Crisis? What Crisis!?
Corporate Profit and Growth Dynamics in Historical Perspective

Christian Babirat *† Simone Alfarano‡ Mishael Milaković†

Abstract

Recent literature on corporate profitability reports statistical regularities that persist in times of economic prosperity and crisis. Profit rates (defined as return on assets) display a remarkable stability in their annual averages and dispersion, resulting in a stationary (Laplace) distribution. A proposed reduced-form model of competitive firms and capital reallocation accounts well for these observed regularities. However, so far no comparison between observed statistical patterns in and the applicability of the model for distant historic episodes of economic prosperity and crisis has been made. In this study we analyse three episodes in U.S. economic and corporate history (1863-1893, 1923-1953, and 1983-2013) within the last 150 years, thus allowing us to stress-test the regularity of statistical patterns and the applicability of the proposed model of competitive firms. We find that the stability in statistical moments and the distribution of the profit rates persists most of the time and survives substantial market crashes and economic downturns in and after 1873, 2001, and 2008. The crash of 1929 and the Great Depression mark, besides the years of war production, the only lasting deviations from these regularities. Direct comparison of economic crises in 1873, 1929 and 2008 unveils an inherent inability of corporations to adjust their assets to the extreme market conditions during the Great Depression, materializing in a departure from the stability in average profitability and the stationary distribution. Our findings demonstrate that observations on the firm-level can contribute substantially to the understanding of patterns on the macro-level. Generally, and along the lines of the Granularity Approach of Gabaix, performance of large corporations mirrors to a substantial extent the fate of the overall economy, thus enabling us to shed light on the impact and severity of historic downturns. Specifically, the firm-level comparison of different downturns within the last 150 years adds to the economy-level literature on economic crisis, as we propose disaggregate factors that relate to the length and severity of economic crisis, e.g., a break-down in capital reallocation and accumulation.

Keywords: Financial Crisis, Firm Profitability, Firm Growth, US before/after 1913
JEL classifications: G01, L25, N11, N12

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1 Introduction

> "Commercial and financial crises, in which business men are overwhelmed with embarrassment and individual fortunes take to themselves wings and fly away, are not mere *accidents*, or events that happen without adequate cause. When the necessary conditions are present they are sure to occur, sooner or later. They have repeated themselves so often as to establish the fact of general laws in respect to their occurrence."
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> *The Independent (New York)*, June 11, 1874

The statistical analysis of corporate profit rates has a long tradition in economics. Starting with Sterrett (1916)[1], the signalling role of profitability in guiding capital investments among alternative uses has been heavily debated on empirical grounds. Applying different concepts of profitability and using varying data and methodology, economists empirically supported and dismissed alike the idea of capital (re-)allocation and profit rate equalization.

We show that profit rates of competitive firms, although never achieving full equalization, display a drift towards a characteristic industry- and even economy-wide average rate. Our economic interpretation of the drift rests on the idea of capital-reallocation where investors channel capital, which is (at least partially) withdrawn from less (i.e., below-average) profitable uses, towards more (i.e., above-average) profitable uses. However, as investors cannot fully anticipate the future it is random alterations in the competitive environment of the firms that hinder full equalisation of the profit rate. Thus, firms tend towards a (hypothetically) ideal rate without ever settling on it.

Our analysis focusses on balance and income statement information of balanced panels of non-financial, publicly-traded corporations in the U.S. throughout three 31 year episodes (1863-1893, 1923-1953, and 1983-2013). The chosen episodes are of special interest in at least two ways. First, we compare experience from diverse stages of the economic development of the U.S.: the Gilded Age and the advance of mass transportation, the Roaring Twenties and the advance of mass-manufacturing, and the Palladium Age of the 2000s and the advance of consumer electronics and telecommunications. Second, we compare several economic crises as each of the episodes includes the defining crises of the respective epoch: the first sample covers the Panic of 1873 that turned into the Long Depression, the second sample covers the Panic of 1929 that turned into the Great Depression, and the third sample covers the Panic of 2008 that turned into the Great Recession. Thus, we are able to directly compare firm-level experiences across several episodes of prosperity and crises alike.

We show that profit rates (defined as accounting returns on assets) display remarkable time-invariant statistical patterns across economic prosperity and crisis. Annual

[1] Earlier contributions analysed...

median profit rates and mean deviations thereof are stable over time, resulting in a stationary Laplace distribution of pooled profit rates. Concerning the time-series behavior, profit rates display significant positive autocorrelation with approximately exponential decay across firms in all periods. We account for these time-invariant patterns with a reduced-form model of capital reallocation among competitive firms, initially proposed by (Alfarano et al., 2012). Besides years of wartime production, we find 1929 and the Great Depression of the 1930s marking the only pronounced and lasting deviation that cannot be explained by the model. A comparative analysis of macroeconomic outcomes and firm-level experiences shows the lasting severity of crisis coinciding with a reversal in capital accumulation (measured by growth in total assets), an observation that does not reoccur in any other year analysed. Further evidence on the potential link between severity of crisis and capital accumulation is given in a comparison of the 1929 Great Depression experience of the U.S. with the 2008 Great Recession experience of Greece, where patterns are similar albeit more pronounced.

The remainder of the paper is organized as follows: Section 2 describes the data and sample selection of corporate information. Section 3 motivates the relevance of large corporations for analysing and better understanding macroeconomic fluctuations. Section 4 introduces a statistical equilibrium model of profit rates of competitive firms, initially proposed by Alfarano et al. (2012) and presents empirically testable hypotheses on assumptions and implications of the model. Section 5 presents the statistical findings in the firm-level data. Section 6 provides a comparison of firm-level experiences with the records of macroeconomic aggregates, allowing us to evaluate the severity of crisis and the robustness of firm-level regularities. Section 7 concludes.

2 Sample Selection and Data Description

We use a novel and extended dataset of balanced panels of non-financial corporations in the United States for three 31-year episodes between 1863 and 2013.[2] We collected annual (accounting) information on corporate size, growth and financial performance for the 31-year periods 1863-1893, 1923-1953 and 1983-2013.

The sample periods are determined by at least two motives; (i) the earliest availability of data in official documents and corporate reports and (ii) the historical relevance of the respective time period. Sample I (1863-1893) contains 30 records of railroad operating corporations extracted from several editions of Poor's *Manual of the Railroads of the United States* which was first published in 1868/69. Although limited to a single industry, this sample provides substantial information on industrial dynamics in the early days of corporations. In those days, railroad corporations began to dominate the

[2]Financial corporations (two-digit SIC codes 60-67) are excluded as they differ in the structure and size of total assets substantially from comparable industrial corporations. In general, there asset holdings are at least one order of magnitude larger. (see **?**).

economy. Approximately 10% of corporations chartered from the 1790s to the beginning of the Civil War were in railroads, making up half of the total authorised minimum capitalization. (Sylla and Wright, 2013). For decades to come, railroad corporations strongly shaped the nature of competition and regulation. (Chandler, 1965; Klein, 1990; Roy, 1997). Sample II (1923-1953) contains 136 records of non-financial corporations extracted from published annual reports and financial and statistical periodicals as *The Commercial and Financial Chronicle*. The sectoral distribution of these corporations is 74 in manufacturing, 43 in utilities, 13 in mining and construction and 6 in services, wholesale and retail trade. While railroads still acount for 26 out of the 43 utility corporations, they have lost there dominant position in comparison to 1863-1893, giving way to mass-manufacturers. Sample III (1983-2013) contains 562 records of non-financial corporations extracted from Thomson Reuters Datastream. The sectoral composition is 317 in manufacturing, 112 in services, wholesale and retail trade, 98 in utilities, 33 in mining and construction, and 2 in agriculture.

While Poor's Manuals in the past and Thomson Reuters today both aim at providing consistent, comparable reports of the accounting information across years and companies, the extraction from corporate reports was a more tedious task. The way of presenting and the notations of accounting information, especially in case of the income statement, varied substantially over time and across companies, at least throughout the 1920s and early 1930s. Overall, we aimed for maximum consistency by extracting data that is in accordance with the following working definitions: (i) *sales* represent gross sales and operating revenues less discounts, returns and allowances, (ii) *operating income* represents the difference between total revenues from main operations (including depreciation and amortization, excluding financial/interest income) and total costs from operations (excluding federal and state income taxes), and (iii) *total assets* represent all current assets, long-term receivables, investments in unconsolidated subsidiaries and other investments, net property plant and equipment and other (non-tangible) assets.

We measure firm size by sales (SA) and total assets (TA). Firm growth is calculated as annual percentage growth rates in SA and TA, both representing conventional measures of firm performance, building the baseline in the industrial dynamics literature. We measure absolute financial performance by operating income (OI), in other words *profits from operations* before income taxes and distribution. Accounting for heterogeneity in the size of operations and thereby allowing for comparisons of performance between corporations of different sizes, we measure relative financial performance by return on assets (ROA, formally X), calculated as the division of OI by TA.

In order to minimize the number of missing values in time series analysis, we restrict the sample to the series of identical corporations (balanced panels), i.e. the set of companies that survive all years within a sample that is the three 31-year periods. This leaves us with 30 firms for 1863-1892, 136 firms for 1923-1953, and 562 firms for 1983-

2013. Although the resulting samples of *surviving* or *long-lived* corporations depict only a small fraction of the total population of corporations, they give a comprehensive list of the largest corporations at the time. So from 1863 to 2013, corporations such as the Pennsylvania Railroad or the New York Central (and Hudson River) Railroad, among the largest publicly-traded corporations well into the 20th century, slowly gave way to the American Telephone and Telegraph Company, General Motors and General Electric Company in the present days.

3 Economic Relevance of Large Corporations

[Work in progress.]

Strengthening the economic relevance of enduring corporations, we find that concentration among the largest surviving firms increased within the last 150 years (see Figure 1). Between 1863 and 2013, the sales to GDP ratio of the largest 25 corporations in each year grew more than fifteenfold. Growing from about 1.1% in 1863 to 2.8% in 1893[3] , the sales to GDP ratio surpassed 6.2% in 1923 and 8.3% in 1953[4] before it came to 13.6 in 1983 and 19.8% in 2013. Within the last 150 years, we find the sales to GDP ratio of the largest 25 corporations following an exponential trend, doubling about every 45 years.

Overall, our corporate samples mirror the destiny of the U.S. economy. Figure 2 compares annual U.S. real GDP growth with median corporate sales growth from the company samples. There is substantial comovement and congruence in all three episodes, with sales growth mimicking even the most extreme swings in GDP. Thus, our samples, although confined to the subgroup of surviving corporations, reflect the overall economic performance almost completely. Surviving companies, which act in the same competitive environment of capital markets such as newly born and perishing firms, reflect the overall economic performance with entries and exits impacting their performance implicitly.

[Work in progress.]

Large corporations as a dominant type of business organization began to emerge from the mid 19th century onwards, by and large with the advent of the railroads. Gabaix (2011) Acemoglu et al. (2012, 2013) Lee et al. (1998)

[3] We are potentially underestimating the sales to GDP ratio as our sample does include a single sector (railway operations) only. Nevertheless, Sylla and Wright (2013) show that early corporate development, 20 out of the 25 largest corporations in 1860 were in the railway business. Thus, our estimate should be a good proxy for a more heterogeneous sample of all industrial activities.

[4] Before 1929 net sales were often not stated in annual reports so that the sample potentially underestimates the true share in GDP.

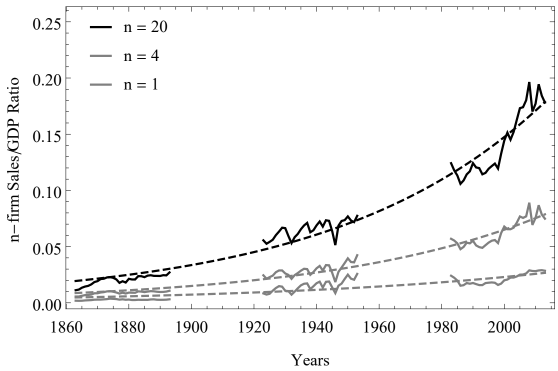


Figure 1: Annual n-firm sales-to-GDP concentration ratios for the n largest corporations (solid line) in periods 1873-1893, 1923-1953 and 1983-2013. Dashed lines indicate an estimated exponential trend of firm concentration.

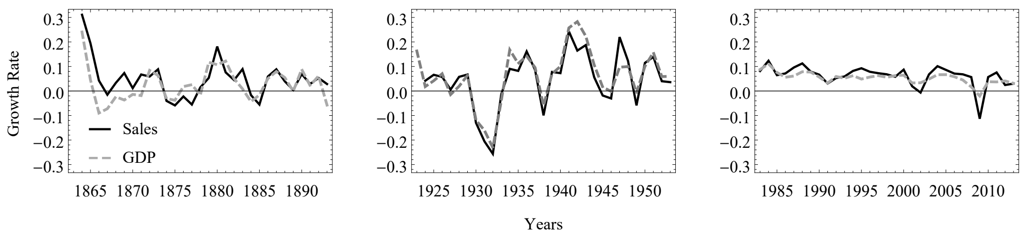


Figure 2: Annual median company sales and nominal GDP growth for sample periods 1863-1893 (30 companies, 892 observations), 1923-1953 (125 companies, 2,910 observations), and 1983-2013 (562 companies, 17,147 observations).

4 Model

Alfarano et al. (2012) and Mundt et al. (2015) propose a reduced-form model of the time evolution of the profit rate of surviving corporations. The stochastic differential equation of the model takes the form

$$dX_{i,t} = -\frac{D_i}{2\sigma} sign(X_{i,t} - m)dt + \sqrt{D_i} dW_t \tag{1}$$

where $X_{i,t}$ denotes the profit rate of firm i at time t, m denotes the median profit rate (i.e., location), and σ denotes the mean deviation of the median (i.e., dispersion) profit rate. The firm-specific diffusion coefficient D_i is time-independent and captures the influence of both the deterministic mean reversion tendency, which is represented by the term with the sign function $sign(\cdot)$, and the stochastic noise, which is represented by the term with Wiener increments $\sqrt{D_i}dW_t$, on the change in the profit rate.

The deterministic mean reversion tendency formalizes the idea of classical competition and capital reallocation motivated by Ricardo (1815). In this view, investors compare the rate of profit on in its current use, $X_{i,t}$ with rates in alternative uses or, more general, an industry- or economy-wide average, m. Uses with above-average profitability attract more capital, given that investors constantly reallocate capital to more profitable uses. Thereby, the denominator of the profit rate increases, ceteris paribus leading to an decline in the overall rate. The reverse holds for uses with below-average profitability, with investors withdrawing their capital, ceteris paribus leading to an increase in the profit rate. Once the profit rate reaches the average realisation m, there is no more incentive to reallocate capital. The sign function becomes zero, as does the change in the profit rate $dX_{i,t}$ assuming there is no stochastic noise.

The stochastic noise term introduces random shocks that impact on a firm's profit rate, composed of a firm-specific diffusion coefficient D_i and normally-distributed Wiener increments dW. Thereby, the system is not allowed to settle down and is constantly pushed out of average profitability m. Although the nature of the shock is not further specified, shocks can be thought of as either internal to the firm (e.g., increase in profits due to cost-cutting, decrease in assets due to downsizing) or external to the firm (e.g., decrease in profits due to new entrants and increased competition or destruction of assets through natural disasters). However, irresponsible of the nature of shocks, the conception of the process with stochastic noise ensures that the profit rate fluctuates and does not settle down in m.

Assuming m and σ to be time- and firm-independent, Alfarano et al. (2012) show that the mean-reverting nature of the diffusion process in 1 *implies* a stationary Laplace distribution of the cross-section and time-series of profit rates X, given by

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

where parameters m and σ correspond with the parameters of the diffusion process in 1. We interpret this outcome as *statistical equilibrium*, a situation of fluctuating profit rates on the firm-level reproducing a stable and robust distribution of pooled profit rates on the economy-level.

While the distribution of profit rates is shown to be Laplace in both, cross-section and time series, the distribution of the random noise is Gaussian on the firm-level but varies on the economy-level according to the distributional characteristics of D_i, which is firm heterogeneity. For a homogeneous population of firms, i.e. $\sqrt{D_i} = \sqrt{D}$, pooled noise terms $\sqrt{D_i}dW_t$ are Gaussian distributed as the product of a constant and a Gaussian distribution is itself Gaussian distributed. In contrast, for a heterogeneous population of firms, i.e. firm-specific $\sqrt{D_i}$, the aggregate distribution of the noise terms deviates from the Gaussian distribution, displaying fatter tails than the firm-level Gaussian distribution of shocks. For example, assuming an exponential (inverse Gaussian) distribution of D_i, the product with the Wiener process would lead to a (fatter than) Laplace distribution of shocks and thus dX.

The time-series behavior of profit rates *implied* by the reduced-form model in 1 is described by the implied autocorrelation function $\kappa(\tau)$ presented in Mundt et al. (2015) and derived by **Touchette (2010)** that takes the form

$$\begin{aligned}\kappa(\tau) \;&= \frac{1}{6\sqrt{\frac{2\pi D\tau}{\sigma^2}}}\exp\left(-\frac{D\tau}{8\sigma^2}\right)\left\{\left(\frac{\sqrt{\frac{\pi D\tau}{2\sigma^2}}}{2}\exp\left(\frac{D\tau}{8\sigma^2}\right)\operatorname{erfc}\left(\frac{\sqrt{\frac{D\tau}{\sigma^2}}}{2\sqrt{2}}\right)-1\right)\right.\\ &\left.\left(\frac{D^3\tau^3}{8\sigma^6}+\frac{3D^2\tau^2}{2\sigma^4}-\frac{6D\tau}{\sigma^2}+24\right)+\frac{D^2\tau^2}{2\sigma^4}+24\right\}.\end{aligned} \tag{3}$$

where τ is the time lag, and m, σ and D correspond with the parameters of 1. The resulting autocorrelation structure is positive with (approximately) exponential decay. The model thus implies that firm-level profit rates are persistent over time.

Alfarano et al. (2012) and Mundt et al. (2015) base the assumptions on and identify the implications of the reduced-form model given by 1 in data of surviving U.S. corporations between 1980 and 2012/13. The model is able to capture both the cross-sectional and time-series characteristics of corporate profit rates, supporting the idea of statistical equilibrium holding throughout the 1980s to 2010s. In the following, we extend the existing analysis to episodes during the 1860s to 1890s and 1920s to 1950s in order to check for the robustness of the observed patterns across time. For profit rates we analyse (i) the time-evolution of the empirical median m and mean deviation from the median σ, (ii) the empirical distribution of the rates X, (iii) the empirical autocorrelation structure, (iv) the empirical distribution of changes in the rates dX and (v) the heterogeneity in firms measured by D. For firm growth rates (of total assets), the prevailing performance measure in the industrial dynamics literature, we report results on (i) and (iii) for comparison.[5]

5 Corporate Profit and Growth Dynamics

Our analysis of profitability and growth dynamics begins with utilities corporations (including transport, communications, gas, water and electricity; two-digit SIC codes 40 to 49), as all sample periods cover activity in this sector. Beginning with descriptive statistics, Figure 3 depicts the time evolution of location (median, m), the time evolution of dispersion (mean deviation from median, σ) of corporate profit and total assets growth rates, and the empirical distribution of pooled profit rates. At this level of analysis, two observations arouse substantial interest.

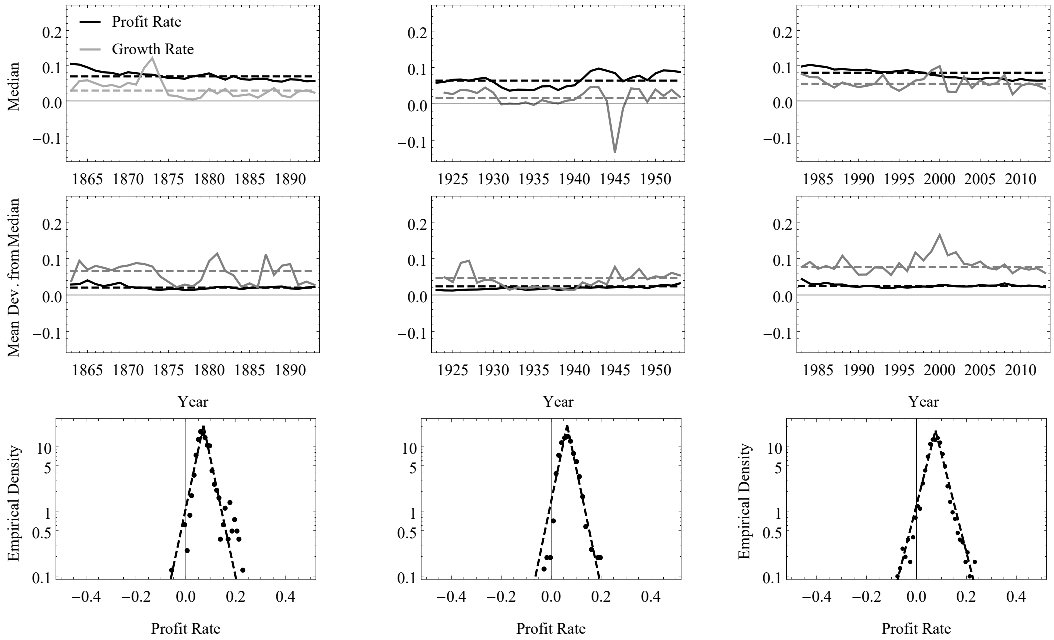
First, there are substantial differences in the cross-sectional behavior of growth rates as compared to profit rates (Figure 3, upper and middle). Location and dispersion of total asset growth rates vary substantially over time, generally following the business cycle with growth hikes and subsequent crashes around well-known market fevers in 1873, 1929, 2001, and 2008. In contrast, location and dispersion of profit rates remain remarkably stable over time, displaying very similar values across most of the 93 years analysed. The only lasting deviations appear in years of large-scale wartime production (1863-65 Civil War, 1942-45 World War II, and 1950-53 Korean War) and during the Great Depression. We take the stability in location and dispersion of profit rates across a wide timespan as evidence for stationarity in corporate profit rates, a feature that is not prevailing in growth rates.

Second, resulting from the stationarity in location and dispersion, we find the distribution of corporate profit rates well described by a stationary Laplace (i.e. double-exponential) distribution in all three episodes (see Figure 3, lower plots). Throughout the 93 years analysed utilities earned an *average* return of about 7.0%, with the sub-samples deviating only marginal from this value ($m_{1863-1893} = 7.03\%$, $m_{1923-1953} = 6.74\%$ and $m_{1983-2013} = 7.63\%$). The dispersion of profit rates *averaged* to about 2.5%-points with sub-samples sticking close to this result ($\sigma_{1863-1893} = 0.024$, $\sigma_{1923-1953} = 0.025$ and $\sigma_{1983-2013} = 0.029$). With these parameter estimates, the resulting Laplace distributions of profit rates collapse onto one another, being almost indistinguishable (see Appendix B, Figure 10, left plot).

Similarities in the time-series behavior of corporate profit rates across time episodes are also evident (Figure 4). The Box-Whisker plots depict the distribution of firm-specific autocorrelation coefficients for time lags 0 to 5.[6] While total assets growth rates

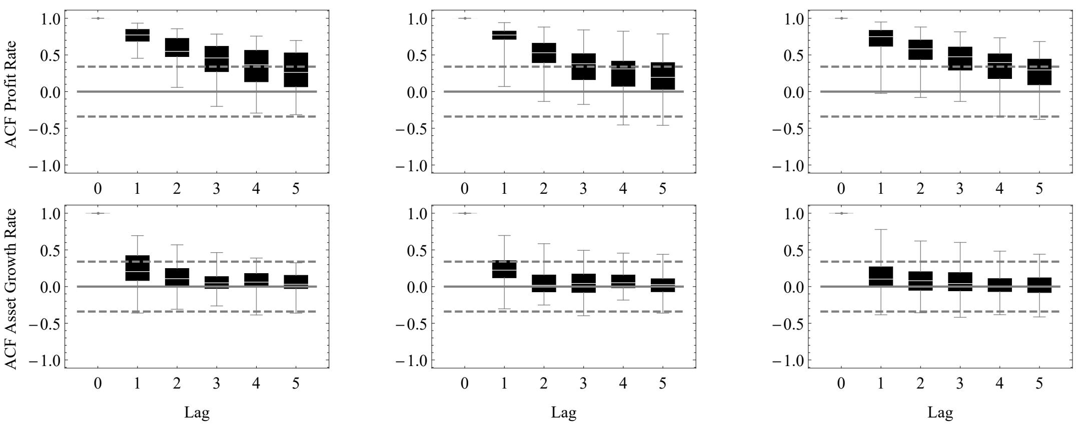
[5] In the case of corporate growth rates, obtaining (ii) necessitates standardization of the data, which we do not provide in this paper. Implications (iv) and (v) are derived from the reduced-form model of profit rates, which cannot be transferred to growth rates.

[6] In line with Mundt et al. (2015) we calculate the standard textbook autocorrelation coefficients for profit rates (upper plots) and asset growth rates (lower plots) with the cross-sectional median of each period replacing the company-specific mean.



(a) 1863-1893 (b) 1923-1953 (c) 1983-2013

Figure 3: Cross-sectional statistical behavior of profit and growth rates of utility corporations. From top to bottom, time evolution of the annual median and mean deviation from the median profit and asset growth rates (solid) and long-run values (dashed) and empirical density of the profit rate (dots) in comparison to Laplace distribution estimates (dashed). Sample periods are (a) 1863-1893 (30 companies, 892 observations), (b) 1923-1953 (43 companies, 1,298 observations) and (c) 1983-2013 (98 companies, 3,030 observations).



(a) 1863-1893 (b) 1923-1953 (c) 1983-2013

Figure 4: Time-series behavior of profit and growth rates of utility firms. From top to bottom Box-Whisker Plots of the autocorrelation functions (ACF) of profit and total asset growth rates. Sample periods are (a) 1863-1893, (b) 1923-1953 and (c) 1983-2013. Dashed lines indicate the 95% confidence interval under the null hypothesis of zero autocorrelation ($\pm 1.96/\sqrt{T}$ with T being the length of time series of 31 years.).

display no significant autocorrelation from lag 1 onwards, profit rates consistently display significant (albeit decaying) autocorrelation for at least the first three lags at all times. Both, the unsystematic or random nature of growth and the persistence of (abnormal) profits are well in line with the pertinent literature, which, however, largely focusses on recent data since the 1980s. Extending the time frame of analysis, however unveils that substantial impact of changes in the competitive environment on the persistence of profits, e.g. by cartelization in the 1890s to 1910s or the downsizing and outsourcing waves of the 1980s to 2000s, are lacking in the data.

However, limiting the analysis to a single industry, that is utilities and transportation with railroads at the forefront, makes the analysis susceptible of being a special case. Indeed, this industry was and still is subject to close governmental supervision and regulation. Thus, we extend the analysis to samples of non-financial corporations that, besides utilities and transportation, include agriculture, mining, construction, manufacturing, wholesale, retail, and services. This extension comes at a cost. As large publicly-traded corporations in all these additional sectors first appeared around the turn of the 19th to the 20th century, we lack comprehensive data for the episode 1863-1893, so that we confine the extended analysis to the latter episodes of 1923-1953 and 1983-2013.

Figures 5 and 6 present cross-sectional and time-series patterns for non-financial for sample periods 1923-1953 and 1983-2013. The time-independent cross-sectional and time-series characteristics of corporate profitability and growth identified in utilities and transportation corporations by and large hold qualitatively, also they display three (more pronounced) quantitative deviations.

First, *average* profitability (mean deviation from the median) of non-financial corporations is larger than for utilities and transportation corporations alone, standing at $m_{1923-1953} = 8.6\%$ ($\sigma_{1923-1953} = 0.058$) and $m_{1983-2013} = 9.2\%$, ($\sigma_{1983-2013} = 0.056$) in 1983 to 2013, on average around 9% (0.057) comparing with about 7% (0.026) in the utilities and transportation industry (see Appendix B, Table 3). Thus, the *average* return in non-utility sectors is persistently higher across both episodes. For total asset growth rates, fluctuations are more pronounced but generally follow the same cyclical patterns. The time-series characteristics remain virtually indistinguishable from the previous analysis, with positive decaying autocorrelation in profit rates and insignificant autocorrelation in growth rates.

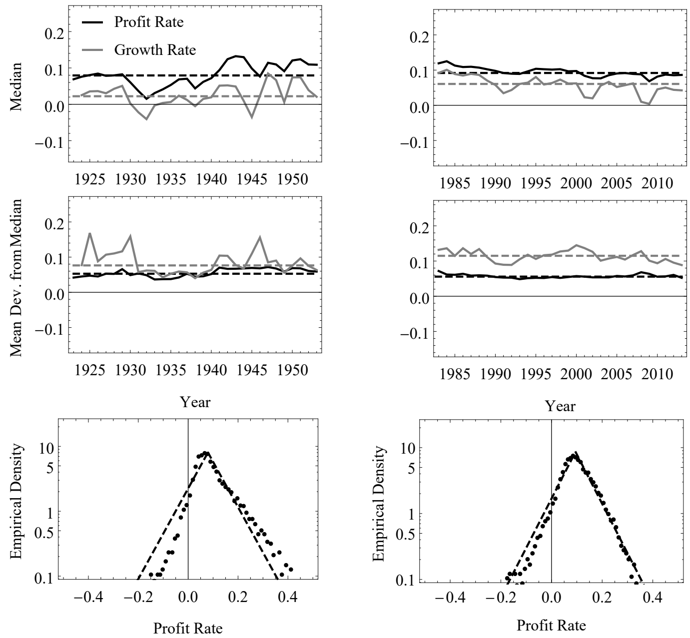
Second, during 1923-1953 there is an over-reporting of high profits when compared with the theoretical Laplace distribution (Figure 5, bottom). By and large, these excess observations can be traced back to wartime profits that vanish once years of war are excluded. This anomaly is reported in the literature (**?**) and ultimately led to the introduction of excess profit taxes from World War I onwards. (**?**).

Third, there is substantial under-reporting of losses and an over-reporting of minor profitability apparent in the distribution of profit rates (Figure 5, bottom). In line with earlier literature, we interpret this finding as the outcome of earnings management, i.e. the strategic avoidance of reporting losses that takes place either within or outside of legal boundarie (Burgstahler and Dichev, 1997; Hayn, 1995). Although the deviation appears more pronounced for the sample period of 1923 to 1953, we can not conclude that earnings management was more extreme at that time. Although the more pronounced discrepancy between empirical observation and theoretical distribution can stem from differences in accounting rules and legal boundaries to strategic profit shifting, the non-stationarity in profit rates during the Great Depression and the presence of excess wartime profits may also distort the theoretical estimates, thereby creating the impression of a more pronounced discrepancy.

Indeed, for utilities and transportation corporations in specific and non-financial corporations in general, the years of the Civil War, the Great Depression, World War II and the Korean War mark the only pronounced and lasting deviations from the long-term median profit rate m and its mean deviation σ, while the cross-sectional distributions of profit rates still largely collapse onto one another when plotted together (see Appendix B, Figure 10). Thus, assumptions about stationarity on profit rates (i) and the implied distributional outcome (ii) support the idea of regularities over most of the analysed 93 years between 1863 and 2013, with deviations being closely tied to rather extreme circumstances. In similar vein, the time series behavior is characterised by regular patterns across all episodes that are well in line with regularities in implication (iii). The first three lags are generally positive and signficant, decaying approximately exponential.

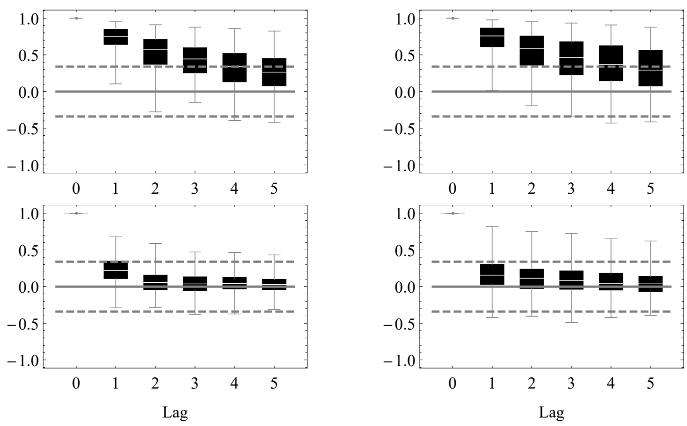
The robustness of regularities in patterns across time episodes is also reflected in the empirical distribution of year-to-year changes in the profit rate dX and of firm-specific diffusion coefficients D. The distribution of dX is similar in its parameters (see Appendix B, Table 4), collapsing onto each other when plotted together (see Appendix B, Figure 12). This supports implication (iv) of the diffusion process 1. Interestingly, year-to-year changes in the cross-sectional profit rate do not display a systematic tendency as the median change is close to zero for all episodes. A suitable narrative is zero-sum competition, which states that the gain in profitability of one corporation is related with an equally strong loss for another corporation (Porter and Teisberg, 2004; Porter, 2008). Furthermore, the heterogeneity in D_i is similar across time episodes, with ranked plots of D_i collapsing onto one another (see Appendix B, Figure 11), supporting implication (v).

Thus, assumptions and implications (i) to (v) of the reduced-form model of competitive firms presented in chapter 4 are robust w.r.t. the chosen sample of either a single industry (utilities and transportation) or the cross-section of non-financial corporations and, more importantly, w.r.t. the analysed time period. Corporate profit dynamics in the 19th, 20th or 21st century display similar characteristics, both qualitatively and quantitatively. This lends strong support to the idea of statistical equilibrium, a situ-



(a) 1923-1953 (b) 1983-2013

Figure 5: Cross-sectional statistical behavior of profit and growth rates of non-financial corporations. From top to bottom, time evolution of the annual median and mean deviation from the median profit and asset growth rates (solid) and long-run values (dashed) and the empirical density of the profit rate (dots) in comparison to Laplace distribution estimates (dashed). Sample periods are (a) 1923-1953 (136 companies, 3,967 observations) and (b) 1983-2013 (562 companies, 17,147 observations).



(a) 1923-1953 (b) 1983-2013

Figure 6: Time-series behavior of profit and growth rates of all firms. From top to bottom Box-Whisker Plots of the autocorrelation functions (ACF) of profit and total asset growth rates. Sample periods are (a) 1923-1953 and (b) 1983-2013. Dashed lines indicate the 95% confidence interval under the null hypothesis of zero autocorrelation ($\pm 1.96/\sqrt{T}$ with T being the length of time series of 31 years.).

ation in which complex and diverse interactions on the micro-level lead to regular and robust distributional patterns on the macro-level that even survive severe crisis.

6 Competition, Capital Reallocation and Crisis

In general, the impact of economic crisis on profitability appears to be negligible, especially when compared with the scale of fluctuations in other performance indicators such as firm growth.[7] Neither 1873 nor 2008 lead to a lasting deterioration in profitability, while firm growth collapses to very low yet positive levels in the aftermath of both crises. 1929 and the Great Depression constitute, besides wartime production (Civil War 1861-65, World War 2 1941-45 and the Korean War 1950-53), the only lasting deviations.

During the Great Depression, profitability drops from near 9% in 1929 to 1.0% in 1932, the worst year of the crisis, with more than 40% of companies reporting losses as compared with $1 - 3\%$ during the boom years of 1923 to 1928. Similarly, annual total assets growth was at 5.8% in 1929, came to halt in 1930, and culminated in a reversal of -6.3% in 1932, the worst year in the records (see Crum (1933) and Crum (1938) for similar results). Subsequent recovery was slow and not completed before 1941, the year the United States entered wartime production during World War II. Wartime production then and during the Civil War and the Korean War, took profitability to unprecedented and unstable highs with average asset growth fluctuating substantially.

While the nature of wartime production with governmental contracting (**?**), price controls (Kohler and Cooper, 1945) and excess profit taxation (Plehn, 1920) provides ample reason for artificial and systematic deviations from the long-run median profit rate, it is more of a puzzle why recessions and depressions, apart from the *Great Depression*, display a lack of lasting and systematic deviations. Neither the Great Panic of 1873 initiating the Long Depression, nor the Dot.Com boom and bust of the late 1990s/early 2000s or the Great Recession after 2008 display pronounced fluctuations of average profitability and dispersion of profit rates. So in what respect differs the Great Depression experience on the micro- and macro-level from other crises?

Our data covers three major episodes of turmoil that shaped the U.S. economically, politically and socially during the 19th, 20th and 21st century. In broad terms these episodes became known as the *Long Depression* (1873-1896), the *Great Depression* (1929-1939/41) and the *Great Recession* (2008-now). Although often perceived as single slumps followed by monotonic recoveries, these episodes are more often characterised by alternating phases of decline and revival of business activity. The *Long Depression* is composed of three downturns in 1873, 1882 and 1893, which had followed recovery (Beales, 1934). Similarly, the *Great Depression* is composed of two downturns in 1929 and 1937, the latter substantially less pronounced, with complete recovery not achieved

[7] Pronounced fluctuations characterize growth in all size measures available in our dataset, that is sales, costs of production and total assets.

before 1941. Table 1 summarizes key macroeconomic and corporate performance indicators for six recessionary periods within the 19th, 20th and 21st century.

[Work in progress]

Episode	Long Depression				Great Depression				Great Recession			
Variable\Year of Crisis	1873		1882		1929		1937		2000		2008	
(in %)	1869-72	1874-77	1878-81	1883-86	1925-28	1930-33	1933-36	1938-41	1996-99	2001-04	2004-07	2009-12
Macroeconomic Aggregates												
(1) Population growth	2.7	2.3	2.1	2.4	1.4	0.8	0.6	0.9	1.2	1.0	0.9	0.8
(2) Nom. GDP growth	2.6	-0.7	8.1	-0.1	2.9	-14.0	9.3	8.6	5.6	4.5	5.9	2.4
(3) Inflation rate (GDP defl.)	-4.2	-3.2	-0.1	-2.3	0.2	-7.1	1.5	1.0	1.7	2.0	2.9	1.5
(4) Unemployment rate	3.8	6.5	5.8	4.2	4.9	15,2	19.3	16.0	5.1	5.1	4.9	9.0
Output and Prices												
Agriculture												
(5.1) Wheat prod. growth	2.4	5.3	0.6	-1.8	2.1	-9.5	-4.5	1.9	2.4	0.5	-3.3	-2.7
(5.2) Wheat price ch.	2.5	-9.6	-9.0	-9.7	1.8	-11.5	22.8	-4.7	0.8	8.2	6.3	-3.8
(6.1) Cotton prod. growth	13.5	3.4	3.4	-1.6	1.5	-3.1	-1.2	-13.2	-8.3	1.8	1.3	7.8
(6.2) Cotton price ch.	-4.7	-10.5	-0.9	-6.3	-8.6	-17.8	-1.2	13.2	-9.1	3.5	0.5	12.0
Mining												
(7.1) Anthracite coal prod.	8.7	0.0	5.6	2.7	-3.8	-9.5	2.3	2.1	3.1	-27.8	4.9	10.3
(7.2) Anthracite coal price ch.	—	—	—	—	-1.0	-5.5	-1.7	2.8	4.4	9.2	1.1	5.3
(8.1) Crude oil prod.	14.6	7.8	20.0	-1.9	6.0	-2.6	8.8	2.3	-0.7	-0.5	-0.8	5.6
(8.2) Crude oil price ch.	0.1	7.2	-22.8	-2.3	-4.9	-14.8	5.8	-0.9	-5.3	12.5	25.9	4.6
Manufacturing												
(9) Motor vehicle sales growth	—	—	—	—	4.9	-22.9	35.3	0.1	14.2	-2.4	-3.5	3.1
Monetary Aggregates												
(10) Money growth (M0)	1.8	-0.7	8.2	1.6	-0.3	4.8	2.3	10.5	6.4	6.6	4.0	7.5
(11) Short-term interest rate,												
ordinary funds	3.9	2.6	2.5	2.4	1.6	1.1	0.3	0.1	5.1	2.9	3.1	0.1
surplus funds	4.5	2.2	3.2	1.9	2.9	1.2	0.6	0.6	5.5	3.2	3.2	0.1
(12) Long-term interest rate	6.4	5.9	4.9	4.2	4.7	4.7	3.8	3.0	7.2	6.7	5.5	4.6
Fiscal Balances												
(13) Nom. debt growth	-3.8	-0.5	-1.0	-4.3	-4.6	7.4	14.7	7.7	4.2	4.6	7.3	12.5
Corporate Data (SIC-Division E: Utilities)												
(14.1) Corporate growth												
in sales	5.2	-4.4	8.0	1.7	3.3	-14.0	5.4	6.3	7.7	4.3	7.4	0.0
in costs	4.3	-6.6	8.8	0.9	1.3	-13.9	6.2	5.1	7.3	4.8	7.5	-1.1
in total assets	5.7	2.5	1.7	1.4	3.6	0.9	0.4	1.3	4.8	3.9	4.8	3.9
(14.2) Return on assets (ROA)	7.7	6.6	7.3	6.4	6.4	4.1	3.9	5.0	8.1	6.5	6.4	5.9
Corporate Data (SIC-Division A-G and I: Nonfinancial Industries)												
(15.1) Corporate growth												
in sales	—	—	—	—	4.6	-15.6	7.8	6.7	6.9	4.5	8.1	0.0
in costs	—	—	—	—	3.3	-14.4	6.2	5.1	6.6	4.7	8.0	0.7
in total assets	—	—	—	—	3.7	-1.7	1.0	2.1	6.4	4.1	5.9	3.6
(15.2) Return on assets (ROA)	—	—	—	—	8.2	3.3	4.7	6.8	10.1	8.1	8.9	8.0

Table 1: Four-year geometric means of key macroeconomic and corporate aggregates for recessionary periods beginning in 1873, 1882, 1929, 1937, 2000 and 2008. Data sources are stated in the appendix.

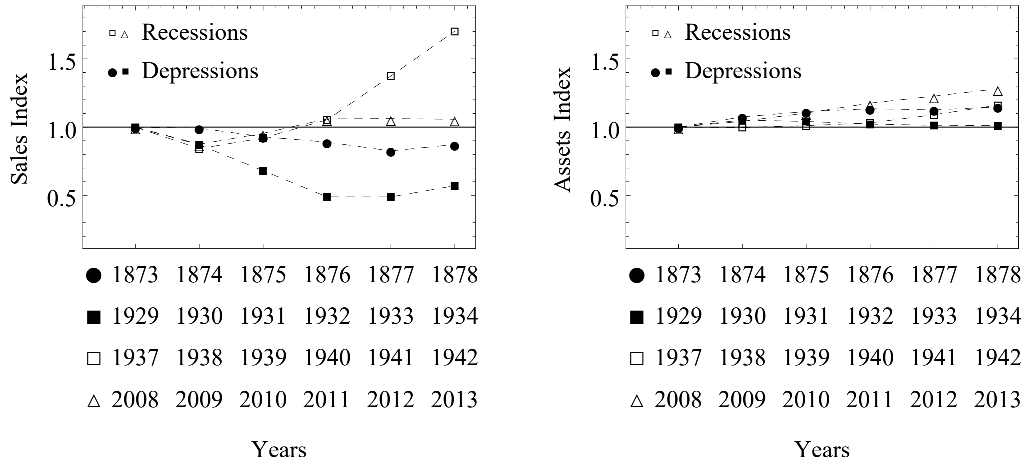


Figure 7: Index of nominal sales (left) and total assets (right) of utility corporations during the *Long Depression* of 1873 and non-financial corporations during the *Great Depression* of 1929, the *Recession of 1937* and the *Great Recession* of 2008. Base years are initial years of crisis (1873, 1929, 1937 and 2008).

Figure 7[8] reflects the firm-level experience of the crises of 1873, 1929, 1937 and 2008. While the level of aggregate sales in 1873 is characterised by almost no decline, the other three crises see similar declines during the first year.

[Work in progress]

	Country	**U.S.**		**Greece**	
	Variable\Year of Crisis	**1929**		**2008**	
	(in %)	1925-28	1930-33	2004-07	2009-12
Macroeconomic Data					
(1)	Population growth	1.4	0.8	0.3	-0.1
(2)	Nom. GDP growth	2.9	-14.0	5.3	-4.4
(3)	Nom. debt growth	-4.6	7.4	7.4	4.3
(4)	Unemployment rate	4.9	15,2	9.3	14.4
(5)	Inflation rate (GDP defl.)	0.2	-7.1	2.9	-6.5
(6)	Short-term interest rate,				
	ordinary funds	1.6	1.1	2.8	0.9
	surplus funds	2.9	1.2	2.8	0.3
(7)	Long-term interest rate	4.7	4.7	4.1	11.4
(8)	Trade openess indicator	12.4	8.6	52.7	54.8
Corporate Data (SIC-Division A-G and I: Nonfinancial Industries)					
(9.2)	Corporate growth				
	in sales	4.6	-15.6	8.0	-11.3
	in costs	3.3	-14.4	8.4	-8.0
	in total assets	3.7	-1.7	6.8	-5.9
(10.2)	Return on assets (ROA)	8.2	3.3	3.2	-1.5

Table 2: Four-year geometric means of key economic and corporate aggregates comparing the American experience in the crisis of 1929 with the crisis of 2008 from a Greek perspective. Own calculations.

[8] Restricting the latter three samples to utility corporations does not alter the results qualitatively.

The experience of the United States is by no means unique, as we find the same pattern in another hard hit country in the recent crisis: Greece. Table 2 compares the historical experience of the United States in 1929 with the situation of Greece around 2008. In macroeconomic terms, both crises take on a comparable magnitude in most dimensions, also the quantitative monetary policy and restrictions on public debt within the recent crisis lead to lower short term interest rates and decreased debt p.c. growth. The firm level outcomes give a similar impression for both countries, dominated by a decline in operating income and total assets that led to an average Greek annual profit rate of -1.5% after 2008, with about 60% of Greek companies receiving losses from operations. Time and again, with average capital accumulation stopping, firms seem to lose their ability to reallocate efficiently, thereby giving in to a decline in average profitability.

7 Concluding Remarks

Our results lend further support to the idea of a statistical equilibrium, that is a stable macroscopic distributional regularity resulting from complex interactions of heterogeneous agents. This concept of equilibrium refers to a state in which economic quantities (here: firm-specific profit rates) do not alter the median outcome nor even the functional form of the distribution on the macro-level, while displaying significant fluctuations on the micro-level. We observe a time-independent distributional regularity that survives recurring crises in all periods under analysis except for the Great Depression and the War years. After 1929, stability is lost for more than a decade with capital accumulation (total assets growth) grinding to a halt and even reversing for several years. Generally, this speaks to the time invariance of the competitive mechanism under an expanding system, which we interpret through the classical theory of capital reallocation among competing sectoral or industrial uses. Once capital accumulation ends, stability breaks down and the proposed process is not able to explain the outcome.

The observed time-invariant patterns of stability in median profit rate and mean deviation from the median profit rate, the Laplace-like distribution of profit rates, and the significant positive autocorrelation in them should make a good discipling advice in testing models and their assumptions on firm profitability. It allows us to evaluate potential statistical equilibrium models against the data (see e.g. Alfarano and Milaković, 2008; Alfarano et al., 2012), and also aids us in the further disaggregation of the process of corporate competition. Finally, in light of the historically remarkable stability of corporate profit rates, the dynamics of corporate profitability provide a robust starting point for studying fluctuations in other (operational) variables and, by virtue of Gabaix's granular hypothesis, making inferences on the overall economy.

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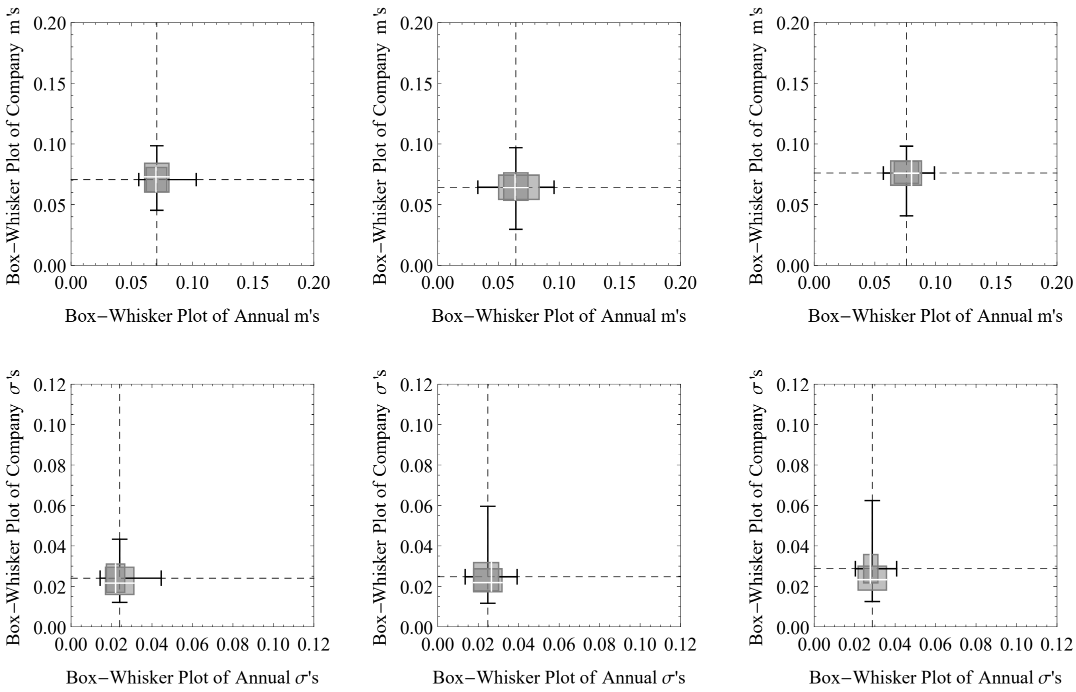
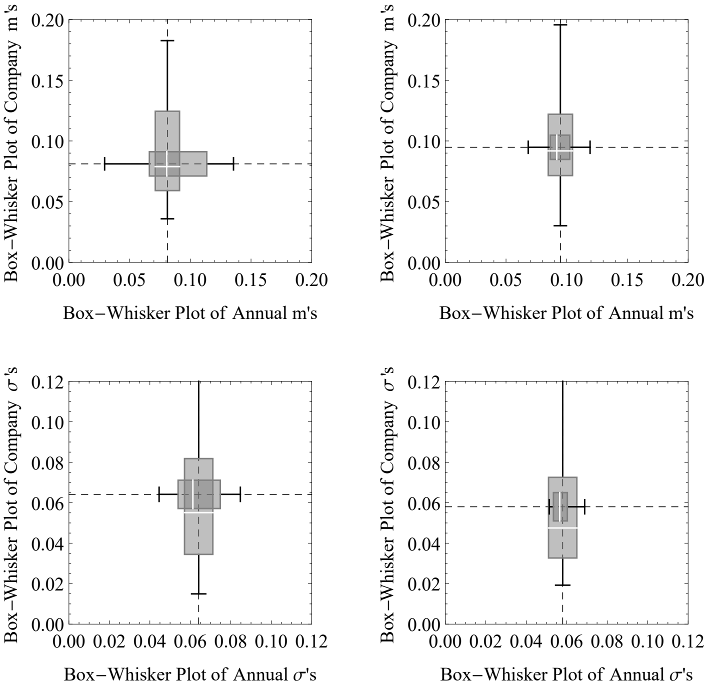
Appendix A: Stationarity and Universality

Figure 8 shows Double Box-Whisker plots of m and σ estimates for company time series (vertical) and pooled annual samples (horizontal), each centred around the phenomenological values of m and σ for the pooled data across companies and years. Although the dispersion of company-specific (and to a lesser extent annual) m's is large, their median realisation is close to the phenomenological value of the pooled data, indicated by the intersection of the dashed lines. Hence, the median profit rate across companies as well as years is substantially close to the value of the pooled distribution. The estimated dispersion parameter σ is substantially more dispersed and lower across companies than across years.



(a) (b) (c)

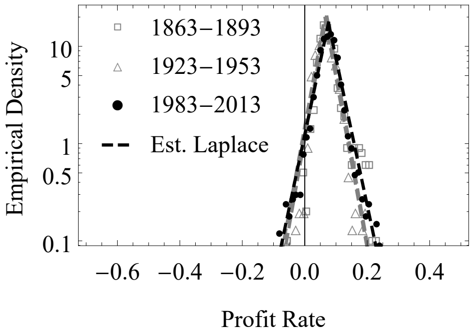
Figure 8: Double Box-Whisker Plots of the distributions of annual and company m's (upper panel) and σ's (lower panel) for the period (a) 1863-1893, (b) 1923-1953 and (c) 1983-2013. Dashed lines indicate the phenomenological estimates for m and σ for the pooled data, around which the Boxes and Whiskers are centered. Whiskers indicate the 5th and 95th percentile.



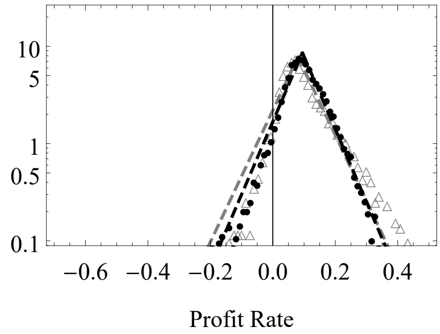
(a) (b)

Figure 9: Double Box-Whisker Plots of the distributions of annual and company m's (upper panel) and σ's (lower panel) for the period (a) 1863-1893, (b) 1923-1953 and (c) 1983-2013. Dashed lines indicate the phenomenological estimates for m and σ for the pooled data, around which the Boxes and Whiskers are centered. Whiskers indicate the 5th and 95th percentile.

Appendix B: Further Results



(a) Utilities

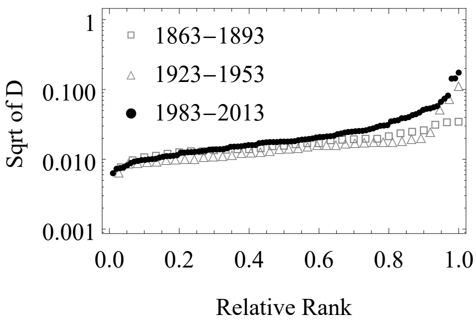


(b) Non-Financials

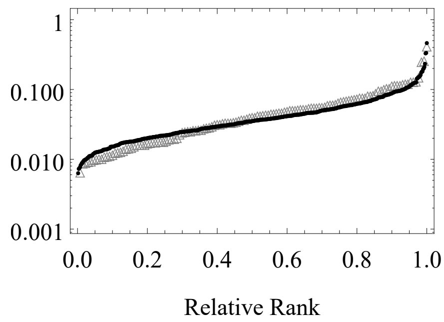
Figure 10: Cross-sectional statistical behavior of profit rates. Empirical density of profit rates for (a) utility corporations and (b) non-financial corporations for different sample periods. Dashed lines indicate the estimated Laplace distributions for the cross-sectional samples.

Sample\Years		**1863-1893**	**1923-1953**	**1983-2013**
Utilities/Railroads	m	0.0703 (0.0016)	0.0638 (0.0017)	0.0760 (0.0016)
	σ	0.0241 (0.0013)	0.0250 (0.0012)	0.0287 (0.0016)
Non-Financials	m	NA	0.0818 (0.0040)	0.0948 (0.0031)
	σ	NA	0.0642 (0.0043)	0.0580 (0.0032)

Table 3: Parameter estimates of the Laplace distribution of profit rates. Bootstrapped standard errors (from 10,000 samples) are given in parentheses.

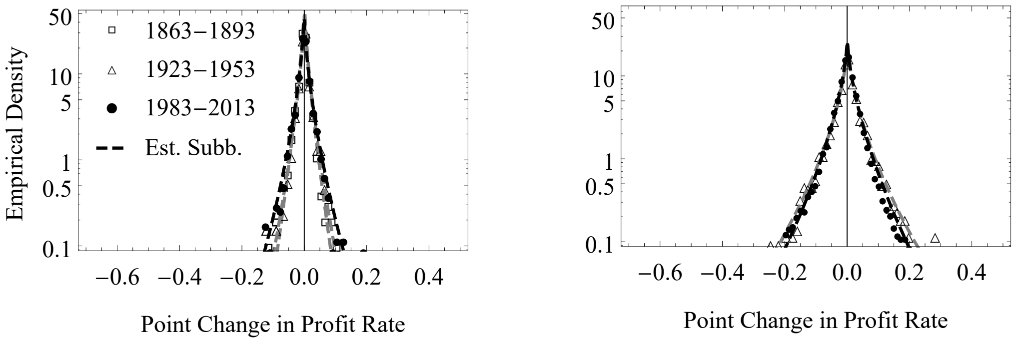


(a) Utilities



(b) Overall

Figure 11: Relative Rank order of approximate Diffusion coefficients for (a) the utilities sector and (b) the overall economy compared at different time episodes. Median D's for utilities: $\sqrt{D}_{1863-1893} = 0.0161$, $\sqrt{D}_{1923-1953} = 0.0152$, and $\sqrt{D}_{1983-2013} = 0.0179$; for the overall economy: $\sqrt{D}_{1923-1953} = 0.0399$, and $\sqrt{D}_{1983-2013} = 0.0256$.

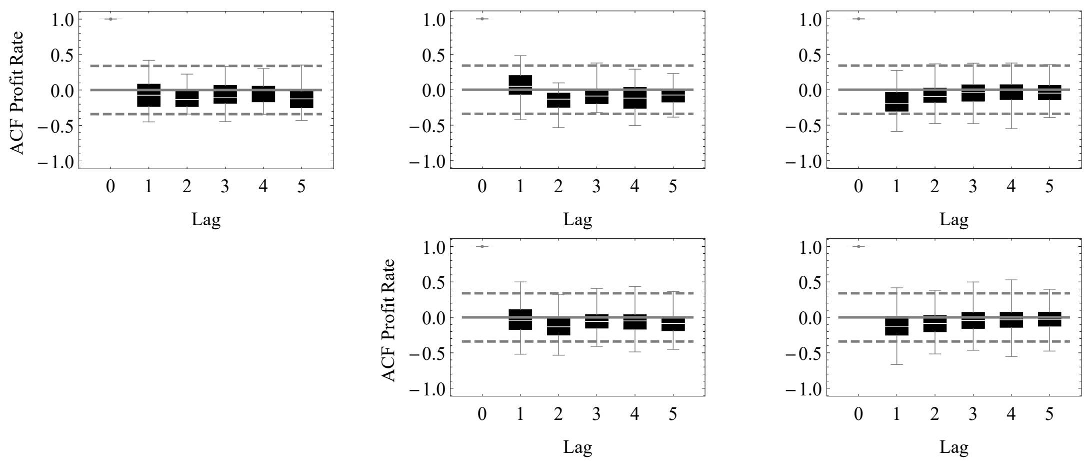


(a) Utilities (b) Non-Financials

Figure 12: Cross-sectional statistical behavior of the change in profit rates. Empirical density of the change in profit rates for (a) utility corporations and (b) non-financial corporations for different sample periods. Dashed lines indicate the estimated Laplace distributions for the cross-sectional samples.

Sample\Years		**1863-1893**	**1923-1953**	**1983-2013**
	α	0.7827 (0.0438)	0.6724 (0.0304)	0.6104 (0.0164)
Utilities/Railroads	m	0.0006 (0.0006)	0.0019 (0.0006)	0.0013 (0.0006)
	σ	0.0109 (0.0005)	0.0109 (0.0005)	0.0140 (0.0003)
	α	NA	0.5860 (0.0155)	0.6379 (0.0074)
Non-Financials	m	NA	0.0019 (0.0014)	0.0006 (0.0012)
	σ	NA	0.0273 (0.0007)	0.0247 (0.0003)

Table 4: Parameter estimates of the Subbotin distribution of the annual percentage point change in profit rates. Bootstrapped standard errors (from 10,000 samples) are given in parentheses.



(a) 1863-1893 (b) 1923-1953 (c) 1983-2013

Figure 13: Time-series behavior of annual changes in the profit rate of utility corporations (top) and non-financial corporation (bottom). Box-Whisker Plots indicate the autocorrelation functions (ACF) of annual changes in the profit rate. Sample periods are (a) 1863-1893, (b) 1923-1953 and (c) 1983-2013. Dashed lines indicate the 95% confidence interval under the null hypothesis of zero autocorrelation ($\pm 1.96/\sqrt{T}$ with T being the length of time series of 31 years.).