

Death and Taxes: Does Taxation Matter for Firm Survival?

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Abstract: This paper investigates the impact of taxation on firm survival, using hazard models and a large-scale panel dataset on over 4 million nonfinancial firms from 21 countries over the period 1995–2015. We find ample evidence that a lower level of effective marginal tax rate improves firms’ survival chances. This result is not only statistically but also economically important and remains robust when we partition the sample into country subgroups. The effect of taxation on firms’ survival probability is found to exhibit a non-linear pattern and be stronger in developing countries than advanced economies. These findings have important policy implications for the design of corporate tax systems. The challenge is not simply reducing the statutory tax rate, but to level the playing field for all firms by rationalizing differentiated tax treatments across sectors, asset types and sources of financing.

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1. INTRODUCTION

Corporate dynamism is critical for the vitality and sustainability of competitiveness, innovation and growth. While creative destruction—through firm entry and exit—is essential for economic progress, establishing a conducive ecosystem for firm survival is also necessary for sustainable private sector development and socioeconomic cohesion. There is an extensive literature identifying firm-level characteristics (such as size, age, indebtedness, and productivity) as well as macroeconomic conditions and institutional features as key contributing factors to growth and survival probability among firms (Evans, 1987; Hall, 1987; Audretsch, 1991; Audretsch and Mahmood, 1995; Ericson and Pakes, 1995; Agarwal, 1997; Zingales, 1998; Agarwal and Audretsch, 2001; Agarwal and Gort, 2002; Bond and others, 2003; Bunn and Redwood, 2003; Clementi and Hopenhayn, 2006; Bridges and Guariglia, 2008; Musso and Schiavo, 2008; Byrne, Spaliara, and Tsoukas, 2016). To the best of our knowledge, however, there is no paper analyzing the impact of taxation on firms' survival prospects. While corporate income taxes are expected to lower firms' capital investment and productivity by raising the user cost of capital, distorting factor prices and reducing after-tax return on investment, taxation also provides resources for public infrastructure investments and the proper functioning of government institutions, which are key to a firm's success. As shown by Barro (1990), Aghion and others (2016), and Cevik and Miryugin (2018), the overall impact of taxation on firm performance depends on the relative weight of these two opposing effects, which can vary with the composition and efficiency of taxation and government spending.

The objective of this paper is to shed light on how taxation affects the probability of firm survival across countries. According to the Orbis database maintained by Bureau van Dijk, the average failure rate among nonfinancial firms from 167 countries is 3.5 percent of active firms during the 1995-2015 period. While the average failure rate of 4 percent in advanced economies is almost double the average failure rate among developing countries, there appears to be a convergence in failure rates over the past decade. In this paper, we focus on how taxation affects the survival prospects of nonfinancial firms, using hazard models and a comprehensive dataset covering over 4 million nonfinancial firms from 21 countries with a total of 21.5 million firm-year observations over the period 1995–2015. As the main explanatory variable of interest, we estimate the effective marginal tax rate (EMTR) for each firm, rather than using the statutory corporate income tax (CIT) rate, as the appropriate measure of the tax burden on firms.² The firm-specific EMTR encapsulates not only the differences in the overall tax burden across countries, but also the discriminatory nature of tax regimes across sectors and types of firms.

To obtain a granular analysis of firm survival across countries and over time, we control for a plethora of firm characteristics, such as age, size, profitability, capital intensity, leverage and total factor productivity (TFP), as well as systematic differences across sectors and countries.

²Devereux and Griffith (2002) provide a comprehensive discussion of backward-looking effective rates, which are inherently prone to endogeneity inducing biased estimation results.

We find that the tax burden—measured by the firm-specific EMTR—exerts an adverse effect on companies' survival prospects. In other words, a lower level of EMTR increases the survival probability among firms in our sample. This finding is not only statistically but also economically important, and remains robust when we partition the sample into country subgroups. We run the estimation on separate samples, and find that the effect of taxation on firm survival is significantly greater in developing countries than advanced economies. Furthermore, digging deeper into the tax sensitivity of firm survival, we uncover a nonlinear relationship between the firm-specific EMTR and the probability of corporate failure, which implies that taxation becomes a detriment to firm survival at higher levels. With regards to the impact of other firm characteristics, we obtain results that are in line with previous research, and see that survival probability differs depending on firm age and size, with older and larger firms experiencing a lower risk of failure. Focusing on the financial health, we find that the probability of failure diminishes with the degree of profitability, but increases with the level of indebtedness. Similarly, in relation to firm structure and performance, we observe that capital intensity and TFP play a significant role in reducing the probability of failure.

The firm-level estimates presented in this paper demonstrate that taxation clearly has a significant effect on the pattern of firm failures across advanced and developing countries. This finding has important policy implications for the design of tax systems. A coherent and fair approach to taxation is important to reduce legal uncertainty and distortions in resource allocation faced by firms. For policymakers, the challenge is not simply reducing the statutory CIT rate, but to level the playing field for all firms by rationalizing differentiated tax treatments across sectors, capital asset types and sources of financing.

The remainder of the paper is organized as follows. Section II describes the data sources, explains the calculation of firm-specific variables, and presents summary statistics and stylized facts. Section III explains the empirical methodology. Section IV presents the econometric results, including various robustness checks. Section V concludes and discusses policy implications.

2. DATA OVERVIEW AND ESTIMATING EMTR AND TFP

The primary dataset consists of annual observations on a total of more than 4 million nonfinancial firms from 21 countries during the 1995-2015 period. We obtain harmonized firm-level financial data, including balance sheets and income statements, from the Orbis database. Unlike other administrative firm-level databases, Orbis provides a comparable coverage of both public (listed) and private (non-listed) firms including small and medium-sized enterprises in advanced and developing countries. The complete Orbis sample consists of more than 200 million firm annual observations from over 100 countries around the world. However, similar to any other large-scale micro dataset, the Orbis data require careful management to ensure consistency and comparability across firms and countries and over time. First, we select countries with sufficient number of observations by setting a threshold of 10,000 annual observations per country. Second, following the data cleaning principles

suggested by Gal (2013) and Kalemli-Ozcan and others (2015), we filter out firms with negative values of total assets, employment, operating revenues, and short-term loans and long-term debt in any given year. Third, we restrict the dataset to the sample of firms and countries for which we have information to compute the measures of EMTR and TFP as described below. Fourth, to minimize the effect of extreme outliers, we exclude 1 percent of observations on both tails of the distribution of variables. After these steps, we obtain an unbalanced panel of 4,026,648 unique firms from 21 countries (14 advanced and 7 developing) with a total of 21,450,725 firm-year observations over the period from 1995 to 2015.³

We follow a commonly-used EMTR approach to estimate a forward-looking measure of the effective tax burden at the firm level.⁴ The firm-specific EMTR framework is based on the user cost of capital concept as developed by Hall and Jorgenson (1967), Auerbach (1983), and King and Fullerton (1984). According to Devereux and Griffith (1998; 2003), the EMTR is the difference between the expected pre-tax (gross) rate of return (\tilde{p}) and the expected post-tax (net) rate of return on a marginal investment (r), divided by the pretax rate of return:

$$EMTR = \frac{\tilde{p} - r}{\tilde{p}}$$

The EMTR is therefore a consolidated indicator of the various tax factors that affect the cost of capital relative to a normal rate of return. The expected pre-tax rate of return (\tilde{p}) is the minimum rate of return of a new investment project (I) that covers the acquisition cost (Q) and the economic rate of depreciation (δ), allowing the firm to pay tax obligations and funding costs.

$$\tilde{p} = \frac{I}{Q} - \delta$$

The expected post-tax rate of return (r), on the other hand, is equivalent to the nominal market interest rate (i) minus the inflation rate (π), both of which are assumed to be common across firms in a given country and time. When there is no tax, \tilde{p} is equal r , and the *EMTR* is zero. With taxation, however, the expected pre-tax rate of return (\tilde{p}) diverges from the expected after-tax rate of return (r), thereby requiring the firm to generate additional profits to cover not only for funding costs but also tax obligations. If the EMTR is the same across different sectors and firm characteristics, then all firms face the same effective tax rate.

³ The list of countries in our sample and the numbers of firms and firm-year observations per country are provided Appendix Table A1. Countries are classified as advanced and developing according to the IMF's World Economic Outlook (WEO) database as of September 2017.

⁴ Egger and others (2009) provide comprehensive guidance on computing EMTRs at the firm level, which is applied recently by Benedek and others (2017) in the context of estimating the impact of tax incentives on firm size in a panel of four European countries.

However, when the tax code allows for changes in tax rates and allowances according to sector- and firm-level differences, the EMTR shows considerable variation across firms in a given country and over time.

The estimation of firm-specific EMTRs requires a combination of firm-level information and country-level factors including the key features of the tax system. We calculate firm-level EMTRs using company-specific information and a set of parameters including the statutory CIT rate, depreciation rules, inflation, the nominal interest rate, and the real before-tax return on equity in each country, which are assumed to be constant across all firms. Following Egger and others (2009), we assume that the key parameters are as follows: $\tilde{p} = 0.2$, $r = 0.05$ and $\pi = 0.02$, and use different rates of economic depreciation (δ) for different types of assets: 0.1225 for machinery; 0.0361 for buildings; 0 for land and inventories; and 0.15 for intangible assets.⁵

We estimate a firm-level measure of TFP to incorporate the impact of efficiency differences across enterprises on the likelihood of firm survival. TFP is an indicator of the efficiency with which capital and labor are used in a production process. As such, it plays a significant role in analyzing economic fluctuations at the macro level as well as assessing differences across sectors and firms. Firm-specific TFP is expressed as the residual from the standard Cobb-Douglas production function with capital and labor as inputs and an underlying assumption of constant returns to scale given by:

$$y_{it} = \beta_k k_{it} + \beta_l l_{it} + \mu_i + \mu_t + \varepsilon_{it}$$

in which y_{it} is the logarithm of real gross output for firm i at time t ; k_{it} and l_{it} denote the logarithms of real capital stock and labor, respectively; μ_i and μ_t stand for firm and time fixed effects, respectively, to capture permanent differences across firms and aggregate changes common to all firms; and ε_{it} is the residual representing the amount of output that cannot be explained by the use of inputs. To compute the real capital stock, we follow the perpetual inventory method detailed in Gal (2013) and define the capital stock, k_{it} , as the book value of fixed tangible assets, and depreciation, δ_{it} , as reported in a firm's accounts. Accordingly, the real capital stock is calculated by:

$$k_{it} = k_{it-1}(1 - \delta_{it}) + I_{it}$$

where I_{it} is net fixed investment in real terms, using industry-specific price deflators. To mitigate the risk of obtaining biased TFP estimates with the ordinary least squares (OLS) method, we utilize the algorithm proposed by Levinsohn and Petrin (2003) and use intermediate inputs, energy or material costs, as proxies to solve the simultaneity problem. Hence, the production function is expressed in the following form with an additional term:

⁵ While inflation and interest rates tend to vary across countries, the macroeconomic parameters used in the analysis are consistent with country-level observations for advanced and developing countries in the sample.

$$y_{it} = \beta_o + \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + \mu_i + \mu_t + \varepsilon_{it} = \beta_l l_{it} + \varphi_{it}(k_{it}, m_{it}) + \mu_i + \mu_t$$

In the first stage of the estimation, $\hat{\beta}_l$ is estimated by the OLS model and a third order approximation in k_{it} and m_{it} substituted for $\varphi_{it}(k_{it}, m_{it})$. In the second stage, $\hat{\omega}_{it}$ is estimated for all values of β_k^* and β_m^* , according to the formula:

$$\hat{\omega}_{it} = \hat{\varphi}_{it} - \beta_k^* k_{it} - \beta_m^* m_{it}$$

Then, the residual of the following equation is computed and interacted with two instruments, which are real capital stock and material costs:

$$\eta_{it} + \widehat{\xi}_{it} = y_{it} - \hat{\beta}_l l_{it} - \beta_k^* k_{it} - \beta_m^* m_{it} - E[\omega_{it} | \widehat{\omega}_{it} - 1]$$

Capital stock in the current period is assumed to be not correlated with the contemporaneous productivity shock, as it is mostly driven by an investment decision made in the previous period, which yields to the first moment condition. The second moment condition is obtained through the fact that the material costs from the previous level are uncorrelated with the current shock.

Table 1. Distribution of Firms Across Sectors

Economic Sector	Number of Firms	Percent
Accommodation and Food Services	338,592	8.4
Construction	699,047	17.4
Information Technology	157,500	3.9
Manufacturing	710,620	17.7
Mining	10,885	0.3
Professional and Administrative Activities	503,135	12.5
Real Estate	148,467	3.7
Transportation and Storage	192,739	4.8
Utilities	33,920	0.8
Wholesale and Retail Trade	1,231,743	30.6
Total	4,026,648	100.0

Table 1 displays the distribution of nonfinancial firms across 10 sector groups over the period spanning from 1995 to 2015. Our sample of firms is unevenly distributed across 21 countries and 10 nonfinancial sectors grouped according to the statistical classification of economic activities based on the *Nomenclature des Activités Économiques dans la Communauté Européenne* (NACE). The substantial majority is concentrated in Europe, accounting for 95 percent of nonfinancial firms covered in our sample. It is important to note that the number of firms covered in the Orbis database varies from one year to another, increasing considerably after 2000. In terms of sectoral coverage, the dataset is based on the NACE classification of economic activities and covers nonfinancial sectors excluding agriculture, public administration and defense, activities of extraterritorial organizations and bodies, and activities of households as employers and for own use. Most of the firms in our sample operate in the wholesale and retail trade sector, accounting for about 31 percent of

observations, followed by services grouped together with 25 percent, manufacturing with 18 percent, and construction with 17 percent.

Table 2 presents descriptive statistics of all variables for the entire sample as well as subgroups of advanced and developing countries. Along with the firm-specific EMTR and TFP measures, we include several key firm characteristics, such as age (measured by the log of years since inception), size (measured as the log of total assets), profitability (measured by the ratio of profits after tax to total assets), capital intensity (measured by capital per worker), and leverage (defined as short-term and long-term debt over total assets). The nominal firm-level variables obtained from the Orbis database are deflated using industry-specific deflators drawn from the OECD STAN database for advanced economies and the UN National Accounts database for developing countries. As described above, the real capital stock is calculated using the perpetual inventory method, as the sum of previous period real fixed assets *minus* depreciation *plus* real fixed investment in the current period. As presented in Table 2, there are considerable variations in firm characteristics, including the EMTR, and macroeconomic features over the sample period from 1995 to 2015. In particular, the variance in the EMTR reflect differences in the composition of assets and source of financing at the firm level.

Table 2. Summary Statistics

Variable	All			Advanced			Developing		
	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.
Firm Characteristics									
Age [log]	20.91 ml	2.14	0.95	18.23 ml	2.21	0.95	2.68 ml	1.68	0.87
Size [log]	21.39 ml	13.55	2.33	18.49 ml	13.61	2.33	2.90 ml	13.17	2.33
Profitability	20.64 ml	0.01	0.21	17.84 ml	0.01	0.16	2.80 ml	0.01	0.40
Capital Intensity	21.45 ml	10.19	2.20	18.54 ml	10.15	2.19	2.91 ml	10.41	2.26
Leverage	17.02 ml	0.18	0.22	15.32 ml	0.18	0.23	1.70 ml	0.10	0.19
TFP [log]	21.45 ml	7.20	1.12	18.54 ml	7.19	1.11	2.91 ml	7.26	1.17
EMTR	16.39 ml	0.28	0.07	14.82 ml	0.29	0.06	1.57 ml	0.20	0.07

Source: Orbis; authors' calculation.

3. ECONOMETRIC METHODOLOGY

We focus on the impact of taxation on firms' survival prospects in a large panel of 4,026,648 firms from 21 countries over the period 1995-2015. We trace the span of survival for each firm over the sample period, and define the survival function as the probability of failure between time t and $t+1$ divided by the probability of surviving at least until t , for a given set of covariates. In line with the literature, we consider a firm as failed in a given year when its status is that of receivership, liquidation, or dissolved (Bunn and Redwood, 2003; Bridges and Guariglia, 2008; Helmers and Rogers, 2010). The observation period in this analysis takes into account both left truncation and right censoring since firms may remain in operation beyond the sample period. We use the year of first appearance in the dataset as the

time at which a firm becomes at risk of failure, and exclude observations when a firm drops out of the database. The survival function for firm i at any point of time $t > 0$ and $t = 1, \dots, T$ is assumed to take the proportional hazard form:

$$\theta_{it} = \theta(t) \cdot X'_{it}\beta$$

where $\theta(t)$ is the baseline hazard function and X_{it} is a series of time-varying covariates summarizing observed differences among firms (Cox, 1972; Cox and Oakes, 1984; Audretsch and Mahmood, 1995; Kleinbaum and Klein, 2005). In a panel setting, the discrete time formulation of the probability of failure is given by a complementary log-log model such as:

$$h_t(X_{it}) = 1 - \exp\{-\exp(X'_{it}\beta + \theta(t))\}$$

in which $h_t(X_{it})$ is the hazard rate at time t for firm i , $\theta(t)$ is the baseline hazard function, and X_{it} comprises a vector of firm characteristics. This discrete time version of the Cox proportional hazard model can be extended to account for unobserved but systematic differences among firms by describing unobserved heterogeneity by a random variable μ_i independent of X_{it} :

$$h_t(X_{it}) = 1 - \exp\{-\exp(X'_{it}\beta + \theta(t)) + \mu_i\}$$

where μ_i denotes an unobserved firm-specific error term with zero mean, uncorrelated with the X s. The complementary log-log model allows us to capture the exact time of failures and deal with the potential right-censoring bias and the endogeneity problem arising from simultaneity between the dependent and explanatory variables. Since our dataset is on an annual basis, the complementary log-log model is also more appropriate compared to the standard Cox model.

Focusing on the impact of corporate taxation on firms' survival prospects, we control for main firm characteristics comprising age, size, profitability, leverage, capital intensity, and productivity. We include sector and country fixed effects to account for unobserved time-invariant heterogeneity. This model can be estimated using standard random effects panel data methods for a binary dependent variable, assuming that the distribution of μ_i is normal. Robust standard errors are clustered at the firm level to account for the fact that observations pertaining to a firm are correlated and thus do not contain as much information as unclustered errors.

4. EMPIRICAL RESULTS

The estimation results, presented in Table 3, show that the corporate tax burden has a significant effect on firms' survival prospects. All variables included in the model have the expected sign with a high degree of statistical significance. Regarding the main variable of interest, we find that the coefficient on the corporate tax burden—measured by the firm-specific EMTR—exerts a positive and highly significant effect on the probability of failure.

In other words, a lower level of effective marginal tax rate increases the survival probability among nonfinancial firms in our sample. This finding is not only statistically but also economically important, and remains robust when we partition the sample into country subgroups. We run the estimation on separate samples and find that the effect of taxation on firm survival is significantly greater in developing countries than advanced economies. We dig deeper into the tax sensitivity of firm survival and discover a nonlinear relationship between the firm-specific EMTR and the probability of corporate failure. These results, presented in Table 4, show that the coefficient on EMTR turns negative when we include its squared value in the model along with other control variables. The coefficient on the EMTR squared, on the other hand, is highly significant and positive with greater economic magnitude. This implies that taxation becomes a detriment to firm survival at higher levels. While this pattern of nonlinear interactions remains intact for firms in advanced economies, the picture is completely different for firms in developing countries where the coefficients on EMTR and its squared term have the opposite values. This could be due to the limited number of observations—267,249 firms from developing countries compared to almost 2.3 million from advanced economies. More importantly, however, we suspect that bankruptcy procedures that tend to take an exorbitant amount of time in developing countries with inefficient bureaucracy and weak rule of law may distort the relationship between the tax burden and firm survival.

Table 3. Firm Survival—Baseline Estimations

Variables	All Countries	Advanced	Emerging
<i>Dependent variable: Probability of failure</i>			
Age	-0.297*** [0.002]	-0.296*** [0.002]	-0.214*** [0.008]
Size	-0.035*** [0.002]	-0.044*** [0.002]	0.054*** [0.005]
Profitability	-1.494*** [0.017]	-1.803*** [0.023]	-0.741*** [0.013]
Capital Intensity	-0.089*** [0.001]	-0.095*** [0.001]	-0.061*** [0.004]
TFP	-0.130*** [0.003]	-0.088*** [0.003]	-0.418*** [0.007]
Leverage	0.401*** [0.008]	0.361*** [0.009]	0.143*** [0.028]
EMTR	3.951*** [0.097]	3.943*** [0.113]	3.927*** [0.404]
# of observations	12,877,294	11,719,946	1,157,348
# of firms	2,555,686	2,288,437	267,249
# of failures	446,983	412,702	34,281
Fixed effects	Yes	Yes	Yes
Wald test	85,784	82,950	12,343
Log-likelihood	-4,435,071	-4,147,730	-281,918

Note: Standard errors clustered at the firm level are displayed in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Pertaining to the impact of firm characteristics, we obtain results in line with previous research in this area. First, the probability of firm survival increases with age and size, as indicated by the negative and statistically significant coefficients. Older and larger firms are better positioned to weather shocks compared to younger and smaller enterprises. However, while age has the similar effect on the incidence of corporate failure across all countries, firm size appears to have the opposite effect in the case of developing countries. These findings may reflect that the latter are likely to face a higher degree of asymmetric information problems and consequently a higher degree of financial constraints, especially in countries with undeveloped financial systems. Second, firms' survival prospects are greatly dependent on the financial health as measured by profitability and leverage. The probability of failure diminishes with the degree of profitability, but increases with the level of indebtedness. Both results are particularly more pronounced among nonfinancial firms in advanced economies. Third, in relation to firm structure and performance, we find that capital intensity and TFP play a significant role in reducing the hazard of failure among nonfinancial firms. These results, consistent across all countries, capture the contribution of greater scale economies and efficiency gains.

Table 4. Firm Survival—Nonlinear Effects of Taxation

Variables	All Countries	Advanced	Emerging
<i>Dependent variable: Probability of failure</i>			
Control variables	Yes	Yes	Yes
EMTR	-5.913*** [0.436]	-6.976*** [0.354]	4.064*** [0.802]
EMTR ²	20.122*** [0.904]	22.182*** [0.626]	-0.242 [1.576]
# of observations	12,877,294	11,719,946	1,157,348
# of firms	2,555,686	2,288,437	267,249
# of failures	446,983	412,702	34,281
Fixed effects	Yes	Yes	Yes
Wald test	86,177	84,900	12,363
Log-likelihood	-4,434,475	-4,147,067	-281,918

Note: Standard errors clustered at the firm level are displayed in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

We conduct several robustness checks to verify our findings, and to attain a more nuanced picture of how taxation affects the incidence of corporate failure. Having identified a significant connection between the tax burden and firm survival, we explore more in detail whether the pattern and magnitude of this relationship differ when we differentiate between types of firms.

- First, we classify a firm as young (or old) if its age falls into the bottom (or top) half of the age distribution of all firms operating in the same industry in that year, and, as presented in Table 5, find that the magnitude of the coefficient on EMTR for old firms is almost five times greater than that for young firms. In other words, taxation has a significantly greater effect on the probability of failure as firms age over time.
- Second, we split the sample into small and large firms by classifying companies with total assets in the lowest quartile as small and those in the highest quartile as large, and, as displayed in Table 5, find that the tax burden has a greater adverse impact on firm survival among large firms than smaller enterprises and relative to the baseline coefficient estimate.
- Third, estimating the probability of firm failure at the sectoral level, we observe a significant degree of heterogeneity in the impact of taxation. As presented in Table 6, while the coefficient on the firm-specific EMTR is consistently positive and statistically significant across all sectors (except real estate), its magnitude varies from the minimum of 1.6 for accommodation and food services to the maximum of 8.7 for information technology and manufacturing. These results indicate that the corporate tax burden has a greater impact on the survival prospects of firms operating in capital intensive sectors such as information technology and manufacturing.

- Fourth, we introduce a personal income tax (PIT) rate to control for its potential impact, since employees may gain from a more favorable rate by moving their earnings into or from the corporate tax base. These results, presented in Appendix Table A2, show that the effect of EMTR on firm survival remains negative and significant even when we include the PIT rate as an additional control variable.
- Fifth, we estimate the probability of firm survival using alternative methodologies, including accelerated failure time (AFT) models. As opposed to Cox proportional hazard model, in which covariates have a uniform shift effect on the survival curve, the AFT models allow covariates to have a multiplicative effect on the survival time (Orbe and others, 2002; Patel and others, 2006; Ali and others, 2015). These findings, presented in Appendix Table A2, are consistent with our baseline findings.
- Lastly, we estimate the multilevel mixed-effects parametric survival model with both fixed effects and random effects, which is not possible in the Cox and AFT models because of computational limitations. These results, also presented in Appendix Table A2, are in line with the baseline findings (based on the Cox proportional hazard model) and other robustness checks.

Table 5. Firm Survival—Effects of Age and Size

Variables	Young	Old	Small	Large
<i>Dependent variable: Probability of failure</i>				
Age	-0.285*** [0.004]	-0.187*** [0.006]	-0.216*** [0.003]	-0.378*** [0.004]
Size	-0.016*** [0.002]	-0.055*** [0.002]	-0.125*** [0.005]	0.079*** [0.005]
Profitability	-1.455*** [0.015]	-1.562*** [0.018]	-1.089*** [0.012]	-4.698*** [0.045]
Capital Intensity	-0.094*** [0.002]	-0.082*** [0.002]	-0.048*** [0.002]	-0.087*** [0.003]
TFP	-0.081*** [0.004]	-0.184*** [0.004]	-0.154*** [0.005]	-0.023*** [0.006]
Leverage	0.318*** [0.010]	0.519*** [0.012]	0.267*** [0.011]	0.526*** [0.017]
EMTR	1.458*** [0.149]	6.494*** [0.149]	3.472*** [0.185]	4.132*** [0.192]
# of observations	5,394,715	7,482,579	2,344,254	3,662,299
# of firms	1,707,355	1,371,568	879,179	739,288
# of failures	235,760	211,223	126,153	92,031
Fixed effects	Yes	Yes	Yes	Yes
Wald test	37,803	29,729	23,731	25,719
Log-likelihood	-2,141,818	-1,989,740	-1,055,296	-790,808

Note: Standard errors clustered at the firm level are displayed in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 6. Firm Survival—Estimations by Sector

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
<i>Dependent variable: Probability of failure</i>									
Age	-0.383*** [0.007]	-0.338*** [0.005]	-0.379*** [0.012]	-0.243*** [0.004]	-0.338*** [0.007]	-0.319*** [0.012]	-0.278*** [0.010]	-0.244*** [0.027]	-0.285*** [0.004]
Size	-0.119*** [0.006]	-0.004 [0.004]	-0.020*** [0.007]	-0.026*** [0.004]	0.009** [0.005]	0.025*** [0.008]	-0.052*** [0.009]	0.020 [0.019]	-0.032*** [0.003]
Profitability	-1.044*** [0.027]	-1.689*** [0.040]	-1.298*** [0.076]	-1.897*** [0.051]	-1.302*** [0.036]	-1.088*** [0.064]	-1.448*** [0.079]	-1.257*** [0.096]	-1.449*** [0.036]
Capital Intensity	-0.063*** [0.005]	-0.105*** [0.003]	-0.012* [0.007]	-0.102*** [0.004]	-0.043*** [0.004]	-0.127*** [0.006]	-0.118*** [0.006]	-0.050*** [0.017]	-0.088*** [0.002]
TFP	-0.357*** [0.012]	0.049*** [0.007]	0.015 [0.013]	-0.270*** [0.010]	-0.063*** [0.007]	-0.042*** [0.010]	-0.018* [0.010]	-0.103*** [0.035]	-0.301*** [0.008]
Leverage	0.155*** [0.018]	0.608*** [0.020]	0.335*** [0.046]	0.453*** [0.020]	0.186*** [0.028]	0.192*** [0.044]	0.282*** [0.041]	0.219** [0.105]	0.395*** [0.014]
EMTR	1.551*** [0.252]	1.224*** [0.267]	8.701*** [0.744]	8.667*** [0.259]	5.681*** [0.336]	-0.055 [0.387]	7.928*** [0.497]	3.183*** [1.201]	3.145*** [0.167]
# of observations	869,025	2,135,058	414,096	2,972,510	1,181,842	369,748	591,338	110,736	4,232,941
# of firms	201,373	449,297	93,164	498,552	278,009	89,263	117,346	20,704	807,978
# of failures	34,970	89,114	15,634	91,824	38,850	12,721	18,001	2,547	143,322
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wald test	13,026	18,487	2,254	19,227	5,208	2,809	3,832	372	33,019
Log-likelihood	-329,812	-902,116	-129,581	-928,259	-361,147	-103,316	-153,248	-16,892	-1,505,110

Note: Standard errors clustered at the firm level are displayed in brackets. *** p<0.01, ** p<0.05, * p<0.1. The columns represent the following sectors: (1) Accommodation and food services, (2) Construction, (3) Information technology, (4) Manufacturing, (5) Professional and administrative activities, (6) Real estate, (7) Transportation and storage, (8) Utilities, (9) Wholesale and retail trade. The mining sector is excluded due to the small number of firm-year observations.

5. CONCLUSION

There is a vast and growing literature on corporate failures, but no paper has analyzed the quantitative effect of tax burden on firms' survival prospects in a broad panel of advanced and developing countries. In this paper, we analyze the probability of failure among more than 4 million nonfinancial firms from 21 countries during the period 1995–2015, using a Cox proportional hazard model and controlling for firm characteristics and systematic differences across sectors and countries. The results indicate that the corporate tax burden—as measured by the firm-specific EMTR—exerts a highly significant adverse effect on companies' survival prospects with a non-linear pattern. Put differently, a lower level of EMTR increases the survival probability among nonfinancial firms in our sample. This finding is not only statistically but also economically important and remains robust when we partition the sample into country subgroups. We run the estimation on separate samples and find that the adverse effects of taxation on firms' survival prospects appears stronger in developing countries than advanced economies, but data constraints limit the extent of the analysis.

We provide quantitative evidence that the impact of taxation on firm survival becomes detrimental at higher levels. Digging deeper into the tax sensitivity of firm survival, we uncover a nonlinear relationship between the firm-specific EMTR and the probability of corporate failure, which implies that taxation becomes a detriment to firm survival at higher levels. With regards to the impact of other firm characteristics, we obtain results that are in line with previous research, and see that survival probability differs depending on firm age and size, with older and larger firms experiencing a lower risk of failure. Focusing on the financial health, we find that the probability of failure diminishes with the degree of profitability, but increases with the level of indebtedness. Similarly, concerning firm structure and performance, we document that capital intensity and TFP play a significant role in reducing the probability of failure among over 4 million nonfinancial firms in the sample.

The empirical analysis presented in this paper demonstrate that taxation unmistakably plays an important role in determining the pattern of failures among nonfinancial firms across advanced and developing countries. This finding has important policy implications for the design of tax systems, since the firm-specific EMTR encapsulates not only the differences in the overall tax burden across countries, but also the discriminatory nature of tax regimes across sectors and types of firms. Therefore, the challenge for policymakers is not simply reducing the statutory CIT rate, but to level the playing field for all firms by rationalizing differentiated tax treatments across sectors, capital asset types and sources of financing.⁶

⁶ As argued in IMF (2017), the complete elimination of differences in tax treatments across firms is not feasible or desirable, as tax policy should aim to influence resource allocation when firms ignore externalities such as excessive carbon emissions or underinvestment in research and development.

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Appendix Table A1. List of Countries

Country	Number of firms	Percent of total number of firms	Number of observations	Percent of total number of observations
<i>Advanced Economies</i>				
Belgium	22,340	0.6	173,927	0.8
Czech Republic	100,705	2.5	582,179	2.7
Estonia	35,130	0.9	238,723	1.1
Finland	87,472	2.2	527,078	2.5
France	739,297	18.4	3,755,091	17.5
Germany	43,556	1.1	163,211	0.8
Italy	774,463	19.2	4,186,215	19.5
Korea	190,408	4.7	680,180	3.2
Norway	76,930	1.9	111,179	0.5
Portugal	261,315	6.5	1,383,457	6.5
Slovak Republic	66,949	1.7	339,876	1.6
Slovenia	37,940	0.9	166,070	0.8
Spain	831,494	20.7	5,285,465	24.6
Sweden	142,390	3.5	949,769	4.4
Subtotal	3,410,389	84.7	18,542,420	86.4
<i>Emerging Economies</i>				
Bulgaria	59,108	1.5	248,636	1.2
Croatia	83,238	2.1	592,858	2.8
Hungary	18,899	0.5	59,009	0.3
Poland	42,045	1.0	119,216	0.6
Romania	296,735	7.4	1,444,237	6.7
Serbia	53,171	1.3	244,295	1.1
Ukraine	63,063	1.6	200,054	0.9
Subtotal	616,259	15.3	2,908,305	13.6
Total	4,026,648	100.0	21,450,725	100.0

Source: Orbis; authors' calculation

Appendix Table A2. Robustness Checks

Variables	Alternative Models			Additional Controls	
	Gompertz (PH)	Exponential (PH/AFT)	Log-logistic (AFT)	PIT	Mixed Effects
Age	-0.396*** [0.003]	-0.306*** [0.002]	-0.427*** [0.002]	-0.267*** [0.003]	-0.188*** [0.002]
Size	0.053*** [0.002]	0.046*** [0.002]	0.064*** [0.002]	0.017*** [0.002]	0.016*** [0.008]
Profitability	-1.397*** [0.029]	-1.413*** [0.030]	-1.762*** [0.008]	-1.448*** [0.015]	-1.689*** [0.007]
Capital Intensity	-0.112*** [0.001]	-0.103*** [0.001]	-0.088*** [0.001]	-0.098*** [0.001]	-0.088*** [0.001]
TFP	-0.160*** [0.003]	-0.155*** [0.003]	-0.092*** [0.002]	-0.196*** [0.002]	-0.168*** [0.002]
Leverage	0.188*** [0.011]	0.189*** [0.010]	0.108*** [0.006]	0.240*** [0.008]	0.389*** [0.007]
EMTR	9.366*** [0.105]	7.986*** [0.058]	8.560*** [0.058]	7.072*** [0.067]	5.578*** [0.030]
PIT rate				0.032*** [0.000]	
# of observations	11,639,304	11,639,304	11,639,304	11,401,501	11,639,304
# of firms	2,380,710	2,380,710	2,380,710	2,297,867	2,380,710
# of failures	667,550	667,550	667,550	429,747	667,550
Cluster	Firm	Firm	Firm	Firm	
Wald test	111,685	170,362	335,391	116,671	253,034
Log-likelihood	-1,761,534	-1,770,586	-1,721,012	-4,202,494	-4,055,095

Note: Standard errors are displayed in brackets. *** p<0.01, ** p<0.05, * p<0.1. PH denotes the proportional hazards model; AFT denotes the accelerated failure time model.