0.00800*** |
| | (-12.71) | (-3.55) |
| FT × Slowdown | | -0.000162 |
| | | (-1.30) |
| FT × TFP | | -0.0000127* |
| | | (-1.95) |
| FT × TFP × Slowdown | | -0.000409*** |
| | | (-3.58) |
| Firm size class FE | Yes | Yes |
| Region FE | Yes | Yes |
| Year FE | Yes | Yes |
| Industry FE | Yes | Yes |
| Observations | 2976075 | 2976075 |

# C Zombie firms and counterfactual exit

## C.1 Delayed exit of zombie firms

In order to establish this link between selection into the zombie state and exit, we look at the exit rates of zombie firms. In fact, the zombie state could represent an intermediate state before exit. For this reason, we compute the exit rates at time $t + n$ for all firms that become zombie at time $t$. This provides a measure of "delayed exit" after becoming zombie.

Figure A2: Zombie firms - delay of exit.

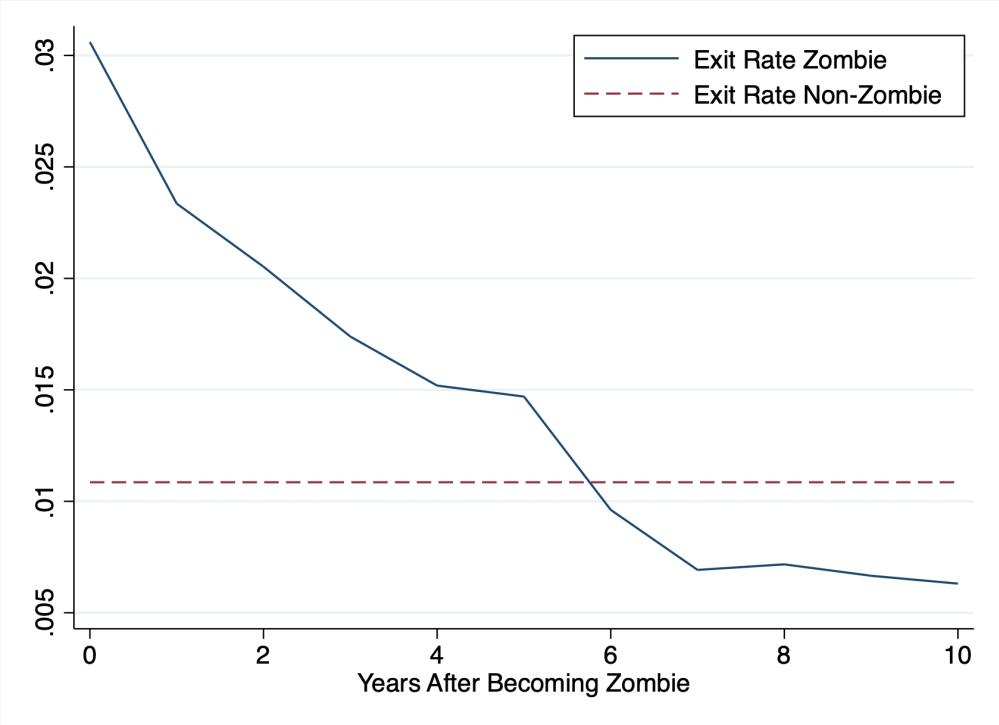
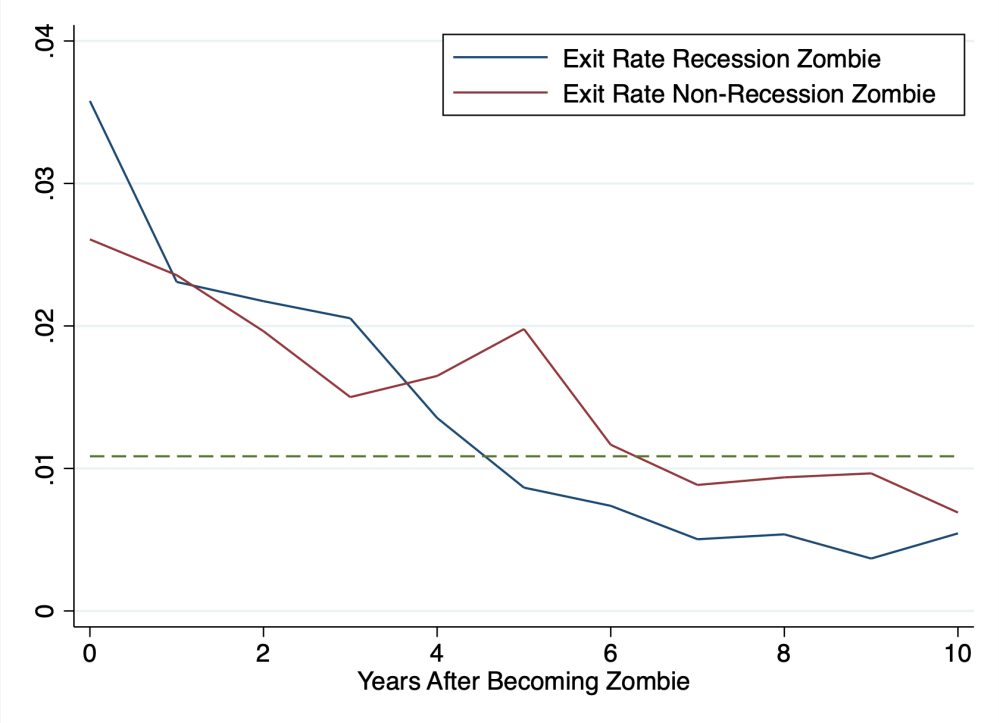



Figure A2 provides two insightful findings. First, the exit rate among zombie firms is higher than among non-zombie firms. Second, the exit rate of zombie firms is particularly higher than the exit rate of non-zombie firms right after firms become zombie. The difference between the exit rate of zombie and non-zombie firms decreases over time and falls below the exit rate of non-zombie firms five years after they become zombie. This happens for two reasons: i) because some zombie firms may recover and become non-zombie, ii) because some zombie firms may remain zombies for a long time period.

In Figure A3, we show the exit rates of firms after they become zombie in a recession year

versus a non-recession year: the exit rates of firms becoming zombie in a recession year are slightly higher in the first three years after becoming zombie.

Figure A3: Zombie firms - delay of exit: recession vs non-recession.




Note: We report the exit rates of firms in periods after they become zombies.

## C.2 Counterfactual exit

In this section, we define a counterfactual firm exit, where we assign exit at time $t$ for all firms that become zombies i) during a slowdown; ii) during a recession; iii) at any period. The counterfactual exit is therefore the sum of zombie firms and actual firm exit. We run the same econometric specification as equation (2) on these counterfactual firm exit and report the results in Table A9.

For all cases of counterfactual firm exit we consider, low TFP firms are more likely to exit and this is further true in slowdowns. Indeed, the coefficient of the interaction term $TFP \times Slowdown$ is negative and significant for all counterfactual exit, whether we include in firm exit only zombies in slowdown, recession or in any period. However, there is a stark difference for the coefficient of the interaction term including the dummy recession ($Recession \times TFP \times Slowdown$). While this coefficient is positive and significant in our baseline results on firm exit (dampened cleansing),

Table A9: Zombie firms - counterfactual exit.

| | (1) Exit *slowdown*-zombie | (2) Exit *recession*-zombie | (3) Exit zombie |
|---|---|---|---|
| TFP | -0.0133*** | -0.00883*** | -0.0304*** |
| | (-6.71) | (-17.63) | (-15.75) |
| Slowdown | 0.1023* | -0.00418 | 0.0294 |
| | (2.21) | (-0.21) | (1.41) |
| TFP × Slowdown | -0.1339*** | -0.0624*** | -0.107*** |
| | (-6.40) | (-4.48) | (-3.89) |
| Recession × Slowdown | -0.0421 | 0.0265 | -0.0162 |
| | (-0.53) | (0.89) | (-0.64) |
| Recession × TFP | -0.0100*** | -0.0194*** | -0.000190 |
| | (-4.72) | (-16.95) | (-0.18) |
| Recession × TFP × Slowdown | 0.0247 | 0.00295 | 0.0410 |
| | (0.79) | (0.26) | (1.49) |
| Firm size class FE | Yes | Yes | Yes |
| Region FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes |
| Observations | 2831683 | 2831751 | 2642701 |

it is close to zero and non-significant for all counterfactual exit considered. This implies that selection of firms during recessions is not statistically different than the one in slowdown.

To sum up, the transition of low productivity firms into the zombie state (rather than exit) blurs the selection at the exit margin during recessions and explains the dampened effect of recessions on cleansing. By considering zombie firms among exiting firms, our counterfactual exit shuts down the impact of delayed exit, and as a result there is not a dampened effect of recessions on cleansing.

These findings help explaining the mixed evidence about the cleansing effect of recessions, that can be rationalized by different transitions into the zombie state in slowdown vs recession. However, we need to understand why this transition into the zombie state is different in recessions, where relatively less productive firms become zombie rather than exit, a pattern we do not observe in slowdowns. In the following section, we provide a theoretical framework to explain this zombie effect of recessions and quantify the impact of this distorted selection on productivity growth.

# D Quantitative results

Table A10: The Cleansing Effect of Recessions - Simulated data, No zombie tolerance.

| | (1)<br>Firm Exit | (2)<br>Firm Exit |
|---|---|---|
| TFP | -0.1812*** | -0.1784*** |
| | (-91.71) | (-81.57) |
| Slowdown | 0.0219*** | 0.0144* |
| | (2.97) | (1.73) |
| TFP × Slowdown | -0.0653** | -0.0315 |
| | (-2.24) | (-0.96) |
| Recession × Slowdown | | -0.0353** |
| | | (1.93) |
| Recession × TFP | | -0.0126** |
| | | (-2.38) |
| Recession × TFP × Slowdown | | -0.1077 |
| | | (-1.42) |
| Observations | 118462 | 118462 |

Table A11: Quantitative results - Robustness.

| | **Constant zombie tolerance** | **Constant zombie subsidy** |
|---|---|---|
| Parameter change | $\tau$ = 0.75 | $p$ = 0.80 |
| | [vi] | [vii] |
| ***Aggregate TFP*** | | |
| Average | 0.345 | 0.350 |
| Volatility | 0.120 | 0.121 |
| ***Firm-level output*** | | |
| Average | 0.146 | 0.147 |
| Volatility | 0.011 | 0.011 |
| ***Firm-level labor*** | | |
| Average | 0.022 | 0.023 |
| Volatility | 0.002 | 0.002 |
| ***Exit rate*** | 0.0254 | 0.0270 |
| ***Zombie rate*** | 0.0748 | 0.0725 |

Notes: For each specification [i-v], we simulate 10,000 stochastic processes and their associated responses over 100 periods (years), using the baseline shock structure.

Table A12: Aggregate TFP growth decomposition - Robustness.

| | **Constant zombie tolerance** | **Constant zombie subsidy** |
|---|---|---|
| Parameter change | $\tau$ = 0.75 | $p$ = 0.80 |
| | [vi] | [vii] |
| | ***Growth*** ***($Z_t > Z_{t-1}$)*** | |
| $\Delta aggTFP$ | 0.0953 | 0.0964 |
| Intensive | 0.0768 | 0.0791 |
| Entry | 0.0143 | 0.0132 |
| Exit (-) | 0.0042 | 0.0041 |
| | ***Slowdown*** ***($Z_t < Z_{t-1}$)*** | |
| $\Delta aggTFP$ | -0.0901 | -0.0876 |
| Intensive | -0.0997 | -0.0981 |
| Entry | 0.0041 | 0.0049 |
| Exit (-) | 0.0055 | 0.0057 |