Firm as a Bundle of Barcodes

Koji Sakai
Institute of Economic Research, Hitotsubashi University
Kunitachi, Tokyo 186-8603, Japan, ksakai@ier.hit-u.ac.jp

Tsutomu Watanabe
Research Center for Price Dynamics, Hitotsubashi University

November 1, 2008

How are firms' boundaries determined? This question has been repeatedly addressed by economists. An important presumption in these researches is that a firm cannot be dismantled into its components. Recently, however, a different view has been proposed by a group of natural scientists, which argues that firm dynamics can be traced back to dynamics in its component. Several papers construct a model in which a firm is composed of smaller units, like divisions and businesses, and derive a probability distribution governing firm growth rates. Specifically, it is shown by Buldyrev et al (2007a) among others, that the distribution of firm growth rates is characterized by a Laplacian cusp in the central part and asymptotic power-law tails, under the assumption that both the number of units within a firm and their size obey a proportional law. Pammolli et al (2007) goes to the data with this theoretical prediction, finding that the data from the pharmaceutical industry is consistent with the theoretical prediction.

The purpose of this paper is to empirically investigate firm dynamics for different sets of firms that produce wider variety of goods. To do this, we employ a unique dataset that records the daily sales for each of more than 200 thousand products, which are identified by their barcodes. These are products sold at about 200 supermarkets in Japan, so they consist mainly of food, beverages, and other domestic non-durables (like detergent, facial tissues, shampoo, soaps, toothbrushes, etc). Their sales are recorded through the so-called point-of-sale, or POS, system. The number of firms that produce these products is about 10,000, and the sample period covers 1998 to 2008. The dataset is compiled joint by Nikkei Digital Media and Research Center for Price Dynamics. We classify products into 200 major groups, and 1,700 subgroups.

Buldyrev et al (2007a) shows that the probability distribution of firm growth rate g is given by

$$P(g) \approx \frac{2V}{\sqrt{g^2+2V}(|g|+\sqrt{g^2+2V})^2} \tag{1}$$

where V represents the variance of g. This indicates that $P(g)$ approaches $1/\sqrt{2V} - |g|/V$ as $g \to 0$, while it goes to $V/(2g^3)$ as $g \to \infty$.

We fit equation (1) to the POS data, as well as the data for sales growth of listed manufacturing firms. The results, which are presented in Figure 1, show that the distributions of sales growth rates are fairly close to the theoretical prediction both at the firm level and at the product level. In Figure 2, we closely look at the central part of each distribution, confirming that the central part is well approximated by Laplace for distributions both at the firm level and at the product level. In Figure 3, we now turn to the tails of the distributions, and find that the tails are close to the theoretical prediction for the growth rates of listed firms, while the tails deviate slightly from it for the other three. These deviations could be due to frequent product turnovers (i.e. frequent creation and destruction of products at the barcode level), as suggested by Buldyrev et al. (2007b).

We plan to conduct the following two empirical exercises, in addition to the modification of Figure 3 by using only products that exist over the entire sample period. First, we will see if the distribution for the number of units, and the growth distribution conditional on the number of unit are both consistent with the predictions by Buldyrev et al (2007a). Second, we will check if their assumption of proportional effects both in the number of units and their size is indeed supported by the data.

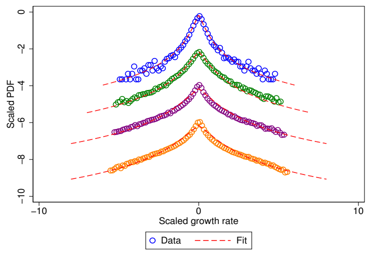

Figure 1: $P(g)$ and fitted PDFs. Shown are 4 symbols: sales for listed manufacturing firms (o); sales for firms in the POS data (o); sales for products at the major group level (o); sales for products at the subgroup level (o). Dashed lines represent fitted values by the power-law distribution with an exponent $\zeta \approx 3$. Growth rates and PDFs are divided, respectively, by $(g-\mu)/\sqrt{V}$ and $P(g)\sqrt{V}$ for normalization.

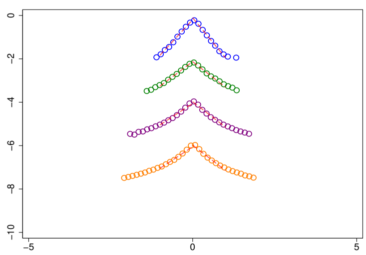

Figure 2: Central part of $P(g)$. Dashed lines represent fitted values by the Laplace distribution.

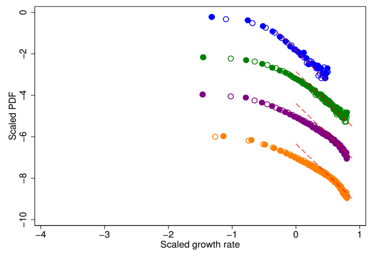

Figure 3: Tail part of $P(g)$. Dashed lines represent fitted values by the power-law distribution with an exponent $\zeta \approx 3$.

Keywords: firm growth; firm organization; scanner data

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