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Chinese firm dynamics and the role of ownership type

A conditional estimation approach of the Asymmetric Exponential Power (AEP) density

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Abstract

This paper investigates the impact of ownership type on the entire growth rate distributional mass of Chinese firms, using a conditional estimation approach of the Asymmetric Exponential Power (AEP) density that goes beyond simple location-shift analysis. We first find a Chinese growth puzzle, i.e., a deviation from the stylized fact of the variance-scaling relationship commonly found in Western European economies. We then find, through five hypotheses, that the ownership type mainly affects the tails of the growth rate distributions. Our results also indicate that barriers of becoming a high growth firm, such as financial constraints, are especially prevalent in the Chinese private sector.

Keywords: firm growth, growth rate distributions, AEP conditional estimation, variance-scaling relationship, China, ownership type

1 Introduction

Recently, a slowdown of China's growth momentum can be observed (Eichengreen et al., 2012). To find ways of sustaining the growth path, say, in China, it is important to understand the dynamics at the level of firms. Since the adoption of an open-door policy in 1978 and subsequent liberalization efforts, the entrepreneurial environment in China has witnessed rapid and dramatic changes (e.g., Milana and Wang, 2013). After China's entry in the WTO in 2001, its firms have shown the highest productivity growth compared to other countries, driven by an increasing focus on global competition and innovation (Brandt et al. 2012). China's private sector, in particular, is increasingly acknowledged as the new engine of growth, although it faces substantial financial constraints and other institutional discriminations compared with the more protected state sector (Allen et al., 2005; Guariglia et al., 2011; Chan et al., 2012). Furthermore, the ownership type of Chinese firms – consisting of mainly state-, private- and foreign-owned firms – is reflected in terms of various differences in their innovation propensity (Guan et al., 2009) and innovation efficiency (Lin et al., 2013), in their ability to maintain and benefit from *guanxi* (Park and Luo, 2001) or political connections (Li et al., 2008), or in their exports orientation (Jefferson et al., 2003). All these aspects are expected to translate into differential growth performances and growth potentials. Yet, the empirical literature on firm dynamics in China so far only finds weak and mixed effects of the ownership type on firm performance (Peng et al., 2004; Choi et al., 2011; Ju and Zhao, 2009).

In this paper, we argue that this lack of evidence results partly from a mere focus on the average firm in the growth rate distribution. Heterogeneity in the performance is also omnipresent even within a group of ownership type (Peng et al., 2004). For example, some of the firms of the state sector have become quite competitive in the global market due to reforms and transformations of their organizational culture, and are now even considered as an important driver of economic growth, as "China's dynamo for the future" (Ralston et al., 2006). This stands in contrast to many state-owned firms which are heavily in debt and perform rather poorly (Sun et al., 2002). Heterogeneity exists also within the private sector. For example, some private- or foreign-owned firms, although confronted with less favorable financial institutions, might overcome these financial constraints by alternative channels, like retained earnings through cash flow (Guariglia et al., 2011; Poncet et al., 2010). Better performing private firms are especially more likely to receive bank loans than others (Cull and Xu, 2005). In addition, other institutional discriminations are often compensated by entrepreneurial and often more aggressive strategies (Peng et al., 2004).

We therefore expect that the mechanisms of how the ownership types affect firm performance can be observed mainly far of the mean value of the growth rates. The compensation strategies mentioned above, like the reliance on informal capital, might work for the average firm in the growth rate distribution, but become restrictively costly in the

case of high growth events. Differences in innovation-orientation involve only a rather small share of the best performing firms, whereas the protective institutions affect the survival chances of the worst performing ones. The reduced exposure to domestic and international market fluctuations of the state-owned firms might primarily be a matter of the general volatility of their growth rates. Recently the firms in the tails of the growth rate distribution have especially gained much attention by science and policy. These so-called high growth firms and their highly shrinking counterpart, otherwise neglected by a mere focus on the dynamics of the average growing firm, are acknowledged to strongly contribute to the overall growth dynamics of the aggregated economy (e.g., Delmar and Davidsson, 2003; Davidsson et al., 2006; Coad et al. 2014a). In light of recent slowdown of economic growth in China, it is of utmost interest to identify the barriers for becoming a high growth firm.

Considering the heterogeneity among and within different kinds of firms, we plea for an analysis of the entire distribution of growth rates which explicitly takes into account the ownership type. It is a stylized fact that the distribution of growth rates of economic entities show tails that are much fatter than the ones implied by a Gaussian normal distribution (e.g., Stanley et al., 1996; Bottazzi et al., 2002). The literature suggests using the more flexible asymmetric exponential power (AEP) density to account for both extreme events and asymmetry in the shape (Bottazzi and Secchi, 2011). This distributional model has been fitted unconditionally to populations of economic entities without considering their heterogeneity. For instance, Bottazzi et al. (2014) have observed that financially constrained firms differ in their growth behavior from unconstrained ones foremost in the tails, and less so in the average. Although by analyzing residual growth rates within a regression framework some control can be achieved in the mean value, the explanatory variables may still impact on other distributional characteristics (Maasoumi et al., 2007). In this paper, we introduce a new approach of estimating this distribution model conditional on other variables, in our case the type of ownership. This approach brings together the advantages of a distributional analysis with the insights gained from a traditional regression approach.

The aim of this paper is twofold. First, it seeks to investigate whether the stylized facts on the distribution of growth rates, which have been established in the context of several Western economies, survive in an East Asian economy. Any findings deviating from those found in the Western economies may help to shed light on the particularities in the firm dynamics in China. Second, it seeks to investigate the role of the ownership type on firm performance by considering its impact on the distributional mass that goes beyond simple location-shift effects.

The paper is structured as follows. Section 2 provides a brief overview of the literature on firm dynamics in China, with a particular focus on the role of the ownership types. By theorizing on the underlying mechanisms, five hypotheses are derived on how the ownership types might impact on the shape of the growth rate distribution. Section 3 discusses some data issues, and section 4 introduces the conditional estimation approach of

the AEP distribution. The results are presented and discussed in section 5, while section 6 concludes by shedding some light on the policy relevance of the findings as well as on the merits and limits of the new methodological approach.

2 Literature and hypothesis

In the literature on the growth performance of Chinese firms, the ownership type has assumed to play a pivotal role. In transition economies that experience a rapid institutional change, the organizational diversity reflected in the ownership differences is a key to understand firm structure and behavior (e.g., Peng et al., 2004; Peng et al., 2008). In China in particular, different firms of ownership types coexist and compete and are exposed to different environmental constraints and competitive advantages (Shenkar and Von Glinow, 1994). For example, firms face, depending upon their ownership types, differences in the access of external resources such as financial capital (e.g., Allen et al., 2005) or knowledge (e.g., Choi et al., 2011). Besides, these firms adopt and develop different competitive strategies (Gedajlovic, 1993), managerial heuristics and mentalities (Peng et al., 2004), or resource allocation and utilization decisions (Ju and Zhao, 2009). All these aspects should result in considerable variation in measures of performance across ownership type (Jefferson et al., 2003).

Within each ownership group, however, firms are also heterogeneous, and thus simply assessing the impact on the average firm, as argued in the introduction, might be insufficient and occasionally misleading. We therefore re-investigate the role of ownership type on Chinese firm dynamics by looking at its impact on the entire shape of the distribution. In this section, we first review the literature to outline relevant historical developments and characteristics of the various ownership types. By theorizing on different mechanisms, we then hypothesize how a specific ownership type might affect the shape of the distribution.

2.1 A brief historical account on the ownership types in China

The ownership types have emerged in different time periods. During the transition phase, private-owned enterprises (POE) and foreign-owned enterprises (FOE) emerged as new ownership types to compete with state-owned enterprises (SOE), a communist-era legacy (Peng et al. 2004). These types are complemented by collective-owned firms (COE), which are nominally owned by the local government but are often run like POE. Their organizational attributes fall somewhere between those of SOE and POE (Peng et al., 2004). While being important in the 1980s, their relevance suffered from a strong competition by POE (Milana and Wang, 2013). Because of their ambiguity and declining importance, we exclusively focus on the three main ownership types, which are characterized as follows.

State-owned enterprises (SOE)

In 1993, China has started its gradual process of privatizing SOE, based on the reform policy of 'keeping the large and letting the small go'. Four years later, in 1997, the ideological discrimination against the private sector was formally removed and in 2004, private property rights recognized by the constitution (Milana and Wang, 2013; Ralston et al., 2006). Since the onset of this process, two important quantitative changes have occurred: the absolute number of SOE as well as the employment levels within the surviving SOE strongly declined (Jefferson et al., 2003). Yet, SOE remain crucial to the Chinese economy. Milana and Wang (2013), for instance, report that the largest 118 SOE still contribute to 43% of the GDP in 2012.

Despite the cutback of formal privileges, SOE are still favored by government policies, providing them with virtually unlimited access to loans from state banks (Poncet et al., 2010; Guariglia et al., 2011) or with monopolistic positions in strategic key industries (Ralston et al., 2006; Ju and Zhao, 2009). Besides, the state as an owner concerns also about other goals than profit maximization, say, responding to social and political needs by absorbing surplus labor, in order to help to maintain social stability (Bai et al., 2006; Choi et al., 2011).

SOE are often described as a group with lowest productivity (Guariglia et al., 2011). This can be explained, on the one hand, by their tendency to build up redundancies by investing in slack resources (Qin and Song, 2009), i.e. "potentially utilizable resources that can be diverted or redeployed for the achievement of organizational goals" (George, 2005: 661). These resources, however, are often diverted from the main business toward unproductive uses (Milana and Wang, 2013). On the other hand, they are less willing to take risks (Poncet et al., 2010) or to innovate (Guan et al., 2009), or to enter new export markets (Jefferson et al., 2003). They are rigidly managed by older executives (Peng et al., 2004) and confronted with bureaucratic and inefficient structures, the lack of managerial knowledge, corruption, and agency problems emerging with malpractice or mismanagement (Choi et al., 2011, Milana and Wang, 2013).

Although these massive, inefficient and pre-reform SOE are still part of the business landscape, many have transformed to become viable and globally competitive, which are called by Ralston et al. (2006) "China's economic dynamo for the future". Relying on the state's secure supply of capital and facilitated access to credit, they have become "protectively competitive" (Milana and Wang, 2013). Hence, it is indispensable to consider this heterogeneity among SOE when studying Chinese firm dynamics.

Private-owned enterprises (POE)

In the 1980s, many POE emerged from COE, which had then been leased out to private entrepreneurs, or from privatized small SOE (Ralston et al., 2006). Although the private

sector is now formally regarded as equally important as the state sector, POE still face institutional barriers and political discriminations, such as industrial entry barriers, lack of commercial conventions, insecure property and contract rights, taxation and asset seizure from the local governments, and most notably, limited access to loans from state banks (Ralston et al., 2006; Ju and Zhao, 2009; Milana and Wang, 2013). Despite this unfavorable and rapidly changing environment, the mostly family-owned and, on average, smaller firms are regarded as the engine of macro-growth (Guariglia et al., 2011), as they show the highest levels and growth rates in terms of productivity (Jefferson et al., 2003).

Many researchers have attempted to explain the "Chinese growth puzzle" (Allen et al., 2005; Guariglia et al., 2011), i.e., China's high economic growth despite its malfunctioning financial system, by showing that POE are actually able to finance their investments through alternative channels, like internal savings (Song et al., 2011) or informal capital (Ayyagari et al., 2010). Moreover, POE are more willing to take risks and to focus on innovation (Peng et al., 2004; Jefferson et al., 2003). Their relatively simpler and flexible organizational structure, often headed by younger managers, allows them to react more quickly to opportunities and to compete against the more established SOE (Peng et al., 2004)

Foreign-owned enterprises (FOE)

Since the adoption of the open door policy initiated by Deng Xiaoping in 1978, foreign investment has flourished in China. In their relationship of business cooperation, foreign partners usually contribute technological and managerial knowledge, equipment, capital, marketing experience, while their Chinese partners contribute to land, buildings and *guanxi* (Ralston et al., 2006).

FOE are the group with the highest productivity (Hu et al., 2005; Choi et al., 2011). On the one hand, this is due to their advantage in accessing foreign knowledge. On the other hand, the parent multi-national enterprises (MNE), which operate in an environment that is less familiar to them and often more volatile, tend to provide established technologies, which makes technology more predictable and allow FOE to better utilize their resources (Ju and Zhao, 2009). Besides, they focus more strategically on the external environment in order to remain flexible within a transitioning economic system (Ralston et al. 2006).

Whereas POE and SOE primarily produce for the domestic market, FOE are the most export-oriented firms, accounting for over half of overall Chinese exports, according to Bloningen and Ma (2007). They also argue that the spectacular success of Chinese exports within the global supply chain was only possible with the contribution of foreign direct investments. In uncertain times, however, MNE also tend to divest rapidly (Milana and Wang, 2013).

2.2 Hypotheses on growth rate distributions

It is a stylized fact that the growth rate distributions of economic entities show fat tails. Empirical evidence exists at the levels of firms (e.g., Stanley et al., 1996), regional economies (Duschl and Brenner, 2013), or national economies (Fagiolo et al., 2008), and for various size measures, like employees, turnover, productivity, profits or assets (Erlingsson et al., 2013). This literature finds that growth processes cannot be described by a Gaussian normal distribution. Instead, it suggests to use more flexible distributional models, say, the asymmetric exponential power (AEP) density, to account for the two features of extreme events and asymmetry of the shape (Bottazzi and Secchi, 2011). A distributional approach to study the firm dynamics has thus far been successfully applied in the context of several Western economies. Yet, no evidence on the firm growth rate distribution exists for East Asian economies. Universality of the underlying growth mechanisms (Amaral et al., 2001), however, strongly suggests that the firm dynamics in China should show similar distributional properties.

The distributional models have been fitted unconditionally to a population of economic entities without considering the heterogeneity among them. For instance, Bottazzi et al. (2014) observe that financially constrained firms differ in their growth behavior from unconstrained ones especially in the tails, and less so in the average. Duschl (2014) shows that the shape of the firm growth rate distribution varies across regional economies. Although by analyzing residual growth rates within a regression framework some control can be achieved in the mean value, the explanatory variables may still impact on other distributional characteristics (Maasoumi et al., 2007). In this study, since we focus on the role of the ownership type on firm performance, we therefore will hypothesize on its impact on the entire distribution of growth rates by theorizing on the underlining mechanisms.

Hypothesis 1: After controlling for structural transformations, the location of the distribution of SOE is shifted to the right due to institutional privileges

During the study period, the state sector has shown weaker growth than the private sector (Allen et al., 2005). As argued, this may mainly result from current structural transformations and the demise of the state sector, implying lower growth potentials across the entire distribution of SOE. Once controlling for structural transformations by subtracting the mean value from the distribution, the growth performance of SOE might turn out to be favored by a less discriminatory institutional environment (Milana and Wang, 2013), by their better access to financial resources (Poncet et al., 2010), or by their ability to maintain and benefit from *guanxi* (Park and Luo, 2001) or their political connections (Li et al., 2008). Hence, the location shift of the distribution of SOE, as compared to POE and FOE, is expected to be positive.

The impact of these mechanisms on firm dynamics, however, is more complex than what can be captured by a simple location shift of the distribution. This is reflected in the empirical literature on ownership type and firm performance, which reports positive, negative, curvilinear or absent relationships (e.g., Peng et al., 2004; Ju and Zhao, 2009; Choi et al., 2011). Due to the mixed results, we do not expect any strong and economically meaningful differences in the central location of the distributions among the ownership types, which go beyond the mere effects resulting from structural transformations.

Hypothesis 2: High growth events, for employment and sales, are more likely among SOE due to financial constraints.

The relationship between finance and growth is well established (see Levine 2005 for a survey on the literature). In China, there exists a strong financial discrimination in favor of SOE (e.g., Allen et al., 2005; Song et al., 2011; Guariglia et al., 2011; Poncet et al., 2010). The literature, however, has also pointed out that POE and FOE are able to circumvent their constraints in the financial market to a considerable degree via alternative financing channels (Allen et al., 2005; Poncet et al., 2010). For instance, Liao et al. (2009) report that the financial sources for the interviewed POE consist of more than 50% from personal savings, 25% from family and friends, and 10% from mortgages of own assets. Bank loans and other debt sources account for only 8% and 7%, respectively. It is also found that especially better performing private firms are more likely to receive loans (Cull and Xu, 2005).

Financial constraints, however, become more binding in the case of high growth events, as a jump in the volume of sales or in the number of employees require large amounts of prior investments (Bottazzi et al., 2014). And it is also well known that firms basically bear higher costs with alternative financial sources, say, internal funds through cash flow and returned earnings or informal finance (Milana and Wang, 2013). The less financially constrained SOE are thus expected to achieve high growth rates more easily and, as a result, show fatter right tails in terms of employees and sales.

Hypothesis 3: High growth events, for productivity, are less likely among SOE, due to a lower innovation orientation, and more likely among FOE due to their access to foreign knowledge.

Productivity growth is strongly related to innovation and knowledge (Geroski, 1989). Recent literature on innovation activities in Chinese firms shows that the incentives to innovate (Guan et al., 2009), the innovation efficiency (Lin et al., 2013) and innovation output (Jefferson et al., 2003) are significantly lower in SOE. From an agency perspective, this is often explained by arguing that SOE prefer to build up slack resources, which can be seen as a "source of inefficiency that inhibits risk-taking investment and innovation and

provides managers with opportunities to engage in excessive diversification, empire building, and on-the-job shirking" (Ju and Zhao, 2009: 703).

Compared hereto, POE and FOE are much more innovation-oriented, although innovation is, in general, less important in China than in Western economies. Instead of being an innovation-driven economy, China is still regarded as an efficiency-driven economy, with mostly capital-widening efforts in traditional primary and secondary industries (Milana and Wang, 2013). The availability of technological and managerial knowledge is an important barrier that is more easily overcome by FOE (Hu et al., 2005; Ralston et al., 2006; Coad et al., 2014b). Foreign partners provide access to imitation- and innovation-relevant knowledge (Guan et al., 2009; Choi et al., 2011), which is essential for improving productivity.

Innovation is a stochastic process showing a heavily skewed distribution. If an innovation is successfully realized, however, it often translates into high growth performance. Hence, innovation activities will primarily affect the right tails of the productivity growth rate distribution. Therefore, high (positive) productivity growth events should be especially more likely among FOE and less likely among SOE.

Hypothesis 4: High decline events, especially for productivity, are more likely among SOE due to a lower selection pressure.

SOE face the lowest selection pressure (Guarglia et al., 2011). In key industries, they maintain monopolistic positions (Ju and Zhao, 2009) and often face goals other than profit maximization (Choi et al., 2011). In contrast hereto, increasing product market competition compels POE and FOE to be more efficient to survive (Ju and Zhao, 2009).

Hence, even the worst performing firms tend to survive and continue to co-exist with better performing ones, for example by exploiting local market niches (Dosi et al., 2012) or by relying on other strategic advantages, like a facilitated access to financial resources (Poncet et al., 2010; Song et al., 2011) or political connections (Li et al., 2008).

In the literature (e.g., Dosi et al., 2012), the selection pressure argument is usually made for the levels of productivity. It might, however, also hold for the dynamic changes in the productivity levels.

Hypothesis 5: General fluctuations are lower for SOE due to limited responsiveness to market fluctuations.

There are at least three reasons why SOE should fluctuate less in their growth rates. First, SOE tend to build up more excess resources (e.g., Stan et al., 2013; Qin and Song, 2009; Ju and Zhao, 2009). These redundancies, or slack resources, buffer the firms from internal

changes and stabilize and absorb fluctuations in the external environments (Pfeffer and Salancik, 2003). This is especially relevant in emerging economies, where environmental uncertainties tend to be higher due to underdeveloped institutions and highly dynamic markets (Stan et al., 2013).

Second, the objectives of their managers are only partially related to market requirements (Guan et al., 2009). Even though some of the SOE have been transformed to become globally competitive, many still serve political and social goals and stay concerned with internal aspects of stability and production (Ralston et al., 2006). This self-sufficiency makes them less dependent on shorter term market fluctuations. In addition, under state protection a business culture has been developed that is regarded as more risk-averse (Milana and Wang, 2013).

Finally, SOE are less export oriented compared to POE and especially to FOE (Jefferson et al., 2003; Bloningen and Ma, 2007; Ralston et al., 2006). Therefore, they are also less exposed to fluctuations and uncertainties of international markets. Taking all these into account, the general volatility of the growth rate distribution should be lower for SOE as compared to POE and FOE. Put differently, SOE tend to follow a more stable growth path.

3 Data

Data is obtained from the Chinese Industrial Enterprises Database conducted by National Bureau of Statistics (NBS) of China for the years from 2001 to 2006. It contains all industrial firms that report directly to the statistics *xitong* (functional bureaucracy), that is, all SOE as well as all other types of firms with more than annual sales of 5 million yuan (Holz, 2013). Empirical works using data from emerging economies have to be particularly concerned with the issues of data quality and coverage.

In a recent survey on Chinese data, Holz (2013: 2) concludes that official data in China is plentiful as a product of the "legacy of a planned economy (with its need for a large volume of data) combined with a current government actively engaged in economic policy". In the literature, Chinese official statistics are usually regarded as accurate and reliable (e.g., Chow, 2006). Besides, firm level data is not used as a direct benchmark for the performance of local governments. Hence, it should not be subject to systematic manipulations. Data errors due to a lower quality in data collection might be higher, but can be regarded as random noise.

The data covers a share of around 87% in sales and 50% in employment of the entire Chinese economy in 2004 and is highly correlated with aggregate data at the industry level (Holz, 2013). It covers many small and young firms (Guariglia et al., 2011), excluding self-employment, which is not registered as an enterprise (Holz, 2013). A break in the data

occurred in 2004, following an economic census, which implies new definitions and procedures in the data collection process (Holz, 2013). To guarantee consistency, two symmetric balanced panels are constructed for the years before (2001 to 2003) and after the break (2004 to 2006).

Firm growth is a multi-dimensional phenomenon, with no universal best size indicator (Gilbert et al., 2006; McKelvie and Widklund, 2010). We therefore study the growth of three alternative size measures: number of employees, sales, and productivity. Whilst the former two can be readily obtained from the data, we follow the related literature (Dosi et al., 2012) and conceptualize productivity as labour productivity, which, according to the OECD (2001), is the industrial output minus the intermediate inputs per employee. All monetary data are deflated relative to the base year of 2001 using an industry-specific producer price index provided by the NBS.

The three ownership types used for this study are grouped by the fraction of paid-in-capital contributed by different types of investors. This procedure is suggested by the literature (e.g., Jefferson et al., 2003; Guariglia et al., 2011), because the official registration codes are not reliable, as they are only updated with delay and state ownership can change meaning over time (Holz, 2013). SOE consist of state investors, POE of legal entities and individuals, and FOE of foreign investors including Hong Kong, Macao and Taiwan. As multiple types of investors may own a company, the absolute majority rule is applied. Guariglia et al. (2011) argue that this reduces measurement errors in the capital variable. The shares of investors are calculated over the growth period to reduce the potential bias resulting from firm transitions, for example from SOE to POE (Jefferson et al., 2003; Guariglia et al., 2011). The drop in the number of firms due to the requirement of having at least 50% of one investor type is small (1.4% of total firms).

Finally, the following preparation steps are performed to increase the reliability of the results. First, all firms with negative or zero sales are excluded (resulting in a drop of around 0.9%). Second, all firms with less than five employees are excluded (0.3%), because micro-firms tend to show a rather stochastic growth process. Third, outliers are excluded (0.2%), following the procedure proposed in Bottazzi et al. (2014). Descriptive statistics on the data are provided in Table 1.

Tab. 1: Descriptive statistics

	N_{firms} *(relative share in growth period)*		*Average size*		
	2001-03	2004-06	Employees	Sales	Productivity
SOE	15,131 (17.5%)	8,452 (4.8%)	643.9	131,147.1	42.2
POE	54,767 (63.7%)	135,348 (76.4%)	214.8	507,26.2	64.9
FOE	16,100 (18.7%)	33,367 (18.8%)	353.5	119,401.5	94.4

Note: Sales and productivity are measured in 2001 US dollars.
Source: Chinese Industrial Enterprises Database (2000-2006).

The sample share of SOE declined from the growth period of 2001-03 to 2004-06 almost fourfold, reflecting the structural transformations at that time, whereas the share of POE increased by 12.7% and the share of FOE remained constant. POE is the largest ownership group in numbers, but these firms are, on average, much smaller than SOE or FOE in terms of both employees and sales. The SOE are, on average, the largest with these two size measures as well, especially with employees. We can also see that labor productivity is lowest for SOE and highest for FOE, which is in accordance with the literature (e.g., Jefferson et al., 2003; Guariglia et al., 2011).

As a byproduct of their specific historic background and the existence of entry restrictions in certain industries, the ownership types are not equally distributed across industries. Pearson's correlation coefficient for the number of manufacturing firms at the 2-digit industry level between POE and SOE is 0.707, between POE and FOE 0.617, and between SOE and FOE 0.198. Given that industries exhibit different patterns of growth dynamics, innovation processes and competitive intensities (e.g. Breschi, et al. 2000; Malerba, 2002), and thus may drive the results instead, this industry composition effect is controlled for in our estimation, which will be discussed in the following section of methodology.

4 Methodology

The growth rates $g_{i,o,t}$ for the two growth periods t = {2001, 2004} are calculated for each firm *i* based on the size levels $S_{i,o,t}$, represented by either employees, sales or productivity, by using the logarithmic definition that follows Gibrat's law:

$$g_{i,o,t} = \log(S_{i,o,t+2}) - \log(S_{i,o,t}), \quad (1)$$

with *o* denoting the ownership type. To control for macroeconomic fluctuations, the mean within a growth period is subtracted from the growth rates. The growth rates are then de-meaned by the ownership-specific mean for each growth period, because the growth within these ownership categories is strongly affected by general structural transformations in China, mainly by the attempt of down-sizing the state sector.

The inverse relationship between S and the variance of g is known to be a universal feature in the growth of complex economic organisations (Amaral et al., 2001). To rescale the growth rates, we follow Bottazzi et al. (2014) in modelling this variance-scaling relationship directly by introducing a heteroskedasticity term into the stochastic growth process:

$$g_{i,o,t} = \exp\left(\beta_o(s_{i,o,t} - \bar{s}_o)\right) e_{i,o,t}, \tag{2}$$

with $s_{i,o,t} \equiv \log(S_{i,o,t})$ and $\bar{s}_i$ denotes the corresponding ownership-specific mean. This expression takes into account the observation that the functional form of heteroskedasticity might be non-linear (e.g., Bottazzi et al., 2011). Be rearranging equation (2), we get:

$$e_{i,o,t} = \frac{g_{i,o,t}}{\exp\left(\beta_o(s_{i,o,t} - \bar{s}_o)\right)}, \tag{3}$$

which yields the rescaled growth rates $\tilde{g}_{i,o,t} := e_{i,o,t}$. Anticipating non-normality, equation (4), which solves for the rescaling parameter β, is estimated by minimizing absolute deviations (LAD):

$$\{\beta_o\} = \operatorname{argmin}_\beta \sum_i \left| \frac{g_{i,o,t}}{\exp\left(\beta_o(s_{i,o,t} - \bar{s}_o)\right)} \right|. \tag{4}$$

The rescaling step, which cleans the data from heteroskedasticity, is performed for each ownership type separately to account for possible differences in the variance-scaling relationship.

The rescaled growth rates can be perceived as stochastic realizations from an underlying probability distribution. The literature suggests that the asymmetric exponential power (AEP) density reasonably describes the empirical growth rates (e.g., Bottazzi and Secchi, 2011; Fagiolo et al., 2008; Duschl and Brenner, 2013). Its density function reads:

$$f_{AEP}(g;\, b_l, b_r, a_l, a_r, m) = \frac{1}{C}\exp\left(-\left[\frac{1}{b_l}\left|\frac{g-m}{a_l}\right|^{b_l}\theta(m-g) + \frac{1}{b_r}\left|\frac{g-m}{a_r}\right|^{b_r}\theta(g-m)\right]\right), \tag{5}$$

where $\theta(.)$ is the Heaviside theta function, $C = a_l {b_l}^{1/b_l - 1}\Gamma(1/b_l) + a_r {b_r}^{1/b_r - 1}\Gamma(1/b_r)$ a normalization constant, which contains the gamma function $\Gamma(.)$. Five parameters define this distribution: the location parameter *m*, which indicates the central tendency in the data, the two scale parameter a_l and a_r, which determine the spread or dispersion of the distribution for the values below and above *m*, and the two shape parameter b_l and b_r describing the tail behaviour on the left and right side of the distribution. Both the normal ($b_l = b_r = 2$) and Laplace ($b_l = b_r = 1$) are special cases of the AEP family of

probability densities. It allows for a continuous variation from non-normality to normality, with a smaller shape parameter b_l or b_r representing fatter tails of the corresponding density. Finally, it is able to cope with asymmetries in the data with the left and right hand side parameters.

This distribution, which is sufficiently flexible to account for fat tails and asymmetries, is fitted to the sample data by using maximum likelihood. Mathematical details and related inference issues are discussed in Bottazzi and Secchi (2011). Here, we rather focus on two dimensions of heterogeneity in the firm population that might bias the results: firms belong to different industries and ownership types, and both dimensions might affect the entire distribution in complex ways, not only the average value of the growth dynamics. As the focus of the paper is primarily on the latter dimension, two different strategies are hence proposed.

First, to control for the industry composition effect, the estimation of the AEP likelihood function is weighted by the share of a firm's industry at the entire economy relative to its ownership-specific share. The industries that are underrepresented in one ownership type will then be compensated by higher weights of their firms, calculated according to this share, in the estimation of the distribution.

Second, to directly address and quantify the impact of the ownership type on the distribution, all distributional parameters of the AEP are assumed to be conditional on the ownership type. The distributional function of the conditional AEP now reads

$$\begin{aligned} F_{AEP}(g;\ b_l &= b_{l,0} + \beta_{bl}X, \\ b_r &= b_{r,0} + \beta_{br}X, \\ a_l &= a_{l,0} + \beta_{al}X, \\ a_r &= a_{r,0} + \beta_{ar}X, \\ m &= m_0 + \beta_m X), \end{aligned} \tag{6}$$

where X is a matrix containing the conditioning variables, and $\{\beta_{bl}, \beta_{br}, \beta_{al}, \beta_{ar}, \beta_m\}$ a set of coefficients containing the magnitude of the effects of X on the distributional parameters $\{b_{l,0}, b_{r,0}, a_{l,0}, a_{r,0}, m_0\}$. The ownership type is represented by a dummy variable. Here, we assume the benchmark to be POE, hence X contains in our case $\{d\_SOE, d\_FOE\}$.

The proposed method can be regarded as a generalization of ordinary regression models (Varian, 2014). Regression models, even if adjusted by more realistic assumptions on the error term, are designed to capture the effects on the average value of the dependent variable, or in other terms, to capture the "location-shift effect […] in the conditional distribution of the dependent variable" (Bottazzi and Secchi, 2013: 2). Following a distributional perspective it becomes clear that "the variables may continue to impact on other distributional characteristics" (Maasoumi et al., 2007: 449). Taking into account the fundamental heterogeneity of economic processes and the therefrom expected heterogeneity

in the responses of economic entities to specific independent variables, a focus solely on the location-shift effect would draw a picture that is much too narrow.

Finally, the significances of the effects of the conditioning variable on the parameters can be obtained within the maximum likelihood framework by implementing the likelihood-ratio test.

5 Results

We separate the discussion of the results into two parts. In the first part, the scaling parameter β from equation (4) is contrasted with the findings reported in the literature on Western economies. In the second part, the growth rate distributions for the three alternative size measures are investigated. Here, both the general properties of the distributions and the impact of the ownership type on firm performance are discussed.

5.1 The variance-scaling relationship – another Chinese growth puzzle

In the literature, the variance-scaling relationship has to our knowledge not yet been investigated explicitly for Chinese firms. Our findings suggest that there exists a clear negative relationship between the variance of the growth rates and the size of the firms (see Table 2). The scaling parameter β, however, is strikingly lower than expected. Studies on Western economies robustly report that β lies in a narrow range between -0.15 (e.g., Stanley et al., 1996; Amaral et al., 2001) and -0.20 (e.g, Amaral et al., 1997; Bottazzi et al., 2011). Here, β is found to be much smaller in absolute terms: it ranges from -0.057 (employment growth in SOE) to -0.120 (productivity growth in SOE).

Tab. 2: The estimated variance-scaling parameter β

	Variance-scaling parameter β		
	Employees	Sales	Productivity
SOE	-0.057	-0.096	-0.120
POE	-0.085	-0.078	-0.061
FOE	-0.066	-0.064	-0.065

Is this deviation from a well-established stylized fact a statistical artefact (due to some data issues) or does it convey any economic meaning? Although the former cannot be ruled out ultimately, it might be insightful to look into the models that explain the emergence of the variance-scaling relationship for the latter. In the literature, two main competing models exist. On the one hand, a tree-based hierarchical model (e.g., Stanley et al. 1996, Amaral et al. 1997), which makes assumptions on the internal structure of the firms, suggests that if the subunits of a firm fluctuate independently, β should be -0.5. The higher the positive correlations among the firm's units at different levels, the closer β approaches 0. Our observed scaling relationship should therefore lie within these two limiting cases (see Figure 1).

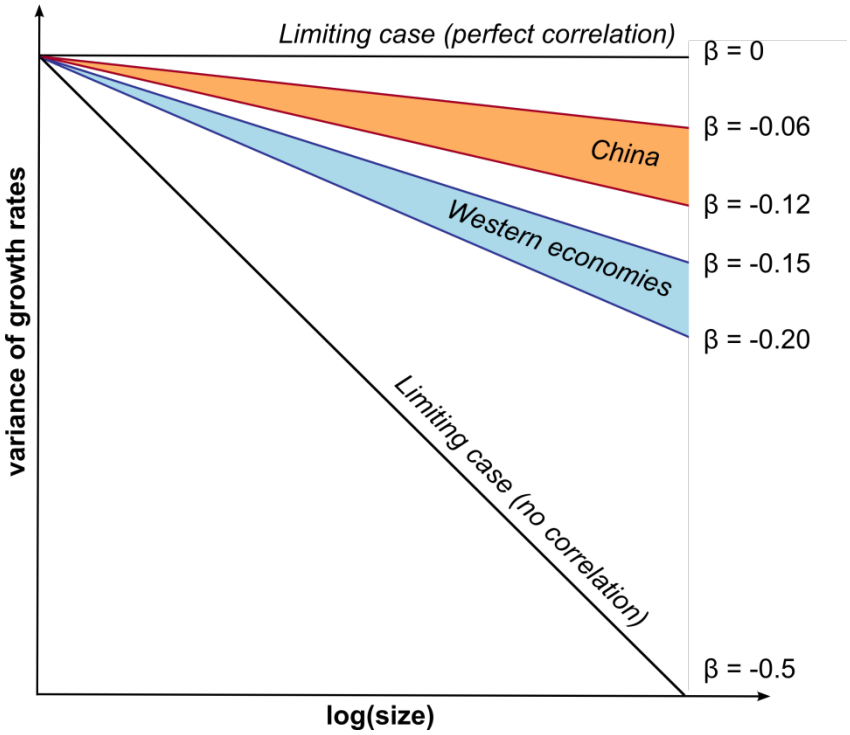

Fig. 1: Variance-scaling relationship in China and Western economies with limiting cases from tree-based hierarchical model

In the Chinese business culture, there is strong emphasis on hierarchical structures (Ralston et al., 2006; Peng et al., 2004). The top-down control in Chinese firms is more stringent, implying that the managerial decisions at upper levels should have a higher statistical impact on the decisions made at lower levels (Stanley et al., 1996). As the sub-units are less independent in China, this model would suggest a lower β compared to Western economies and is thus in line with our findings.

On the other hand, Bottazzi and Secchi (2006: 848) show that the variance-scaling can be explained by "a similar scale relation that exists between the size of the firm and its diversification structure". In other words, the variance-scaling relationship can be directly derived from the firms' diversification pattern. Using data on Italian pharmaceutical firms, they find that the number of active sub-markets is exponentially related to the size of the firm, as the firms' "ability to effectively enter in new sub-markets progressively increases with the number of sub-markets already penetrated" (Bottazzi and Secchi, 2006: 871). Thus, they propose a stochastic branching model of firm diversification, in which all active sub-markets become possible sources of new diversification events.

This competence-based diversification is in line with the Penrose's (1958) theory on the firm. In the context of an emerging economy like China, the evolutionary idea that firms learn how to diversify (Dosi et al., 1995) is less a matter of the incremental development of technological capabilities and product innovations, but rather related to the daily struggle of survival in uncertain environments. The lower β found in China would imply that the "scope economy to diversification" argument due to learning (Bottazzi and Secchi, 2006) becomes even relatively more important. However, the variance-scaling relationship could have other possible origins, like the way in which the activities of a firm are distributed or concentrated among its active markets.

To sum up, this deviation from a well-established stylized fact is another "puzzle" in the Chinese growth literature. Therefore, future research should try to test the theoretical models on the variance-scaling more explicitly, for example by exploiting data at the product or sub-market level. The focus of this paper, however, is on the growth rate distribution and the role of the ownership type, which is the topic of the next section.

5.2 The growth rate distributions of Chinese firms – the type of ownership matters

The study of the entire growth rate distribution provides a comprehensive picture on firm dynamics. In section 2, several mechanisms are proposed on how the ownership type might affect the distribution. Therefore, the AEP distribution is estimated conditional on the ownership type. The results for employees, sales and productivity are reported in Table 3. The upper part of this table reports the estimated coefficients for intercepts in equation (6), which represent the distributional parameters after conditioning, while in the lower part it contains the coefficients of the ownership dummies and the corresponding p-values. Hence, it shows the effects (and their significance) of belonging either to the group of SOE or FOE, compared to the baseline of POE on the corresponding distributional parameter.

Tab. 3: Results from conditional AEP estimation

	Employees		*Sales*		*Productivity*	
	coef.	p-values	coef.	p-values	coef.	p-values
$b_{l,0}$	0.633		0.904		1.040	
$b_{r,0}$	0.784		1.483		1.238	
$a_{l,0}$	0.262		0.399		0.641	
$a_{r,0}$	0.309		0.636		0.746	
m_0	-0.075		-0.205		-0.119	
b_l *d_SOE*	0.035	0.0001 ***	-0.011	0.4978	-0.171	0.0000 ***
b_l *d_FOE*	0.008	0.2380	0.007	0.5572	0.030	0.1897
b_r *d_SOE*	-0.320	0.0000 ***	-0.333	0.0000 ***	0.100	0.0014 **
b_r *d_FOE*	0.093	0.0000 ***	-0.096	0.0000 ***	-0.004	0.8310
a_l *d_SOE*	0.015	0.0000 ***	0.111	0.0000 ***	0.126	0.0000 ***
a_l *d_FOE*	-0.015	0.0000 ***	-0.019	0.0002 ***	0.045	0.0000 ***
a_r *d_SOE*	-0.129	0.0000 ***	-0.169	0.0000 ***	0.041	0.0036 **
a_r *d_FOE*	0.015	0.0000 ***	-0.053	0.0000 ***	0.055	0.0000 ***
m *d_SOE*	0.062	0.0000 ***	0.017	0.1794	-0.042	0.0173 *
m *d_FOE*	0.013	0.0000 ***	-0.036	0.0014 **	-0.069	0.0001 ***

*p-values: * < 0.05, ** < 0.01, *** < 0.001*

To be more intuitive, the growth rate distributions in terms of employees, sales, and productivity are visually represented in Figure 2 through 4, which is only possible because the conditioning variables are binary. Hence, the data can be split into three subsets and the parameters of the AEP estimated for each ownership type separately. The densities are normalized such that they cover the same area, and centered to zero to control for (ownership-type specific) structural transformations.

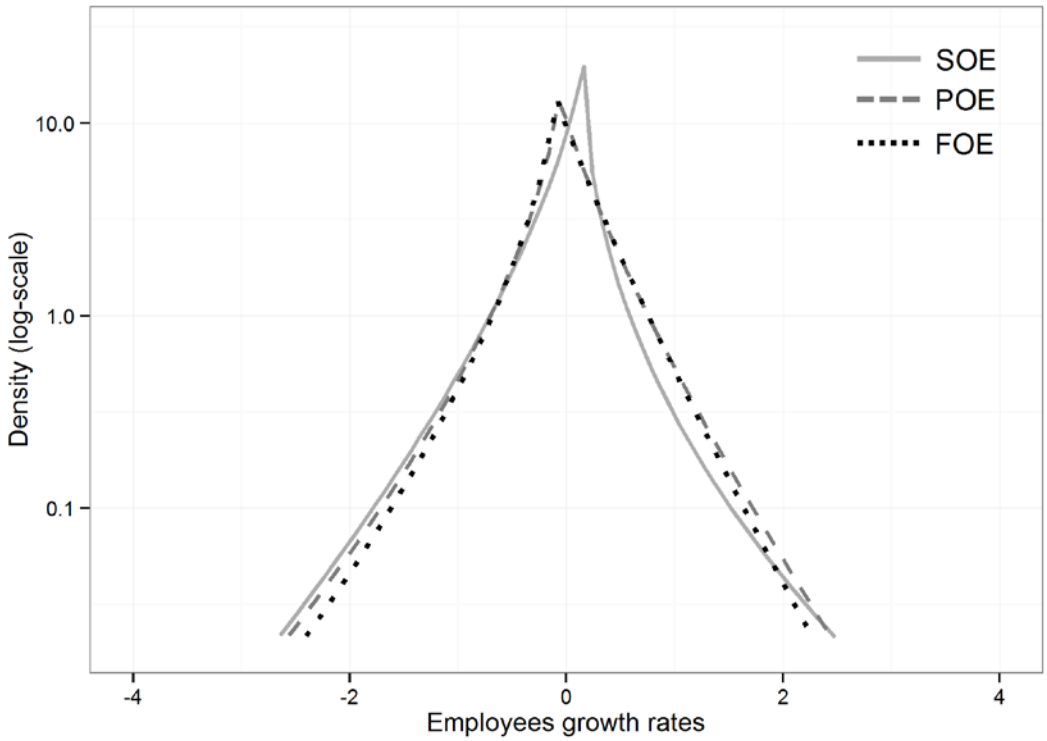

Fig. 2: Growth rate distributions for employees

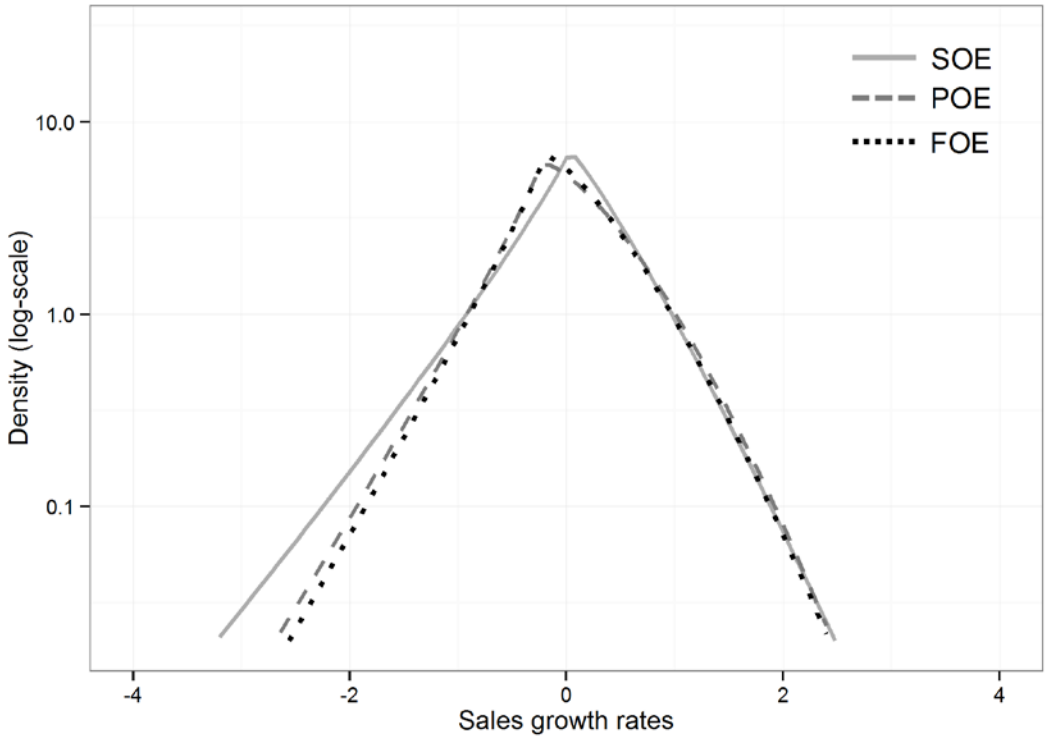

Fig. 3: Growth rate distributions for sales

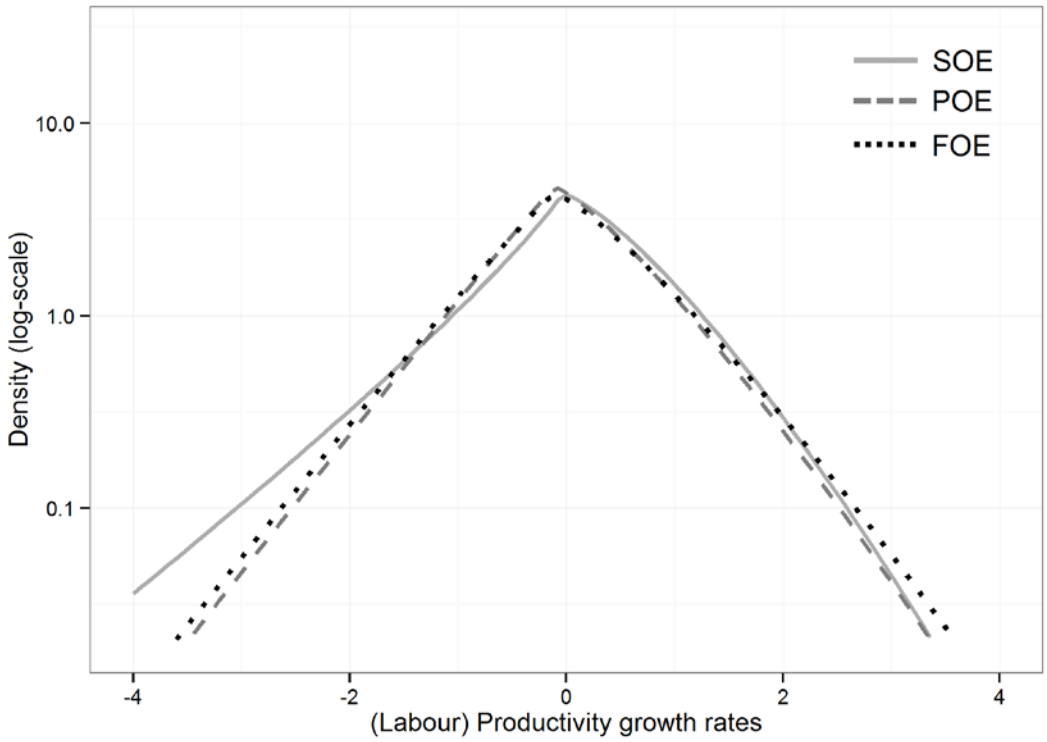

Fig. 4: Growth rate distributions for (labour) productivity

General properties of the growth rate distributions of Chinese firms

The distributional analysis of the growth rates shows that extreme growth events, especially negative ones, are a prominent feature of firm growth in China. This finding confirms one of the most robust stylized facts on firm growth for the case of China – the presence of fat tailed and asymmetric growth rate distributions. Thus, it provides new evidence for an emerging Asian economy and complements the study of Mathew (2012) on Indian manufacturing firms.

Fat tails are observed in the literature independent of the measure for size (Erlingsson et al., 2013). However, we note important differences among employees, sales and productivity. For employees, both b_l and b_r are clearly lower than 1, hence the tails are much fatter than those of a Laplace distribution. For sales and productivity, the left tails are similar to the Laplacian ones. The right tails, however, are the least fat ones. In case of sales, they even come close to the shape of the Normal distribution, with b_l around 1.5.

The fatter tails for employees can be explained by the nature of the growth process. Firms often make lumpy adjustments to their employment level, which are, due to non-convexities and irreversibility either large or nil (Caballero et al., 1997; Coad, 2012). Haltiwanger (1997), for instance, observed that plants spend a large fraction of time within +-30% of their desired employment level. If they do grow, extreme growth events become more likely

(Duschl, 2014). This is reflected in the peaked and fat tailed shape of the growth rate distribution.

More intriguing is the finding of the right tails of sales and productivity. These are less fat, especially for sales, than usually found in the literature on Western economies (e.g., Reichstein and Jensen, 2005; Bottazzi et al., 2014). In other words, high positive growth events are less likely among Chinese firms. Two explanations can be brought forward. The first relies on the observation that Chinese firms are still less innovation-oriented (Milana and Wang, 2013). An engagement in knowledge-based activities, as has been shown in Duschl and Brenner (2013), is correlated with the fatness of the tails. The second explanation is based on the idea that there might be some barriers to growth, like the access to financial resources and knowledge, management and marketing problems, or regulatory obstacles (Coad and Tamvada, 2012; Coad et al., 2014b), making the realization of high growth events, in contrast to decline events, much more difficult to achieve.[1] As outlined in the conclusion, this finding might have important policy implications.

The role of the ownership type for firm dynamics in China

Another striking finding is that the shape of the distribution is strongly influenced by the ownership type. In the remainder of this section, the results are confronted with the hypotheses of section 2.

Starting with the effect of the ownership type on the central location of the distribution, *hypothesis* 1 is confirmed in case of employees: the growth rate distribution of SOE, which are institutionally privileged in China, is shifted towards the right. For the other size measures, however, the effect is either insignificant (sales) or only slightly significantly negative (productivity). Besides, the distribution of FOE, as compared to POE, is shifted towards the right for employees, and towards the left for sales and productivity. It was argued that the central location of the distribution is not of high interest, as it mainly concerns the firms that do not grow much in absolute terms. Rather, growth events far off the center are relevant, as they crystallize the underlining mechanisms as well as contribute more to macro-economic dynamics.

To begin with, SOE are much more likely to become high growth firms in case of employees and sales, confirming *hypothesis* 2. A non-negligible share of SOE, having virtually unlimited access to financial resource and operating under conditions of global competition, is able to show a superb performance (Ralston et al., 2006). This shift of the

[1] To account for the fact that the distribution move closer to the normal one with an increased time lag (Bottazzi and Secchi, 2006b; Duschl and Brenner, 2013), we also study 1-year growth rates. As expected, b_r becomes lower, however clearly remains above 1 for sales and productivity. This decrease was relatively larger for sales, indicating that it is more difficult to sustain high growth over longer time periods, a feature of high growth firms, especially in case of sales.

distributional mass towards the right tail becomes clearest visible for employees (see Figure 2). In addition, we find that FOE are significantly more likely to show high growth events in case of sales compared to POE, probably as their foreign partner might contribute critical resources in prospect of economic opportunities. In the case of employees, it is the opposite: FOE have the thinnest right tails, reflecting the observation that POE tend to follow a more aggressive and growth-oriented business strategy, whereas FOE tend to concentrate on established technologies of their core business (Peng et al., 2004; Choi et al., 2011).

In the case of productivity growth, SOE are less likely to show high productivity improvements, supporting *hypothesis* 3 as a consequence of their lower orientation towards innovation. Apart from our expectation, no significant difference is found between POE and FOE for b_r. This difference, however, is rather reflected in the general volatility measure of a_r, which is higher for FOE compared to POE. It remains an open question why FOE, which have better access to foreign knowledge and higher innovation capabilities, seem to be prevented from becoming also high growth firms in productivity, that is, why they cannot be found so much in the right tails of the distribution.

High decline events, as captured by b_l, are significantly more likely for SOE in the case of productivity. As argued in *hypothesis* 4, these worst performing firms are still able to survive due to the lower selection pressure faced by SOE. No difference is found in the case of sales, and of employees, SOE are even less likely to show extreme negative growth events. The latter finding might be explained by the political reluctance of abruptly laying off large amount of employees in the state sector. Taking into account simultaneously the general negative fluctuations a_l, it becomes clear that there is a strong overall shift of distributional mass towards the left for SOE (but less strong so for employees), underlining the selection pressure argument.[2] Finally, no difference in the left tail behaviour is found among FOE and POE.

In *hypothesis* 5, three mechanisms – slack resources, self-sufficiency and export-orientation – are brought forward why the general volatility of the growth rate distribution should be lower for SOE, resulting in a more stable growth path. The relatively small and highly significant coefficients confirm this expectation in case of employees and sales for a_r. For productivity growth, however, a_r is significantly larger for SOE. Here, the three mechanisms do not seem to be at work. Rather, one might argue that SOE show the highest heterogeneity in their performance, with many firms performing very poor (but still survive) and many firms performing quite well (Ralston et al., 2006). For the left side, fluctuations are higher among SOE, conflicting with the hypothesis. We can explain this finding only by arguing that the selection pressure argument, as outlined above, might outweigh these

[2] Comparing 1-year and 2-year growth rates, it is found that both the tails and volatility of the left side decrease less strong over time for SOE than for POE and FOE. As selection forces should become more effective in case of sustained poor performance, this finding provides additional indirect evidence for the selection pressure argument.

mechanisms. To conclude, it is important to acknowledge the complex interplay between the various parameters.

6 Conclusions

The conclusion is dedicated to the discussion of the policy relevance of the findings as well as the merits and limits of the new conditional estimation approach of the AEP distribution.

The analysis of Chinese firm dynamics has shown the importance of taking into account the entire distribution of growth rates. Our findings are particularly relevant in light of the recent slowdown of China's growth momentum. In the literature, it is stressed that growth-oriented firms and innovative entrepreneurship are the engine of economic development and a key factor for maintaining sustainable growth paths (Delmar and Davidsson, 2003; Davidsson et al., 2006; Coad et al., 2014). In this paper, however, we provide evidence that high growth events are less likely among Chinese firms, especially in case of sales and productivity. This fact is attributed, on the one hand, to Chinese firms' lower innovation orientation and capability. To increase the pool size of potential high growth firms, policy might set incentives and provide support such that firms go beyond their focus on input factor accumulation and labor-intensive activities with low technology content, but undertake innovations and productivity improvements (Milana and Wang, 2013). In addition, in the policy forum of the Science magazine, Cao et al. (2013) discuss the historical roots of the underperforming Chinese innovation system and possible pathways for political interventions. On the other hand, it was reasoned that some significant barriers of growth exist, making especially the realization of high growth events more difficult to achieve. These barriers seem to be strongest for the private sector due to financial constraints and other institutional discriminations. If external finance had been available less restrictively, these quite efficient POE and FOE would have been able to grow at even higher rates, as they would not have had to rely on more expensive alternative sources to finance their growth (Guariglia et al., 2011; Song et al., 2011). Even though high growth was possible in the past, some growth potential was missed and is in danger of being missed in the future. Hence, policy is suggested to increase its effort to improve the capital market and to focus on the remaining discriminations against the private sector (Milana and Wang, 2013; Chan et al., 2012). This is also visible in the relatively lower selection pressure SOE face, which might be addressed by removing their monopolistic market positions and establishing a competitive economic environment.

The conditional estimation approach of AEP distribution combines the advantages of both traditional regression models and unconditional distributional analyses. Compared to regression approaches, it accounts for the fact that the variables, like ownership type, might

impact not only on the average or some specific arbitrarily chosen quantiles of the growth rate distribution, but on the central location, the variance, the tails or the asymmetry, i.e. on the entire shape of the distribution, *simultaneously*. For instance, studying the shifts of distributional mass towards the tails is of high interest due to the importance of the fastest growing firms to the dynamics of the aggregated economy. But this approach also goes beyond the insights from an unconditional distributional analysis. The value of a conditional approach was already outlined by Bottazzi et al. (2014), who visually inspect the complex effects of financial constraints on the entire shape of the firm growth rates distribution. Moreover, high growth firms, which populate the right tail of the distribution, might be studied without the requirement of delimiting a sub-population *ex ante*, for example by choosing some arbitrary growth rate distribution (on the difficulties of measuring high-growth firms see also Delmar et al., 2003; or more recently Coad et al., 2014a). In this paper, we introduce this approach by investigating the simultaneous impact of binary variables, i.e., the ownership dummies, on five parameters of the AEP, which allows us to inspect the results with a complementary visual assessment. This approach may become even more interesting for continuous variables, such as R&D, exports or financial variables, which would allow us to test the proposed mechanisms more directly and for which visual comparisons are only possible by subsetting the data using some arbitrary thresholds.

Two main disadvantages remain. First, a distributional model must be assumed in the first place. In the context of firm growth, however, there is widespread agreement that the AEP provides a reasonable description of the reality (Fagiolo et al., 2008). Second, the numerical optimization of the corresponding likelihood function is computational expensive, with each conditioning variable introducing five new parameters to estimate. Even so, this approach will become even more promising for future research, as computational costs are an increasingly less restrictive factor.

References

Allen, F., J. Qian and M. Qian (2005), 'Law, finance and economic growth in China', *Journal of Financial Economics*, **77**, 57-116.

Amaral, L., S. Buldyrev, S. Havlin, P. Maass, M. Salinger , E. Stanley and M. Stanley (1997), 'Scaling behavior in economics: The problem of quantifying company growth', *Physica A*, **244**, 1–24.

Amaral, L., P. Gopikrishnan, V. Plerou and E. Stanley (2001), 'A model for the growth dynamics of economic organizations', *Physica A*, **299**, 127–136.

Ayyagari, M., A. Demirgüç-Kunt and V. Maksimovic (2010), 'Formal versus informal finance: evidence from China', *Review of Financial Studies*, **23**, 3048–3097.

Bai, C., J. Lu and Z. Tao (2006), 'The multitask theory of state enterprise reform: empirical evidence from China', *American Economic Review*, **96**, 353–357.

Bloningen, B. and A. Ma (2007), 'Please pass the catch-up: The relative performance of Chinese and foreign firms in Chinese exports', NBER working paper 13376.

Bottazzi, G., E. Cefis and G. Dosi (2002), 'Corporate growth and industrial structures: some evidence from the Italian manufacturing industry', *Industrial and Corporate Change*, **11**, 705–723.

Bottazzi, G., A. Coad, N. Jacoby and A. Secchi (2011), 'Corporate growth and industrial dynamics: evidence from French manufacturing', *Applied Economics*, **43**, 103–116.

Bottazzi, G. and A. Secchi (2006), 'Gibrat's law and diversification', *Industrial and Corporate Change*, **15**, 847–875.

Bottazzi, G. and A. Secchi (2006), 'Explaining the distribution of firm growth rates', *RAND Journal of Economics*, **37**, 235–256.

Bottazzi, G. and A. Secchi (2011), 'A new class of asymmetric exponential power densities with application to economics and finance', *Industrial and Corporate Change*, **20**, 991–1030.

Bottazzi, G. and A. Secchi (2013), 'Financial Fragility and the Distribution of Firm Growth Rates', LEM Working Paper Series.

Bottazzi, G., A. Secchi and F. Tamagni (2014), 'Financial Constraints and Firm Dynamics', *Small Business Economics*, **42**, 99–116.

Brandt, L., J. Biesenbroeck and Y. Zhang (2012), 'Creative Accounting or Creative Destruction? Firm-level Productivity Growth in Chinese Manufacturing', *Journal of Development Economics*, **97**, 339–351.

Breschi, S., F. Malerba and L. Orseniga (2000), 'Technological regimes and Schumpeterian

patterns of innovation', *The Economic Journal*, **110**, 388–410.

Caballero, R., E. Engel and J. Haltiwanger (1997), 'Aggregate employment dynamics: building up from microeconomic evidence', *American Economic Review*, **87**, 115–137.

Cao, C., N. Li, X. Li and L. Liu (2013), 'Reforming China's S&T system', *Science*, **341**, 460–462.

Cha, K., V. Dang and I. Yan (2012), 'Chinese firms' political connection, ownership, and financing constraints', *Economics Letters*, **115**, 164–167.

Choi, S., S. Lee and C. Williams (2011), 'Ownership and firm innovation in a transition economy: Evidence from China', *Research Policy*, **40**, 441–452.

Chow, G. (2006), 'Are Chinese Official Statistics Reliable?', *CESifo Economic Studies*, **52**, 396–414.

Coad, A. (2012), 'Firms as Bundles of Discrete Resources - Towards an Explanation of the Exponential Distribution of Firm Growth Rates', *Eastern Economic Journal*, **38**, 189–209.

Coad, A., S. Daunfeldt, W. Hölzl, D. Johansson and P. Nightingale (2014a), 'High-growth firms: introduction to the special section', *Industrial and Corporate Change*, Advanced Access doi:10.1093/icc/dtt052

Coad, A., M. Savona and G. Pellegrino (2014b), 'Don't Stop Me Now: Barriers to innovation and firm productivity', SPRU-Science and Technology Policy Research No. 2014-04.

Coad, A. and J. Tamvada (2012), 'Firm growth and barriers to growth among small firms in India', *Small Business Economics*, **39**, 383–400.

Cull, R. and L. Xu (2005), 'Institutions, ownership, and finance: the determinants of profit reinvestment among Chinese firms', *Journal of Financial Economics*, **77**, 117–146.

Davidsson, P., F. Delmar and J. Wiklund (2006), 'Entrepreneurship as growth: Growth as entrepreneurship', in P. Davidsson, F. Delmar and J. Wiklund (eds), *Entrepreneurship and the Growth of Firms*. Edward Elgar Publishing: Cheltenham, UK.

Delmar, F., P. Davidsson and W. Gartner (2003), 'Arriving at the high-growth firm', *Journal of Business Venturing*, **18**, 189–216.

Dosi, G., O. Marsili, L. Orsenigo and R. Salvatore (1995), 'Learning, market selection and the evolution of industrial structures', *Small Business Economics*, **7**, 411–436.

Dosi, G., M. Grazzi, C. Tommasi and A. Zeli (2012), 'Turbulences underneath the big calm? The micro-evidence behind Italian productivity dynamics', *Small Business Economics*, **39**, 1043–1067.

Duschl, M. and T. Brenner (2013), 'Characteristics of Regional Industry-Specific Employment Growth Rates' Distributions', *Papers in Regional Science*, **92**, 249–270.

Duschl, M. (2014), 'Regional resilience and fat tails - A stochastic analysis of firm growth rate distributions of German regions', Working Papers on Innovation and Space Vol. 01.14.

Eichengreen, B., D. Park and K. Shin (2012), 'When Fast-Growing Economies Slow Down: International Evidence and Implications for China', *Asian Economic Papers*, **11**, 42–87.

Erlingsson, E., S. Alfarano, M. Raberto and H. Stefánsson (2013), 'On the distributional properties of size, profit and growth of Icelandic firms', *Journal of Economic Interaction and Coordination*: 1–18.

Fagiolo, G., M. Napoletano and A. Roventini (2008), 'Are output growth-rate distributions fat-tailed? Some evidence from OECD countries', *Journal of Applied Econometrics*, **23**, 639–669.

Gedajlovic, E. (1993), 'Ownership, strategy and performance: is the dichotomy sufficient?', *Organization studies*, **14**, 731–752.

George, G. (2005), 'Slack resources and the performance of privately held firms', *Academy of Management Journal*, **48**, 661–676.

Geroski, P. (1989), 'Entry, Innovation and Productivity Growth', *The Review of Economics and Statistics*, **71**, 572–578.

Gilbert, B., P. McDougall and D. Audretsch (2006), 'New venture growth: A review and extension', *Journal of Management*, **32**, 926–950.

Guan, J., R. Yam, E. Tang and A. Lau (2009), 'Innovation strategy and performance during economic transition: Evidences from Beijing, China', *Research Policy*, **38**, 802–812.

Guariglia, A., X. Liu and L. Song (2011), 'Internal finance and growth: Microeconometric evidence on Chinese firms', *Journal of Development Economics*, **96**, 79–94.

Haltiwanger, C. (1997), 'Measuring and Analyzing Aggregate Fluctuations: The Importance of Building from Microeconomic Evidence', Federal Reserve Bank of St. Louis.

Holz, C. (2013), 'Chinese statistics: classification systems and data sources', MPRA Paper No. 43869.

Hu, A., G. Jefferson and Q. Jinchang (2005), 'R&D and technology transfer: firm-level evidence from Chinese industry', *Review of Economics and Statistics*, **87**, 780–786.

Jefferson, G., A. Hu, X. Guan and X. Yu (2003), 'Ownership, performance, and innovation in China's large- and medium-sized industrial enterprise sector', *China Economic Review*, **14**, 89–113.

Ju, M. and H. Zhao (2009), 'Behind organizational slack and firm performance in China:

The moderating roles of ownership and competitive industry', *Asia Pacific Journal of Management*, **26**, 701–717.

Levine, R. (2005), 'Finance and growth: theory and evidence', in P. Aghion and S. Durlauf (eds), *Handbook of economic growth*, Vol. 1, North Holland: The Netherlands, 865–934.

Li, H., L. Meng, Q. Wang and L. Zhou (2008), 'Political connection, financing and firm performance: Evidence from Chinese private firms', *Journal of Development Economics*, **87**, 283–299.

Liao, J., Q. Ye, D. Pistrui and H. Welsch (2009), 'New venture financing: An empirical investigation of Chinese entrepreneurs', in J. Li and S. Hsu (eds), *Informal Finance in China*. *American and Chinese Perspectives*. Oxford University Press: Oxford.

Lin, Z., Y. Chen and X. Qin (2013), 'The effects of ownership types on enterprise innovation efficiency: Do industrial and regional heterogeneity matter?' Management Science and Engineering International Conference IEEE: 833–844.

Maasoumi, E., J. Racine and T. Stengos (2007), 'Growth and convergence: A profile of distribution dynamics and mobility', *Journal of Econometrics*, **136**, 483–508.

Malerba, F. (2002), 'Sectoral systems of innovation and production', *Research Policy*, **31**, 247–264.

Mathew, N. (2012), 'Drivers of Firm Growth: Micro-evidence from Indian Manufacturing', LEM Working Paper Series 2012/24.

McKelvie, A. and J. Wiklund (2010), 'Advancing Firm Growth Research: A Focus on Growth Mode Instead of Growth Rate', *Entrepreneurship Theory and Practice*, **34**, 261–288.

Milana, C. and J. Wang (2013), 'Fostering Entrepreneurship in China: A Survey of the Economic Literature', *Strategic Change*, **22**, 387–415.

OECD (2001), *Measuring Productivity*. OECD: Paris.

Park, S. and Y. Luo (2001), 'Guanxi and organizational dynamics: organizational networking in Chinese firms', *Strategic Management Journal*, **22**, 455–477.

Peng, M., J. Tan and T. Tong (2004), 'Ownership types and strategic groups in an emerging economy', *Journal of Management Studies*, **41**, 1105–1129.

Peng, M., D. Wang and Y. Jiang (2008), 'An institution-based view of international business strategy: A focus on emerging economies', *Journal of International Business Studies*, **39**, 920–936.

Penrose, E. (1959): *The theory of the growth of the firm*. John Wiley and Sons: New York.

Pfeffer, J. and G. Salancik, (2003), '*The external control of organizations: A resource*

dependence perspective', Stanford University Press: Stanford.

Poncet, S., W. Steingress and H. Vandenbussche (2010), 'Financial Constraints in China: Firm-level Evidence', *China Economic Review*, **21**, 411–422.

Qin, D. and H. Song (2009), 'Sources of investment inefficiency: the case of fixed-asset investment in China', *Journal of Development Economics*, **90**, 94–105.

Ralston, D., J. Terpstra-Tong, R. Terpstra, X. Wang and C. Egri (2006), 'Today's State-Owned Enterprises of China: Are they dying dinosaurs or dynamic dynamos', *Strategic Management Journal*, **27**, 825–843.

Reichstein, T. and M. Jensen (2005), 'Firm size and firm growth rate distributions - The case of Denmark', *Industrial and Corporate Change*, **14**, 1145–1166.

Shenkar, O. and M. Von Glinow (1994), 'Paradoxes of organizational theory and research: Using the case of China to illustrate national contingency', *Management Science*, **40**, 56–71.

Song, Z., K. Storesletten and F. Zilibotti (2011), 'Growing like China', *American Economic Review*, **101**, 196–233.

Stan, C., M. Peng and G. Bruton (2013), 'Slack and the performance of state-owned enterprises', *Asia Pacific Journal of Management*, DOI 10.1007/s10490-013-9347-7.

Stanley, M., L. Amaral, S. Buldyrev, S. Havlin, H. Leschhorn, P. Maass, M. Salinger and E. Stanley (1996), 'Scaling behavior in the growth of companies', *Nature*, 379, 804–806.

Sun, S., W. Tong and J. Tong (2002), 'How does government ownership affect firm performance? Evidence from China's Privatization Experience', *Journal of Business Finance & Accounting*, **29**, 1–27.

Varian, H. (2014), 'Big Data: New Tricks for Econometrics', *Journal of Economic Perspectives*, **28**, 3-28.