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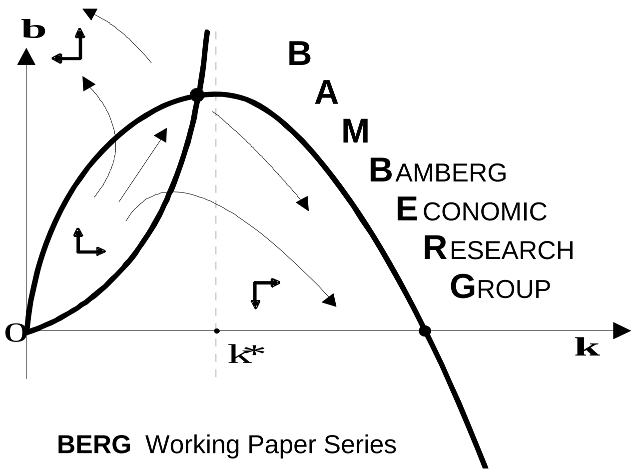

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Survival and the ergodicity of corporate profitability *

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October 2, 2020

Abstract

The cross-sectional variation in corporate profitability has occupied research across fields as diverse as strategic management, industrial organization, finance, and accounting. Prior work suggests that industry affiliation as well as different forms of corporate idiosyncrasies are important determinants of profitability, but it disagrees widely on the quantitative importance of particular effects. This paper shows that industry and corporate specificities become irrelevant in the long run because profitability is ergodic conditional on survival, implying that there is a uniform, time-invariant regularity in profitability that applies across firms. Conditional on survival, we cannot reject the hypothesis that corporations are on average equally profitable and also experience equally volatile fluctuations in their profitability, irrespective of their individual characteristics. The same is not true for shorter-lived firms, even for up to 20 years after entry or before exit, and would explain the contradictory findings in the extant literature, which usually considers samples containing heterogeneous mixtures of surviving and shorter-lived companies. Therefore the mere fact of survival, rather than any previously suggested set of variables, becomes the only relevant information for corporate profitability in the long run.

JEL classifications: C14, L10, D21, E10.
Keywords: Performance, dynamic competition, corporate strategy, stochastic differential equation.

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1 Introduction

We answer the question how or whether corporate idiosyncrasies affect profitability, finding that idiosyncracies do correlate with profitability for shorter-lived firms but surprisingly have no impact for surviving firms, whose profitability is ergodic. Here ergodicity refers to the fact that we cannot statistically distinguish the parameters and moments of the cross-sectional distribution of survivors' profit rates from the parameters and moments governing their individual profit rate time series, implying not only that survivors exhibit the same profitability on average, but that they also experience equally volatile fluctuations in their profitability. This finding stands in sharp contrast to an extensive literature across fields as diverse as strategic management, industrial organization, finance, and accounting, which has investigated the dynamics and cross-sectional properties of corporate profitability, seeking to identify robust regularities that provide guidance for management decisions, improve analysts' forecasts, and inform policy recommendations. After decades of empirical research, the extant literature concludes that various idiosyncrasies, particularly year, industry, corporate-parent, and business-unit specificities have a systematic influence on profitability and imply persistent cross-sectional variation in firms' profit rates. Yet it disagrees widely on the quantitative importance of particular effects because the established patterns are unstable in the sense that they are neither invariant over time nor across firms. The identification of stable and invariant regularities, however, is required to set up universal, quantitative, and predictive models of corporate profitability across firms and time. So contrary to perceived wisdom, we argue here that conditional on survival such a stable regularity in corporate profitability indeed exists, and is independent of firms' individual characteristics.

Since the perpetual flux of companies into and out of the market apparently obscures this regularity in corporate profitability, our empirical analysis emphasizes the destinies of surviving corporations to uncover it. In spite of the fact that few corporations survive the proverbial gales of creative destruction for more than a couple of decades (Fama and French, 2004), it seems that creative destruction occurs more in name than in substance because transfers of ownership are responsible for the vast majority of corporate 'mortality,' while bankruptcy and liquidation historically account for merely eight percent of corporate deaths (Daepp et al., 2015). This leads to a striking continuity in corporate capital over time and renders surviving firms as worthwhile objects of economic investigation. Moreover, according to the granular hypothesis in recent macroeconomics (Acemoglu et al., 2012; Gabaix, 2011), long-lived corporations are also relevant for understanding how sizable economy-wide fluctuations can arise from idiosyncratic shocks to the largest and most interconnected firms in the economy. Concerns of survivorship bias, however, have traditionally prevented exclusive interest in the subset of long-lived firms, and so far we know surprisingly little about the granular capital that has accumulated over time in surviving corporations.[1] To fill this void, Alfarano et al. (2012) and Mundt et al. (2016) have recently begun to investigate the distributional and time series properties of long-lived corporations' profit rates, finding them to be remarkably stable both over time and across firms.

Building on this observation, the purpose of the present paper is a careful statistical analysis of three phenomena that relate to this finding. First, using a heterogeneous sample of firms across nearly all industries of the US economy, we show that firm-specific estimates of average profitability and volatility converge to the cross-sectional expectation and dispersion of profit rates when the (time) distance to entry and exit becomes sufficiently large. This finding has its origin in the ergodic property of profit rates, that is to say that cross-sectional and time series moments are the same when the number of observations in both dimensions goes to infinity. The validity of the ergodic hypothesis entails a fundamental change in the modeling of corporate profitability because, under ergodicity, the cross-sectional moments of a given year reflect what happens to an individual firm as time passes, implying that a dynamic characterization of corporate profitability can be replaced with a simpler probabilistic description that is time-invariant (see Peters, 2019, for a recent discussion of ergodicity and the historical disregard for it in most economic models).[2] Actually, we are not aware of any other economic or financial observable that exhibits this peculiar property.[3] Thus, the profit rate, which transforms the (non-ergodic) level of operating income into an ergodic observable by dividing through (non-ergodic) total assets, strikes us as the relevant and most appropriate quantity to describe the system of competitive firms in terms of a universal, time-independent regularity. Second, as

[1]As far as corporate survival is concerned, the contested questions have typically revolved around whether executives prioritize the maximization of profits over survival or whether they even care for corporate survival. Recent contributions show that survival is both of theoretical and empirical relevance; Dutta and Radner (1999) demonstrate under reasonably weak assumptions that profit-maximizing corporations will go bankrupt almost surely in finite time such that over longer horizons none of the surviving firms could have been maximizing profits, while Oprea (2014) shows in a closely related experimental setup that individual subjects exhibit a widespread bias towards survival even after controlling for standard risk aversion.

[2]Mundt et al. (2020) show how one can exploit this property to obtain more accurate forecasts of corporate profitability.

[3]This is even true for variables that have a defining effect on the profit rate; for instance, neither asset turnover nor profit margin, the product of which is the profit rate, are ergodic because they depend (amongst others) on the industry of a particular firm.

a corollary to the ergodic hypothesis, the evolution of surviving firms' profit rates is well described by one and the same stochastic differential equation (SDE), first introduced in Alfarano et al. (2012). We interpret this SDE as a reduced-form model of competition in the classical sense of a perpetual reallocation of capital in search of abnormal profits, ultimately resulting in the dispersion of profit rates around a systemic rate of profit. Based on a parametric test and regression analyses, we use the parameter estimates of this process to test the stark and unexpected implication of our model that corporate idiosyncrasies are irrelevant for the time evolution of surviving corporations' profitability. We find that there are indeed a uniform long run average rate of profit and even a uniform volatility for surviving capital, irrespective of individual corporate characteristics. Third, we reconcile our findings with previous work by investigating whether the profitability of shorter-lived firms is also independent of idiosyncrasies. In contrast to long-lived firms, we do find dependencies between profitability and corporate characteristics for shorter-lived firms, explaining the contradictory findings in the extant literature that usually considers samples containing heterogeneous mixtures of surviving and shorter-lived companies.

Our investigation of the dynamics and cross-sectional properties of corporate profitability relates to different strands of the literature studying the determinants of performance. The classical industrial organization perspective, which dates back at least to Bain (1951, 1956) and Mason (1949), argues that structural industry characteristics lead to persistent profit rate variation across firms. According to the so-called structure-conduct-performance paradigm (SCP), firms operating in industries with high seller concentration, economies of scale, and with significant entry and exit barriers that restrict free capital mobility, will be more profitable on average than companies in more atomistic industries due to weaker rivalry or tacit collusion. An opposing view within the field of industrial economics, later coined the revisionist approach by Schmalensee (1985) and Amato and Wilder (1985), emphasizes the impact of inter-firm differences in productive efficiencies to explain intra-industry variation in profitability (Demsetz, 1973; Stigler, 1963). Like the SCP paradigm, this approach predicts a positive correlation between concentration and profitability. Unlike the classical view, however, this perspective argues that disproportionally productive companies grow faster than their competitors, leading to higher market shares, concentration, and excess profitability. Therefore, variation in profitability does not necessarily reflect market power or collusive behavior, but instead originates in productivity and size differences among firms.

The management literature emphasizes the influence of resources, strategies, capabilities and the role of competitive positioning to explain differential performance.[4] Resource-based theories (see, e.g., Barney, 1991; Barney et al., 2011; Barney, 2001; Levinthal, 1995; Peteraf, 1993; Teece, 2007; Wernerfelt, 1984) argue that a sustainable competitive advantage may arise from the possession of organizational, financial, technological, or intellectual resources which are valuable, rare, and imperfectly imitable by the competitors. Consequently, excess profitability can be interpreted as a Ricardian rent obtained from the exploitation of such resources, and the persistence of cross-sectional variation in profitability depends on the existence of appropriate isolation mechanisms (e.g. patents) to exclude other companies from these resources. Referring to arguments originating in both resource-based theory and industrial organization, persistent cross-sectional variation in profitability has also been attributed to corporate-parent and business effects. While the former arise when the profitability of a firm is determined by its pattern of diversification and the performance of member businesses, the latter originate in the variety of factors influencing strategy and organization (McGahan and Porter, 2003). The view that firm idiosyncrasies, mostly financial characteristics, have a defining effect on corporate profitability is also prevalent in accounting and finance (e.g., Fairfield et al., 2009; Fama and French, 2000). It is widely perceived that the risk aversion of capital providers should imply an equilibrium structure of profit rates that implies a higher average return as a compensation for investors' willingness to bear additional risk.

Several studies have examined the quantitative importance of year, industry, corporate-parent, and business effects, mostly using variance decomposition techniques (see, e.g., Bowman and Helfat, 2001; Goddard et al., 2009; McGahan and Porter, 2002; Misangyi et al., 2006; Ruefli and Wiggins, 2003; Rumelt, 1991; Schmalensee, 1985), and have yielded varying conclusions about the relative contribution and importance of such effects.

In contrast to the prevailing view that corporate idiosyncrasies are important for profitability, the main contribution of the present study is to show empirically that the profitability of surviving capital obeys a universal and time-invariant 'law.'

The remainder of this article is structured as follows. Section 2 introduces the data. Section 3 motivates the ergodic hypothesis by comparing the cross-sectional and time series properties of profit rates conditional on the time that firms survive in the market. Section 4 presents the reduced-form model that is consistent with the ergodic

[4] It is noteworthy that a clear demarcation line between the different approaches is sometimes absent. The management literature, for instance, also acknowledges the influence of industry structure on profitability via its defining effect on competitive strategy (see, e.g., the seminal 5-forces model by Porter, 1980).

hypothesis, and tests for a common parametrization of the process across surviving firms. In Section 5, we compare the impact of idiosyncrasies on profitability for surviving and shorter-lived firms using regression analysis. Finally, we discuss our results in Section 6.

2 Data

Our data come from the commercial Datastream Worldscope database and consist of 5,313 US companies whose equity is publicly traded in US stock markets. The unbalanced sample covers the period 1980-2012 and includes companies operating in one of 610 4-digit SIC industries. From these we merely exclude banking corporations because their balance sheets differ structurally from other industries, which reduces the sample size by less than 1% to 5,266 firms, with a total of 75,692 firm-year observations. Depending on the year, the number of companies in the sample varies between 543 in 1980 and 4,249 in 2008, with an average of 2,293 observations per year. Considering the individual time series, the average firm remains in the surveyed population for approximately 14 years, and 498 corporations in the sample survive over the entire period 1980-2012. These 498 firms, while merely representing 9.5% of firms in the sample, on average account for 72% of total assets, 75% of market capitalization, and 74% of employment in the entire sample.

At the center of our investigation are annual corporate profit rates, measured by the return on assets, i.e. the ratio of operating income to total assets in a given year, and hereafter denoted by $x \in \mathbb{R}$. Regarding individual corporate characteristics, we retrieve additional variables including common equity, total liabilities consisting of long-term and short-term debt, sales, number of employees, and stock market prices. To investigate the effect of industry concentration on corporate profitability, we employ 4-digit SIC codes.

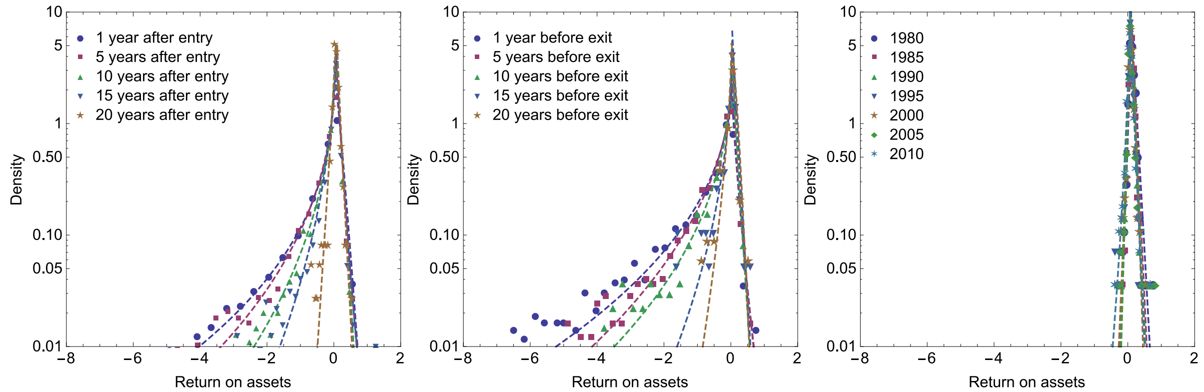
The available time series cover more than three decades of firm history, enabling us to uncover the long run regularities of corporate profitability by studying firms that survive in the market during this period. While concerns of survivorship bias have obstructed exclusive interest in these long-lived firms, the explicit focus on surviving (and mostly granular) capital is a major novelty in the present study. The number of observations in the time domain also implies that the sample includes different phases of the business cycle, refuting potential concerns that our results are driven by the choice of the sample period. In addition to surviving corporations, the sample also includes a large number of shorter-lived firms with heterogeneous lifespans, allowing us to compare the behavior of surviving capital to that of entering and exiting firms. As we will argue below, sample heterogeneity is crucial for understanding the divergent views between our study and prior work on how or whether idiosyncrasies affect corporate profitability. Finally, the sample covers a wide range of different industries and therefore provides a comprehensive view of the US economy.

3 Corporate survival and the ergodic hypothesis

This section discusses the ergodic hypothesis for the profitability of surviving capital, which is also the basis of our reduced-form model in Section 4. The notion of ergodicity implies that all existing cross-sectional and time series moments are the same when the number of observations in both dimensions grows sufficiently large. To illustrate the empirical relevance of ergodicity for the present data, we approach the firms in our sample from a time series and a distributional perspective, paying careful attention to the role of survival for the observed regularities. These two alternative perspectives provide complementary views on the profitability of companies. While the cross-sectional profit rate distribution defines the space of possible outcomes and their respective probabilities at a given point in time, the profit rate time series is a more relevant source of information for stakeholders as it captures what happens to the individual firm over time. Notice that cross-sectional moments, e.g. the expected value, are irrelevant to the single firm in non-ergodic systems because the states of other firms are inaccessible, as noted by Peters (2019).

Let $T = 33$ denote the maximum length of the time series, while $L \leq T$ is the number of years that a firm is present in the data set. In Fig. 1 we start out by considering the cross-sectional profit rate distribution for three different groups of firms. Fig. 1 (a) shows the distribution for relatively young companies, say $\tau = \{1, 5, 10, 15, 20\}$ years after entry, while Fig. 1 (b) illustrates the profit rate distribution for exiting firms with $\theta \equiv L - \tau$ years before they leave the sample. Both distributions are heavily skewed and reasonably well approximated by the family of asymmetric exponential power (AEP) distributions, introduced by Bottazzi and Secchi (2011) and formally defined in Eq. (4) in Appendix A.1.[5] The negatively skewed and leptokurtic shape of these densities suggests that the profit rates of entering and exiting companies are widely dispersed, consistent with the popular view that profitability exhibits substantial cross-sectional variation. These firms report disproportionately many extreme profit rates, particularly in the left

[5] See Mundt and Oh (2019) for a derivation of this distributional regularity in a statistical model of competitive firms.



(a) Entering firms **(b)** Exiting firms **(c)** Surviving firms

Figure 1: Cross-sectional distributions of profit rates for US non-bank corporations. Panel (a) considers entering firms, while panel (b) focuses on exiting companies. The former are identified as those companies which do not report data for the first year of the sample period, 1980, while the latter do not report data for the last year, 2012. Panel (c) shows the distribution conditional on survival over the entire sample period. The dashed lines illustrate a fit of the asymmetric exponential power distribution (Appendix A.1) to the data. We cannot reject the hypothesis that the distribution of profit rates is symmetric for surviving firms at conventional significance levels.

tail.[6] It is noteworthy that the fat left tail does not merely prevail for the year immediately after entry or before exit, but instead characterizes the cross-sectional distribution for more than two decades after or prior to these events. With the survival time τ growing large, however, the dispersion in the left tail declines and the cross-sectional density converges to a more symmetric and less fat-tailed distribution, which implies both an increase of expected profitability and a decline of cross-sectional variation.

Fig. 1 (c) illustrates the cross-sectional profit rate distribution for the 498 incumbent corporations that survive in the market over the entire period 1980-2012 for 7 different years of the sample period (other years exhibit virtually identical patterns). All these distributions are well approximated by the symmetric double-exponential (or Laplace) distribution

$$L(x; m, \sigma) = \frac{1}{2\sigma} \exp\left(-\left|\frac{x-m}{\sigma}\right|\right), \tag{1}$$

which is a nested special case of the AEP distribution in Eq. (4).[7] Both the functional form and parametrization of the distribution in Fig. 1 (c) are largely stable over time,

[6]Considering numerical estimates of the mean absolute deviation of profit rates above and below the mode m, we find that the dispersion in the left tail exceeds that in the right tail by at least one order of magnitude.

[7]See Mundt et al. (2020) for more formal tests of this property.

suggesting that this cross-sectional distributional regularity represents a stationary outcome. We can therefore pool the profit rates of surviving firms across all years and, again, obtain strong evidence for a Laplace distribution (not shown) with pooled parameter values $\hat{m} = 0.0947 \pm 0.0006$ and $\hat{\sigma} = 0.0581 \pm 0.0005$, which are henceforth referred to as the phenomenological values of the location and scale parameters. These estimates imply that the median profit rate of surviving corporations is 9.5% per year, along with a mean absolute deviation of approximately 6%.[8]

A complementary perspective to the cross-sectional analysis is provided in Fig. 2, which shows estimates of the average profit rate and its volatility obtained from individual time series as a function of τ and θ.[9] Perhaps somewhat surprisingly, we find that the average firm has to operate in the market for more than 20 years for its median profit rate to eventually turn positive, suggesting that survival confers a considerable premium on corporate profitability.[10] Moreover, as in the cross-sectional analysis, we observe that survival reduces volatility in profit rates, mainly through a reduction of fluctuations below the measure of central tendency, implying a negative relationship between volatility and average returns. This is reminiscent of the risk-return paradox initially described by Bowman (1980), as it challenges the conventional view that risk must carry its own reward. Economic explanations for this phenomenon range from the existence of superior managerial conduct and strategic and organizational factors (Andersen et al., 2007) to arguments originating in prospect theory, according to which managers' risk attitudes vary with performance in such a way that individuals are risk-averse when expected profits are high, and risk-seeking when business prospects are negative (Fiegenbaum and Thomas, 1988). Moreover, consistent with our empirical results in this section, Henkel (2009) provides a statistical argument whereby the skewness of the return distribution has a considerable yet spurious effect on the empirically estimated mean-variance relationship. The most fundamental result is, however, that individual estimates of average profitability and volatility converge to the cross-sectional moments (graphically illustrated as dashed lines in Fig. 2) for increasing values of τ. While this finding is consistent with the

[8]Median and mean absolute deviation from the median are the maximum likelihood estimates of m and σ for a symmetric Laplace distribution (see, e.g., Kotz et al., 2001).

[9]To facilitate comparison with the cross-sectional findings in Fig. 1, we use the median and mean absolute deviation as measures of central tendency and volatility.

[10]Similarly, Coad et al. (2013) report that old firms are more profitable on average than young firms. In their paper, the increase of profitability over the life-span of firms essentially reflects a positive size effect because old firms tend to be larger than young firms. This argument would be consistent with the "granular" hypothesis of surviving capital, and perhaps even indicates that size increases the probability to survive.

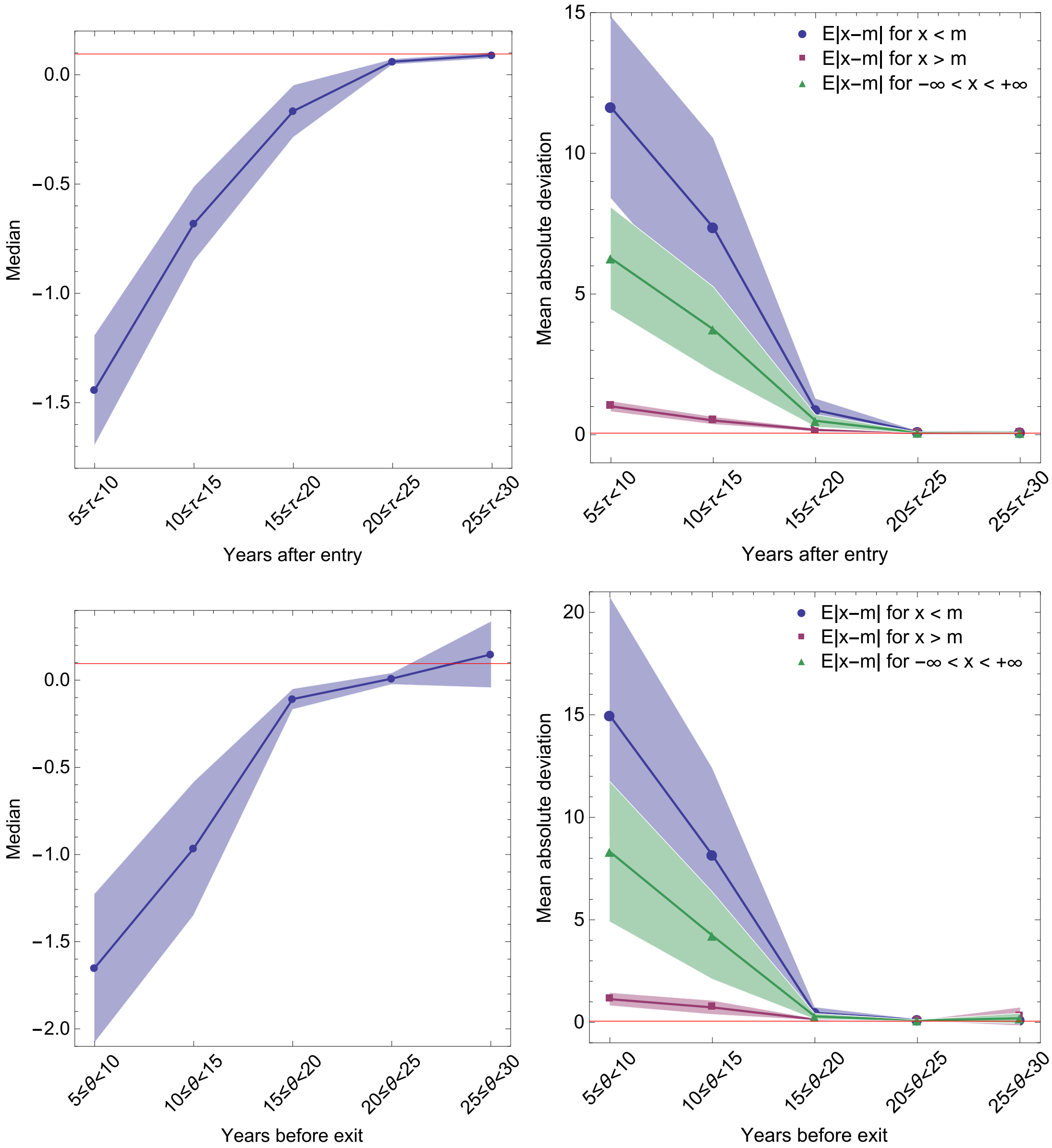


Figure 2: Time series median and conditional mean absolute deviation from the median profit rate as a function of years after entry and before exit. Conditional volatility considers observations from an individual time series that are either above or below the median, while neglecting the others. Markers represent the average observation in each bin, while error bars illustrate two standard deviations. The red horizontal lines represent the phenomenological values $\hat{m} = 0.0947 \pm 0.0006$ and $\hat{\sigma} = 0.0581 \pm 0.0005$ obtained from the pooled cross-sectional profit rate distribution.

ergodic hypothesis, it is ultimately at odds with the view that average profitability and volatility vary systematically due to industry, corporate, or business effects because the cross-sectional distribution of profit rates would not be representative of individual profit rate series in the presence of such idiosyncrasies. Entering and exiting firms, on the other hand, exhibit significant variation in their time series moments as shown in Fig. 2, implying that ergodicity only applies to surviving capital.

Two additional remarks are in order. First, as the profit rates of both entering and exiting firms in Fig. 1 (a)-(b) exhibit similar distributional regularities, the shape of the asymmetric exponential power distribution does not originate in a small sample bias. If this were the reason for the observed regularity, the profit rates of relatively old yet disappearing firms would be a symmetric Laplacian even before exit. Second, the monotonic convergence of the cross-sectional distribution towards a symmetric density indicates that the Laplacian nature of surviving firms' profit rates does not arise from innate characteristics of these companies, but instead probably reflects some "acquired" properties of surviving capital that separate it from short-lived firms. Building on the Laplacian shape of the profit rate distribution and the ergodic property of surviving capital, the next section reviews a stochastic process for the individual evolution of profit rates that enables us to test whether the ergodic hypothesis provides an accurate description of survivors' profitability.

4 Reduced-form model

This section reviews a relatively general model of corporate profitability, originally proposed by Alfarano et al. (2012), that is consistent with the ergodic profitability of survivors. The model encodes the reduced-form dynamics of profitability for surviving corporations through a mean-reverting stochastic differential equation (SDE) built on the classical idea that competition tends to equalize profit rates. As we will see momentarily, the notion of ergodicity implies a specific parametrization of the SDE by prescribing a common central tendency and volatility for all surviving firms, irrespective of their individual characteristics.

The number of stochastic processes that have the Laplace distribution in Eq. (1) as its stationary density is in principle infinite. Heeding the dictum of parsimony and relying on a considerable analytical apparatus that is in place for SDEs, Alfarano et al.

(2012) construct the following linear SDE for the time evolution of profit rates $\{X_t\}_{t=0}^T$ for firm i

$$dX_{i,t} = -\frac{D_i}{2\sigma_i}\,\mathrm{sgn}(X_{i,t} - m_i)dt + \sqrt{D_i}\,dW_t \tag{2}$$

such that it results in a stationary Laplace density. Eq. (2) defines a regular diffusion on the real line around the measure of central tendency m_i with dispersion σ_i, where the constant diffusion function $\sqrt{D_i}$ that scales the Wiener increments dW_t determines how rapidly the process fluctuates. From an economic viewpoint, the process can be interpreted as a reduced-form model of dynamic competition in the classical sense of a perpetual reallocation of capital in search of abnormal profits, which leads to a tendency for profit rate equalization that is captured by the mean-reverting first term. The functional form of the stationary Laplace distribution in Eq. (2) implies that the systematic drift toward average profitability is constant and equal to $D_i/2\sigma_i$, while its sign depends on the difference between current and average profitability via the signum function. The stochastic innovations from the diffusion function in the second term are interpreted as idiosyncratic corporate efforts in the competitive process. Notice that the level of idiosyncratic noise D_i shows up in both the deterministic drift and the random diffusion function, indicating that idiosyncratic efforts and the tendency for profit rate equalization are intertwined aspects of the same competitive mechanism. On the other hand, the idiosyncratic noise is "washed out" over time (for survivors) as D_i does not affect the stationary outcome in Eq. (1), yet it is still crucial for the competitive mechanism because eliminating the noise by setting $D_i = 0$ leads to a degenerate limit where all survivors are equally profitable and experience no fluctuations over time.

The distributional regularity in Eq. (1) refers to cross-sectional data, while Eq. (2) describes the time evolution of profitability for an individual firm, so we close the model by assuming that the cross-sectional and time series moments are identical, i.e. $m_i = m$ and $\sigma_i = \sigma \ \forall i = 1, \ldots, N$. This is the ergodic hypothesis, and leaves D_i as the only source of idiosyncratic variation in the time evolution of profitability. To test the empirical validity of the ergodic hypothesis, we estimate the three parameters of the SDE with maximum likelihood, making use of the fact that the solution to the pertinent Kolmogorov forward equation (cf. Gardiner, 2009) can be solved in closed-form (Appendix A.2). The pertinent sampling distributions are illustrated in Figure 3. A maximum likelihood ratio test suggests that the null hypothesis of a common location parameter cannot be rejected in 431 out of 498 or 86% of all cases, while the null hypothesis of a common dispersion parameter cannot be rejected for 445 out of 498 companies, corresponding to approximately 89% of

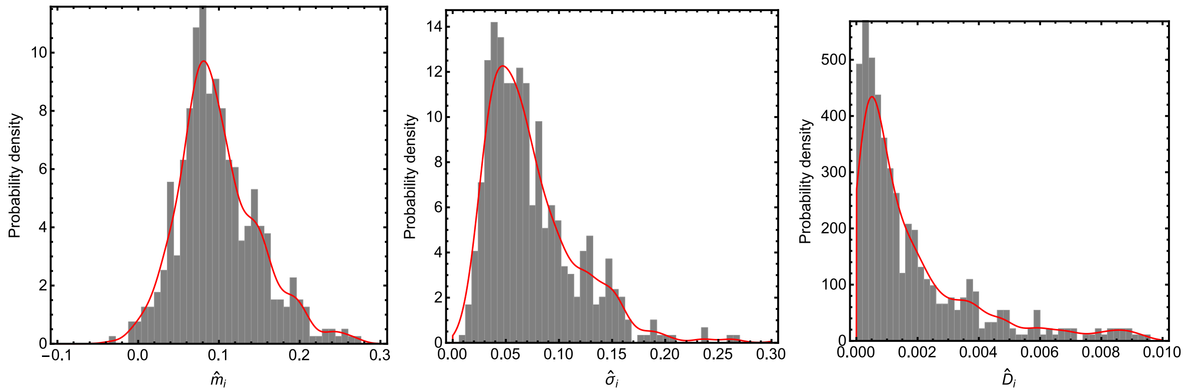


Figure 3: Histogram and smoothed kernel density of the fitted location parameters (left), dispersion parameters (middle), and diffusion coefficients (right).

all firm observations.[11] The individual estimates of average profitability and dispersion thus appear consistent with the phenomenological values from the cross-sectional profit rate distribution, speaking in favor of the ergodic hypothesis.

5 Do firm idiosyncrasies matter?

While our ergodic model and the empirical evidence in Sections 3-4 suggest a uniform long-run average profit rate and volatility for all surviving firms, the extant literature emphasizes the systematic influence of corporate idiosyncrasies on profitability. Hence we need to address whether the cross-sectional variation of profit rates in Fig. 3 can be explained by firm heterogeneity. To this end, we examine empirically how or whether the individual estimates of average profitability and volatility relate to financial and industrial characteristics such as industry concentration, size, sales growth, market share, leverage, productivity, or market valuation. The reason why we concentrate on these particular variables is that they have been the most prevalent in prior studies of profitability (see the meta-analysis by Capon et al., 1990, in addition to the studies listed

[11]Since Wilks' theorem is violated due to the non-differentiability of Eq. (2) at $x = m$ (see Figure 6 in Appendix A.3), the critical value for the location parameter is obtained from a finite sample distribution instead of the standard χ^2 distribution. To this end, we simulate 10,000 realizations of the process with location and scale parameters equal to their phenomenological values, a diffusion coefficient $D = 0.001$ equal to the median over surviving firms, and a time series length of 33 years. Then we re-estimate the parameters and compute the likelihood ratio. The critical value is approximated by the 95% quantile of this simulated distribution.

in the introduction).[12] While our model focuses on the profitability of surviving corporations, prior studies consider mixed samples that do not distinguish between surviving and shorter-lived companies, so we suspect that the diverging views on the relevance of firm idiosyncrasies for profitability originate from differences in the data. The aversion to survivorship bias, as justified as it is in most contexts, has apparently prevented exclusive interest in the destinies of long-lived corporations and veiled the ergodic profitability of survivors, hence we want to investigate whether shorter-lived firms do not only exhibit more cross-sectional variation in their profitability than surviving firms, as shown in Section 3, but also whether their profitability depends on individual firm characteristics.

To this end, we estimate the expectation $E[Y|\mathbf{Z}] = g(\mathbf{Z})$ of the model parameters, where Y is a placeholder for either m or σ, conditional on a set of industrial and financial characteristics of the companies that are summarized in the p-dimensional vector of explanatory variables $\mathbf{Z} = (Z_1, \ldots, Z_p)'$. Because the functional form of these relationships is not obvious a priori, we employ a kernel regression that allows flexible estimation of a nonparametric, smooth function $g(\cdot)$ in

$$y = g(\mathbf{z}) + \epsilon, \tag{3}$$

with the residuals ϵ. This relationship is fitted using the multivariate generalization of the local constant estimator proposed by Nadaraya (1964) and Watson (1964).[13] To assess the sensitivity of the results with respect to entry/exit and survival, we group firms into three subsamples. The first group contains 1804 firms which remain in the population surveyed by the database between 10 and 17 years, the second sample consists of 837 companies with a life span of 18-25 years, and the third group contains 720 firms that survive in the sample for at least 26 years.[14]

[12] In an earlier version of this paper we have also experimented with alternative characteristics such as capital intensity, financial liquidity, and diversification. Yet, the results were nearly identical. Conditional on survival, profitability is also independent of these characteristics.

[13] See, e.g., Härdle et al. (2004) for details.

[14] We are aware that the number of observations is only a rough proxy for survival time because firms could have been incorporated before 1980, implying that the observation count underestimates the true survival time. To assess the significance of this issue, we considered the firms with data in 1980 in more detail. 543 firms are present in the full sample in that year, 498 (i.e. more than 90%) of which are classified as long-lived corporations. 30 out of the remaining 45 firms exist in the sample for 25 years or more, implying that these firms are already included in the group with the longest survival time. 5 out of the remaining 15 corporations have a life span between 10 and 17 years, while the additional 10 companies are included in the second group with $10 \leq L \leq 25$. Since the risk that firms have been incorrectly classified as shorter-lived entities in the first group affects at most 5-15 firms, the measurement error should still be small enough to obtain meaningful results.

The results in Figs. 4-5 suggest that corporate characteristics have indeed a significant influence on the profitability of shorter-lived compared to surviving firms. Large, growing shorter-lived firms with high market shares and productivity tend to be more profitable on average and also exhibit less volatile fluctuations. Often these relationships are non-monotonic, which might explain the mixed and sometimes inconclusive or even contradictory results in the literature. Conditional on survival, however, profitability does not exhibit any systematic relationship with corporate idiosyncrasies, consistent with the ergodic hypothesis. Thus surviving firms cannot do better but also must not do worse than their competitors, both in terms of their average profitability and the volatility of their returns. The only exception is Tobin's q, in line with the well-known dichotomy between "real" corporate characteristics and financial market valuations.

To assess the validity of our results, we conducted several robustness checks. First, we confirm that average profitability and volatility remain independent of real characteristics for surviving firms when Tobin's q is excluded from the regressions, thereby ruling out the possibility that the independence of profitability from these variables is an artefact and merely prevails because all statistical variation is captured by Tobin's q. Second, to strengthen the argument that financial variables behave differently from real ones, we have also experimented with alternatives to Tobin's q, for instance considering the ratio of market value of equity to total assets, or the ratio of market value to the book value of equity. As expected, profitability also relates to these variables and confirms that quantities involving market valuation exhibit peculiar patterns. Third, we have also considered the relation between the location and dispersion of profit rates and the volatility of corporate characteristics to check if changes in these variables might explain variation in profitability. The results are robust with respect to these modifications as we find that m and σ are also independent of the volatility in these characteristics.

6 Discussion

In summary, this paper makes two contributions. First, contrary to the widespread view that industry and corporate characteristics imply persistent cross-sectional variation in profitability, we show that there is a common long-run average rate of profit and volatility for surviving capital, irrespective of corporate idiosyncrasies. Our results thereby unmask a formerly undetected regularity in corporate profitability that applies across firms and is time invariant, reflected in the ergodicity of profitability conditional on survival. Note that while survival is a necessary condition for ergodicity, it is not sufficient

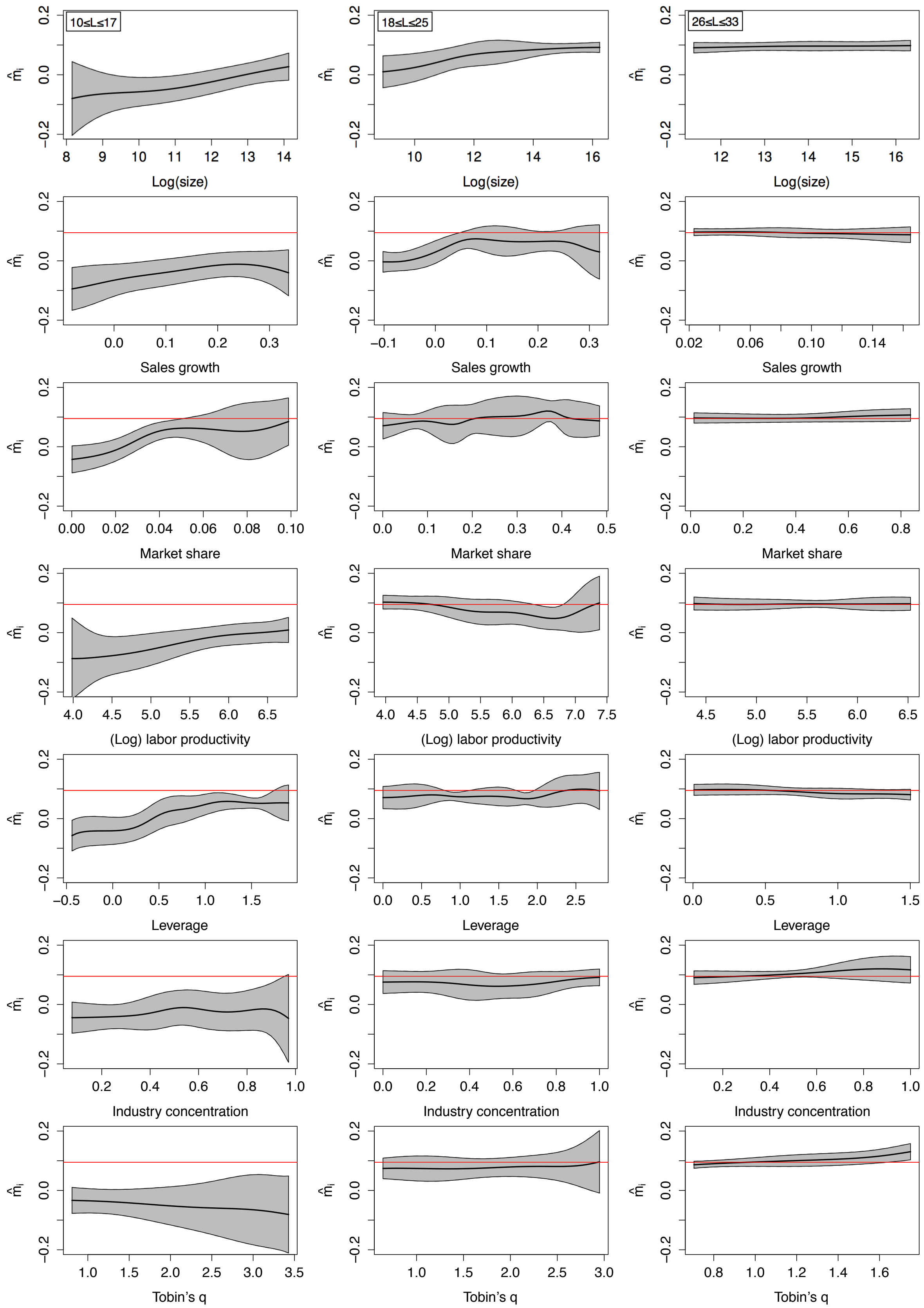


Figure 4: Partial nonparametric regression plots for the location parameter, conditional on the number of years that firms survive in the sample. The right panels shows firms with 10 up to 17, the middle panel those with 18 up to 25, and the right panel those with more than 25 observations. 95% confidence bands are adjusted for multiple testing using the Bonferroni method. The dependent variable is the median profit rate; the independent variables are firm size (sales), growth of sales, market share (defined on the 4-digit SIC level), labor productivity (sales per employee), leverage (the ratio of the sum of short-term und long-term debt to common equity), the Herfindahl industry concentration measure, and Tobin's q (the ratio of the sum of book value of debt and the market value of equity to total assets). The red horizontal line illustrates the phenomenological value of the location parameter.

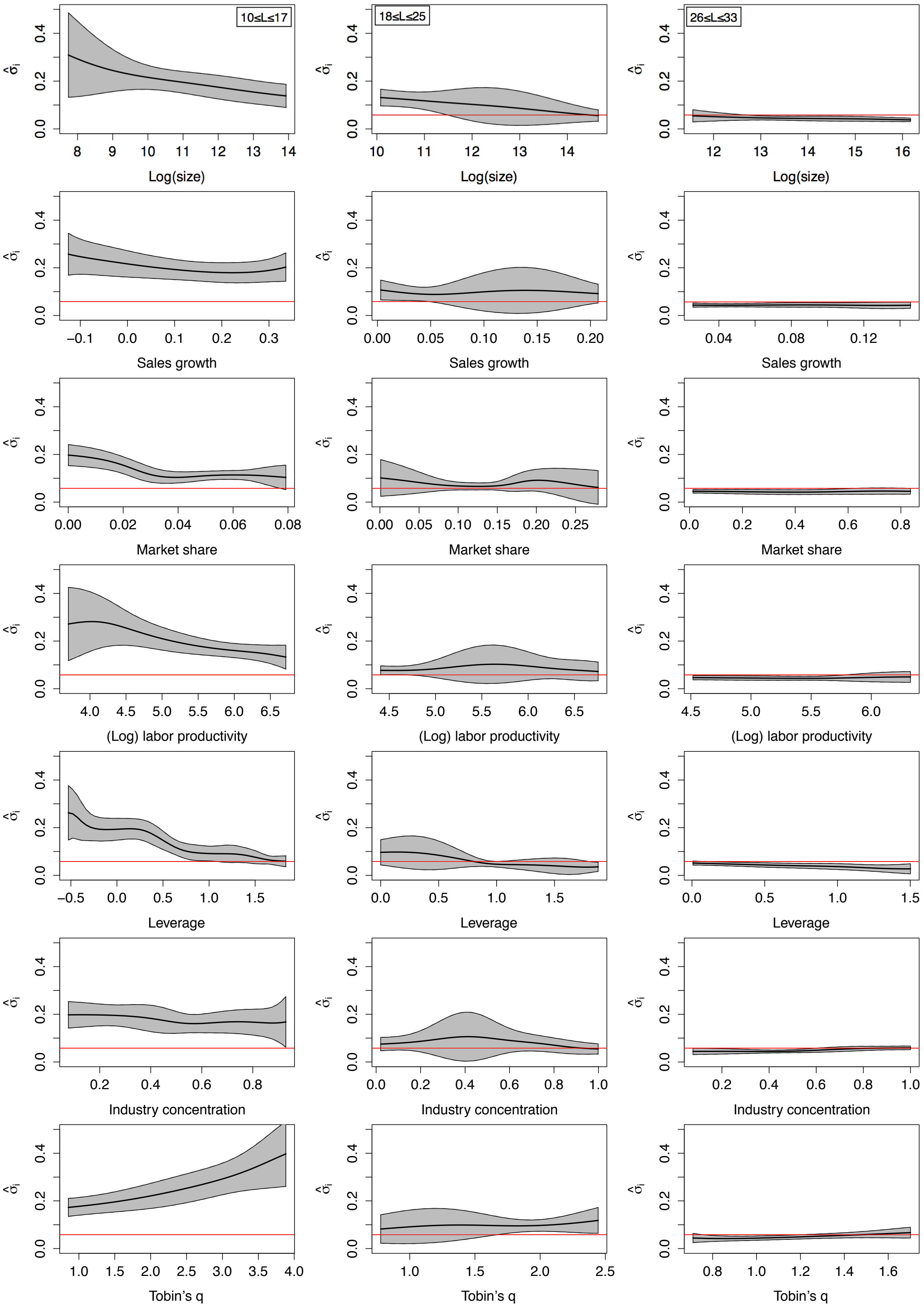


Figure 5: Partial nonparametric regression plots for the disperson parameter, conditional on the number of years that firms survive in the sample. The right panels shows firms with 10 up to 17, the middle panel those with 18 up to 25, and the right panel those with more than 25 observations. 95% confidence bands are adjusted for multiple testing using the Bonferroni method. The dependent variable is the mean absolute deviation of profit rates; the independent variables are firm size (sales), growth of sales, market share (defined on the 4-digit SIC level), labor productivity (sales per employee), leverage (the ratio of the sum of short-term und long-term debt to common equity), the Herfindahl industry concentration measure, and Tobin's q (the ratio of the sum of book value of debt and the market value of equity to total assets). The red horizontal line illustrates the phenomenological value of the dispersion parameter.

since survivors could in principle exhibit different profit rate trajectories, which would make the system non-ergodic. We conjecture that it is survival and the interaction of firms through competitive capital (re-)allocation that lead to the observed ergodicity in corporate profitability.

Second, our investigation shows that the profitability of shorter-lived companies, even for approximately twenty years after entry or before exit, is non-ergodic and correlated with the individual characteristics of these firms. This finding raises the question whether the large set of idiosyncrasies that has been identified in prior work really explains profitability, or whether these variables ultimately predict selection into the sample of long-lived corporations, that is to say whether these idiosyncrasies impact the probability to survive rather than profitability itself. A related question in this context is what distinguishes shorter-lived from surviving companies. Mundt and Oh (2019) speculate that the skewed and asymmetric profit rate distribution for these firms has its origin in the presence of financial constraints or capital markets pressure that interfere with idiosyncratic corporate efforts, competition, and capital reallocation, thereby creating the fat left tail. While we can currently neither confirm nor reject this argument, it is interesting to note that nearly all prominent indexes of financial constraints (e.g. Hadlock and Pierce, 2010; Kaplan and Zingales, 1997; Whited and Wu, 2006) incorporate variables whose impact on profitability has been stressed in the existing literature.

Given that profitability is ergodic conditional on survival, it might be tempting to conclude that managers should prioritize survival over profitability or other corporate objectives. An argument in this direction is provided by Dutta and Radner (1999) who show that the maximization of shareholder value almost surely leads to bankruptcy of the company because the maximizing manager undervalues the insuring effect of retained earnings, which provide a buffer against future losses. Therefore a more conservative policy that focuses directly on survival and implies withdrawals below the shareholder value maximizing optimum increases the value of the capital stock and thus increases the probability of survival. Interestingly, Peters (2019) also advocates to reduce leverage and to increase capital buffers as a means to overcome the problem of time irreversibility in non-ergodic games, that is to obtain the chance to repeat the game in case of an unlucky sequence of events that results in ruin. At the same time, despite the fact that surviving firms' profit rates and their volatility are the same for survivors, it is of course still possible that individual firms engage in profit maximizing behavior. After all, our reduced-from model suggests that it is both the systematic tendency of competition to equalize profit rates as well as firms' idiosyncratic (and possibly profit-maximizing) efforts to stay ahead of the game that lead to the observed regularities. In any case, analysts, investors, managers and other stakeholders are well advised to realize that survival apparently prevents sustained deviations from the systemic rate of profit and volatility.

A Estimation

A.1 Asymmetric exponential power distribution

The asymmetric exponential power (or Subbotin) distribution reads

$$AEP(x;m,\alpha_l,\alpha_r,\sigma_l,\sigma_r) = \begin{cases} \frac{1}{C}\exp\left(-\frac{1}{\alpha_l}\left|\frac{x-m}{\sigma_l}\right|^{\alpha_l}\right) & \text{if } x < m \\ \frac{1}{C}\exp\left(-\frac{1}{\alpha_r}\left|\frac{x-m}{\sigma_r}\right|^{\alpha_r}\right) & \text{if } x > m, \end{cases} \tag{4}$$

where $m \in \mathbb{R}$ is a measure of central tendency, and $\alpha_l, \alpha_r \in \mathbb{R}^+$ are shape parameters reflecting the thickness of the left (l) and right (r) tail of the distribution. $\sigma_l, \sigma_r \in \mathbb{R}^+$ are scale (or dispersion) parameters, and $C \equiv \sigma_l \alpha_l^{1/\alpha_l}\Gamma(1+1/\alpha_l) + \sigma_r \alpha_r^{1/\alpha_r}\Gamma(1+1/\alpha_r)$ is a normalization constant with the Gamma function $\Gamma(\cdot)$.[15]

A.2 Transient density of the diffusion process

The transient density of the time-continuous Markov process in Eq. (2) obeys the Kolmogorov forward equation[16]

$$\frac{\partial}{\partial t}p(x,t) = \frac{D}{2\sigma}\text{sign}(x_t - m)\frac{\partial}{\partial x}p(x,t) + \frac{D}{2}\frac{\partial^2}{\partial x^2}p(x,t), \tag{5}$$

with $p(x,t) \equiv f(x,t|x_0,0)$, and the initial condition $f(x,t|x_0,0) = \delta(x-x_0)$, where $\delta(\cdot)$ denotes Dirac's delta function. The time-dependent solution to this partial differential equation has been derived by Toda (2012) and reads

$$\begin{aligned} f(x_i,t|x_{i,0},0) = {} & \frac{1}{\sqrt{2D_i\pi t}}\cdot\exp\left(-\frac{(x_i-x_{i,0})^2}{2D_it} - \frac{1}{2\sigma_i}(|x_i-m_i| - |x_{i,0}-m_i|) - \frac{D_i}{8\sigma_i^2}t\right) \\ & + \frac{1}{2\sigma_i}\exp\left(-\frac{1}{\sigma_i}|x_i-m_i|\right)\Phi\left(-\frac{|x_i-m_i| + |x_{i,0}-m_i| - (D_it)/(2\sigma_i)}{\sqrt{D_it}}\right) \end{aligned} \tag{6}$$

[15]More specifically, σ measures the L_α-norm distance from $m \in \mathbb{R}$, i.e. $\sigma = (E|x-m|^\alpha)^{1/\alpha}$.

[16]For brevity, we omit firm subscripts that should appear on each realization of the profit rate x.

with $\Phi(\cdot)$ the cumulative distribution function of the standard normal distribution.

A.3 Likelihood ratio test

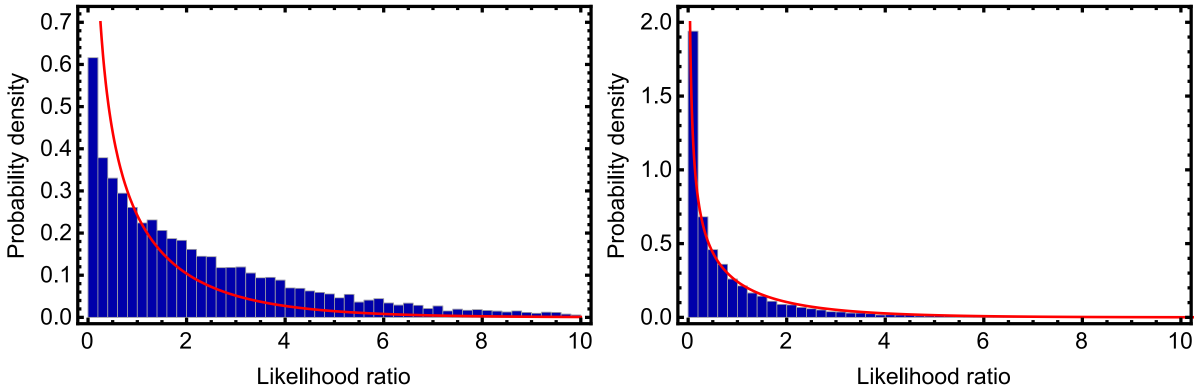


Figure 6: Simulated probability density of the likelihood ratio test statistic (histogram) for the location (left) and dispersion parameter (right), superimposed with a Chi-squared distribution with one degree of freedom (solid line). We observe that the Chi-squared distribution is a good approximation for the dispersion parameter, while it turns out to be too restrictive for the location parameter due to the singularity of equation (2) in $x = m$.

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