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Diversity of firm sizes, complexity, and industry structure in the Chinese economy

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ABSTRACT

Among the phenomena in economics that are not yet well-understood is the fat-tailed (power-law) distribution of firm sizes in the world's economies. In the present paper we discuss different mechanisms suggested in the literature to explain this distribution of firm sizes. The paper uses the China Industrial Enterprises Database to study the distribution (firm size in terms of the number of employees, capital, and gross profit) for the provinces of China for the years 1998–2008. We estimate the power-law distribution and confirm its plausibility using the KS test and the log-likelihood ratio vs. lognormal and exponential distributions. The analysis on regional levels allows an assessment of regional effects on differences in the distribution; we discuss possible explanations for the observed patterns in the light of the recent regional economic development and the economic reforms in the PRC.

1. Introduction

The distribution of firm sizes in the world's economies seems to be remarkably homogeneous and stable across different countries as well as across time. It has been characterized as fat tailed, specifically as following a power law in the tail by different studies for different regions (e.g. the US (Axtell, 2001), the G7 countries (Gaffeo et al., 2003), or China (Zhang et al., 2009)). Other studies Marsili (2005), Bottazzi et al. (2007), Dinlersoz and MacDonald (2009) found that the distribution only holds on an aggregate level across either sectors or firms of different ages – which may imply an evolutionary process or a self-organized criticality system depending on typical life-cycle developments of firms.[1] A consensus has not yet emerged and no generally accepted theory of how the distribution emerges has been found. There are, however, a number of candidate explanations as will be detailed in Section 2 below – an ongoing debate to which the present study will contribute as well. While differences in the shape and parameters of the distribution have been investigated for sectors (Marsili, 2005; Bottazzi and Secchi, 2006; Bottazzi et al., 2007) and international comparisons exist as well (Okuyama et al., 1999; Gaffeo et al., 2003) there are to our knowledge no studies of regional differences within a country. While international differences also reflect differences in political systems and

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[1] This idea was earlier proposed by Dosi et al. (1995).

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culture, regional variation may highlight what actually governs the emergence of the power law distribution and its particular shape. Of course this is also true for sectoral disaggregation, which has, however, already been studied extensively (Marsili, 2005; Bottazzi et al., 2007; Bottazzi and Secchi, 2006; Dosi, 2007; Dosi et al., 2015). This is related to the question of the very existence and persistence of diversity in firms and firm sizes (moreover in exactly this pattern), a question that also seems to require explanations related to evolutionary economics and self-organization (Nelson and Winter, 1982; Dosi et al., 1995; Kwaśnicki, 1998; Bottazzi and Secchi, 2006).

We use the People's Republic of China's[2] *China Industrial Enterprises Database* to analyze this distribution (the firm size in terms of (1) the number of employees, (2) capital, and (3) gross profit) for China for the years 1998 through 2008 both for the country as a whole and for individual provinces in Section 4. It is attempted to model the distribution as a power law – a hypothesis that is supported by the Kolmogorov–Smirnov test for measure 1 (number of employees), as well as for some regions for measures 2 and 3 – following the well-established methods laid out in, e.g. Clauset et al. (2009) or Maschberger and Kroupa (2009). The analysis on regional (i.e. province level) and sectoral levels allows us to assess differences in the distribution and their relation to the respective industry dynamics and regional specifics.

As firm size distributions are likely affected by – besides other factors – economic policy and development strategy, we devote Section 3 to this aspect. The section covers the historical development of China, its economic policy since the 1980s, and how this may have impacted the distribution of the firm size differently across different provinces and in comparison to other countries. Specifically, reforms and economic transition towards a market economy in the 1980s and 1990s led to a very different development of different regions regarding their distinctive industrial profile, geographic advantages, and cultural characteristics. It may also have provided incentive for some regions to obtain and utilize first mover advantages and to create growth opportunities for other regions. A number of coastal cities and provinces were selected as the first special economic zones to be opened to the global market in 1980s, whereas the Western and Central areas did not benefit directly from the reforms until the late 1990s. This makes the regional firm size distribution in China a historically unique example the study of which may help in understanding the processes behind the astounding properties and similarities of firm size distributions in economies around the world.

Section 2 discusses the literature on firm size distribution with particular emphasis on the possible origins of the power law shape. This is followed by considerations on recent economic history in China in Section 3. Section 4 proceeds with the empirical analysis and results for which potential explanations are introduced in Section 5. Section 6 concludes.

[2] In the following, we occasionally refer to the PRC as China; we do not have data on either Taiwan or the Special Administrative Regions of the PRC (Macao and Hong Kong).

2. Literature review

It had first been hypothesized by Zipf and shortly afterwards empirically substantiated by Mandelbrot and Simon[3] that firm sizes follow power law distributions, that is sizes s occur with frequency

$$p(s) = Cs^{-\alpha}$$

$$P(s > s^*) = \frac{C}{\alpha - 1} s^{-\alpha+1}.$$

In fact, it was conjectured with reasonable empirical evidence, that they specifically follow the Zipf distribution with exponent $\alpha = 2$.

A number of theories have been put forward, why this might be the case (both, that the measure is power law distributed, if the second conjecture is accepted, that the exponent is $\alpha = 2$). Notable theories include:

1. A Gibrat process, a scale-invariant growth process which converges (fast enough) to a steady state distribution, will yield a power law with exponent $\alpha = 2$. Further, processes with almost any growth rate distribution will lead to a distribution converging to a power law as long as there is a lower bound to the distribution (Kesten process) (Gabaix, 1999; Axtell, 2001; Delli Gatti et al., 2005; Luttmer, 2007); see also item 2.
2. Exponentially mixed Gaussians, that is, lognormal distributions mixed with exponentials lead to power laws under certain conditions. The lognormal distribution can for instance be given by a normally distributed growth rate, the exponential distribution can be assumed for other measures, such as the firm age (Coad, 2010) or the firm's product diversity (Buldyrev et al., 2007).
3. Aggregation over not power law distributed sectoral firm sizes as suggested by Dosi et al. (1995), Dosi (2007). The Bose–Einstein statistic, first suggested by Ijiri and Simon (1977) has been proposed as the distribution of growth opportunities that are subject to increasing returns following a generalized Eggenberger-Pólya-urn process and that result in Subbotin distributed (ideally, for the infinite limit Laplace distributed) firm growth rates (Bottazzi and Secchi, 2006).[4]
4. Multiplicative stochastic processes can give rise to power laws, the simplest such case being an AK model with A being drawn from a uniform distribution with nonzero mean (e.g. Zhang et al., 2009).
5. The power law property is introduced through another variable and retained in the firm size. The variable often suspected to potentially act in this way is the

[3] For a short historical overview, see Buendía (2013); for a comprehensive early theoretical account, see Ijiri and Simon (1977).

[4] It should be noted that exponential (in this theory Laplacian) growth rates should sum up to sizes that are Gamma distributed, not power law. There is limited evidence for sectoral size distributions that do not match the power law shape (Marsili, 2005; Bottazzi et al., 2007). In spite of overwhelming evidence for power law figures in the aggregated distributions, it has further been noted that scale free power law distributions should be persistent under disaggregation (Dosi et al., 2015) which may cast doubt on whether the true distribution indeed follows a power law.