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The Growth of Industrial Sectors: Theoretical Insights and Empirical Evidence from U.S. Manufacturing

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The Growth of Industrial Sectors: Theoretical Insights and Empirical Evidence from U.S. Manufacturing*

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Abstract

In this paper, we study the growth rates of 4-digit sectors in U.S. manufacturing. Two measures of size (value of shipments, value added) are considered, for each of the 38 years (1959-1996) of a sample of 458 4-digit sectors, drawn from the NBER Manufacturing Productivity database. Whole sample results are partly in line with firm growth facts: (i) sectoral growth rates are distributed according to heavy-tailed Subbotin distributions, with shape coefficient between 1.0 (Laplace) and 1.5; (ii) the volatility of growth rates is decreasing with respect to size, with a scaling exponent varying over time, but always between -0.20 and -0.10. Preliminary analyses on more homogeneous groups cast doubts on the evidence of scaling, but leave basically unaffected the distributional properties of sectoral growth. These results shed light on the role of inter-firm correlations, market concentration, and positive intersectoral feedbacks as drivers of meso-economic dynamics.

Keywords: Sectoral Growth, Subbotin Distribution, Scaling, U.S. Manufacturing.

JEL Codes: C10, O47, O51.

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1 Introduction

The growth of industrial sectors is heavily conditioned by the technological interdependencies between them. In his analysis of the evolution of the U.S. machine tool, firearms, sewing machines, bicycles and automobiles sectors during the period 1840-1910, Rosenberg (1976) observed that "the growing volume of manufacturing output [...] was accompanied by the technological convergence of larger groups of industries" (p. 29).

Since then, a number of scholars have documented the important role that technologies with application in different sectors have played in stimulating widespread economic growth. Cases in point are chemicals, electricity, semiconductors, and more recently information and communication technologies. Case studies are in Arora, Landau, and Rosenberg (1998), David (2000), Dosi et al. (1988), Bresnahan et al. (1996), Rosenberg and Trajtenberg (2001), Freeman and Louca (2001).

Theoretical reasoning has followed, too. Bresnahan and Trajtenberg (1995) formalized the concept of a General Purpose Technology (hereafter GPT), characterized not only by a wide range of application sectors, but also by technological cumulativeness and dynamism, and by innovational complementarities. Technical advance in the GPT fosters or enables productivity advances across a broad spectrum of application sectors.[1] The main features of a GPT have been highlighted by Lipsey, Bekar and Carlaw (1998), and by David and Wright (2003).

The presence of technological interdependencies across sectors, fuelled by the existence of GPTs, and coupled with an *off-the-shelf* view of technological knowledge, may suggest that the dynamics of sectors will closely co-evolve, and that convergence to similar growth rates will take place (see Harberger, 1998). However, using historical data, Rosenberg (1982), Freeman and Perez (1989) and David (1990, 2000) have argued that the diffusion of innovative solutions throughout the economy may take years, if not decades, because of coordination problems and the need for complementary investments (both tangible and intangible) in application sectors. Heterogeneous adoption rates and absorption lags may thus induce wide dispersion of sectoral growth rates (see Napoletano, Roventini, and Sapio, 2004).

The foregoing considerations and the related debate quite naturally lead

[1] Improvements in those sectors increase in turn the demand for the GPT itself, which makes it worthwhile investing in further improvements, thus closing up a positive loop that may result in faster, sustained growth for the economy as a whole.

to some basic questions, such as: What is the distribution of sectoral growth rates? How does the dispersion of sectoral growth rates change over time? While these issues are widely explored in research about corporate growth (cf. Stanley et al., 1996; Bottazzi and Secchi, 2003a), to our knowledge there exists no empirical evidence on the distribution of sectoral growth rates, with the only exception of the cross-country analysis by Castaldi and Dosi (2004) on 2-digit sectoral data. This paper is devoted to bridging this gap, within a broader research agenda that aims to uncover the main regularities and generating mechanisms of economic growth at the meso-economic level.

In our contribution to the empirics of sectoral growth, we draw on the NBER Manufacturing Productivity database to study the growth rates of two measures of size (value of shipments, value added), for each of the 38 years (1959-1996) of a sample of 458 4-digit sectors in U.S. manufacturing. A baseline account of our whole sample results is the following: (i) sectoral growth rates are distributed according to heavy-tailed Subbotin distributions, with shape coefficient between 1.0 and 1.5; and (ii) volatility of growth rates scales as a power law of the initial size, with a scaling exponent varying over time, but always between -0.20 and -0.10. These results resemble the stylized facts on corporate growth. Furtherly, there is some tendency to a quadratic scaling in the last two decades of the sample (1980s and 1990s). However, splitting the whole sample in more homogeneous groups (nondurable and durable consumption, intermediate goods, investment goods) and according to the Pavitt (1984) taxonomy (supplier dominated, scale intensive, specialized supplier, science based) tends to invalidate the evidence on scaling, while leaving basically unaffected the distributional properties of sectoral growth.

We believe there may be something extremely interesting in these results. Indeed, it is not a priori obvious whether the generating mechanisms so far proposed in the literature on firm growth keep their validity at a more aggregate level. Bottazzi and Secchi (2003a) have suggested an island model, wherein competition over a finite set of opportunities self-reinforcing probabilities to seize them lead to a Laplace shape of the growth distribution. However, at the sectoral level, correlations between firm growth paths, market concentration, and positive inter-sectoral feedbacks may play a fundamental role. We are thus left with some intriguing question marks.

The plan of the paper is as follows. In Section 2, we describe the data and define the relevant variables for our analysis. The core sections of our paper are Section 3, in which the properties of sectoral growth processes are presented, and Section 4, which illustrates the evidence for some sub-samples.

Results are discussed in the concluding Section 5, which also provides insights and challenges for future research on this topic.

2 Data and variables

This work exploits data drawn from the NBER Manufacturing Productivity (MP) database, a joint effort between the NBER and the U.S. Bureau of Census' Center for Economic Studies (CES). The data are compiled from various official sources, most notably the Annual Survey of Manufactures (ASM) and the Census of Manufactures (CM), carried out by the Bureau of Census, and based on a sample of about 60,000 manufacturing establishments. The database covers all 4-digit manufacturing industries from 1958 to 1996 (1987 SIC codes from 2011 to 3999), for a total of 458 industries.[2]

For this paper, we have selected two variables: the value of industry shipments (VS henceforth), and the value added (VA). Both have been expressed in constant 1987 million dollars, using the deflator included in the NBER MP database (see Bartelsman and Gray, 1996, for further information). The analysis is performed using the following variables, indexed by sector i and by year t:

- normalized logarithmic size:

$$vs_{i,t} = \log(VS_{i,t}) - < \log(VS_{i,t}) >_t \tag{1}$$

$$va_{i,t} = \log(VA_{i,t}) - < \log(VA_{i,t}) >_t \tag{2}$$

  where $< . >_t$ denotes a cross-sectoral average at time t;

- growth rates:

$$gvs_{i,t} = vs_{it} - vs_{i,t-1} \tag{3}$$

$$gva_{i,t} = va_{it} - va_{i,t-1} \tag{4}$$

[2] In the database, industries are actually 459. One is discarded due to missing data in the last three years of the sample.

By definition, the variables vs and va have zero mean. Normalization is performed in order to wash away common trends. Non-normalized log-size measures shall be occasionally used, too.

3 Empirical evidence

In this section, empirical evidence on the whole sample properties of sectoral growth rates is provided. After an illustration of the main statistical properties, the scaling properties are investigated, and Subbotin distributions are fitted to the data.

3.1 Basic statistical properties

To begin with, let us consider the distribution of the logarithimic size. Fig. 1 depicts mean, standard deviation, skewness and kurtosis of the log-size for each year of the sample (1958-1996). Some interesting patterns emerge. The average log-size follows an increasing trend over time, with perhaps a slow-down after 1970. The cross-sectoral standard deviation decreases quite steadily until about 1980, only to grow afterwards: sectoral sizes in the 1990s were more dispersed than in the 1960s. Furtherly, the sectoral log-size distribution reaches the highest positive skewness in the 1970s (between 0.3 and 0.4), while in the early 1960s and in the 1990s it is almost perfectly symmetric. Finally, the kurtosis is slightly above the Normal value of 3 for the whole time span, more so in the early years. These patterns are shared by both measures of sectoral size (value-of-shipments and value-added). However, in both cases Kolmogorov-Smirnov tests cannot reject the null hypothesis of Gaussian log-sizes. Therefore, sectoral size empirical distributions can be approximated by Lognormal laws. This fact is in accordance with the evidence of right-skewed distributions in corporate size (Dosi, 2005) and with the Lognormal evidence in Bottazzi and Secchi (2003a).

We then plot the moments of the non-normalized growth rates distributions (Fig. 2). The upper charts show mean values and standard deviations. Mean growth rates have been positive all along the 1960s, wildly fluctuated during the 1970s (notice also the sharp drop in 1975), and lower on average after the 1970s. Standard deviations have been roughly constant over time, but for gva they have been relatively low during the 1960s, only to rise in subsequent years. The lower charts show that distributions of growth rates are approximately symmetric (the skewness fluctuates mildly around zero). Tails are quite fat: kurtosis is between 5 and 10 for most years. Notice also the wide changes in kurtosis over time, and the high values during the '80s. These patterns might indicate that growth rate distributions are not strong-form stationary. By comparing growth rate distributions for all possible couples of years, Kolmogorov-Smirnov tests confirm this: the null hypothesis (identical distributions) is most often rejected. This is at variance with the evidence about strong-form stationarity in the growth of firms (Stanley et al., 1996; Bottazzi and Secchi, 2003a). However, panels analyzed in firms growth empirics cover a much shorter time-span.

Further properties are uncovered via Augmented Dickey Fuller tests, performed sector by sector. We have run unit root tests by regressing growth rates on size, a constant, a trend, and 4 lags of the dependent variable. The trend has been included because of the positive drift noticed before, whereas taking lags accounts for the significant autocorrelations observed in many sectoral growth rates.[3] The null hypothesis I(1) is rejected at the 95% level in only 15 sectors out of 458, for the log-value of shipments (16 in the case of the log-value added).[4] These results are robust to changes in the number of lags considered in the test. We thus conclude that the series of growth rates are weakly stationary for the great majority of sectors.

3.2 Volatility-size scaling

Investigations on the existence of volatility-size scaling in sectoral growth are performed here. This analysis is motivated by the evidence found by Stanley et al. (1996), Amaral et al. (1997), and Bottazzi and Secchi (2003a), according to which the conditional standard deviation of firm growth rates is related to company size according to a power law, as follows:

$$\sigma(g_{it}|S_{i,t-1}) = kS_{i,t-1}^{-\beta_i} \tag{5}$$

In other words, larger companies tend to experience relatively more stable

[3]The distribution of the growth rates autocorrelation coefficients ρ_k (where k is the lag in years) is centered around zero. Yet, it displays quite a large support - there are sectors with $\rho_2 = -0.6$, some with $\rho_5 = 0.6$, and others in which even at lag 10, ρ_{10} can be as large as -0.4 or 0.4. These values are statistically significant.

[4]A list of "I(0) sectors" is provided in the Appendix. In what follows, all 458 sectors will be considered in the analysis. Indeed, removing the I(0) sectors from the sample does not affect results in any significant way.

growth processes, whereas very noisy growth paths are typical of small firms. In firm growth empirics, the scaling exponent β lies in the range 0.15, 0.20 for data on U.S. companies and for companies in the pharmaceutical industry (Stanley et al., 1996; Amaral et al., 1997), whereas no scaling has been detected on Italian (Bottazzi and Secchi, 2003a) and French data (Bottazzi, Coad, Jacoby, and Secchi, 2005). We wonder what is the evidence at the 4-digit sectoral level.

Suppose each sector includes a constant number n of firms. Define $S_t \equiv \sum_{i=1}^{n} S_{it}$ as the total size of a sector, and $g_t \equiv \frac{S_t}{S_{t-1}} - 1$ as its growth rate. It is straightforward to show that the sectoral growth rate is

$$g_t = \sum_{i=1}^{n} \theta_{i,t-1} g_{it} \tag{6}$$

where $\theta_{i,t-1} \equiv \frac{S_{i,t-1}}{S_{t-1}}$ is the market share of firm i at time $t-1$. The variance of g_t therefore reads:

$$\sigma^2 = \sum_{i=1}^{n} \theta_{i,t-1}^2 \sigma_i^2 + \sum_{i,j=1;i \neq j}^{n} \rho_{ij} \theta_{i,t-1} \theta_{j,t-1} \sigma_i \sigma_j \tag{7}$$

where σ_i is the standard deviation of firm i's growth rates, and ρ_{ij} is the correlation coefficient between the growth rates of firms i and j. Firm-specific growth volatilities, however, are not constant: they scale according to (5). Let us therefore substitute (5) into (7), to yield, after some algebra:

$$\sigma^2 = k^2 \left[\sum_{i=1}^{n} \theta_{i,t-1}^{2(1-\beta_i)} S_{t-1}^{-2\beta_i} + \sum_{i,j=1;i \neq j}^{n} \rho_{ij} \theta_{i,t-1}^{1-\beta_i} \theta_{j,t-1}^{1-\beta_j} S_{t-1}^{-\beta_i-\beta_j} \right] \tag{8}$$

Notice that, if $\beta_i = \beta$, $\forall\ i = 1, ..., n$, then the variance of the sectoral growth scales as a power law of the sectoral size (Power Law Scaling):

$$\sigma^2 = k^2 \left[\sum_{i=1}^{n} \theta_{i,t-1}^{2(1-\beta)} + \sum_{i,j=1;i \neq j}^{n} \rho_{ij} \theta_{i,t-1}^{1-\beta} \theta_{j,t-1}^{1-\beta} \right] S_{t-1}^{-2\beta} \tag{9}$$

In such a case, one can proceed exactly as it is usually done in the analysis of firm growth rates. For any given year, sectoral sizes VS and VA are binned in equipopulated groups, and standard deviations of the associated 1-year growth rates are computed.[5] Next, the log-standard deviations are

[5] We have tried with different values for the number of bins, between 20 and 80. Differences in results are negligible. Results to be presented refer to the 20-bins case.

regressed (OLS) on the logarithm of the mean size within the corresponding bins:

$$\log \sigma = \beta_0 + \beta \log S_{t-1} \tag{10}$$

It is worth noting that the intercept β_0 is the logarithm of the term in brackets in (9): it depends on a measure of dispersion of the market shares, and on the cross-correlations between firm growth rates. However, the scaling coefficient β does not depend on them: it only reflects the causes behind volatility scaling in the dynamics of individual firms - for instance, the mechanism proposed by Amaral et al. (2001). Suppose the firm is composed by equally-sized units, organized hierarchically. The manager of the firm decides a common growth rate for all units. If all units enact perfect fulfilment, no scaling emerges. Conversely, if all units grew independently, then the standard deviation of the firm growth rate would decay as a power law with coefficient -0.5. The observed scaling coefficients suggest that the truth is in the middle. Closer to economic reality, scaling phenomena in the growth of firms may be related to patterns of diversification (see Bottazzi, 2001, on this issue).

Alternatively, one may assume that scaling coefficients vary across firms. If this is true, (9) does not hold, and the following approximation, based on a Taylor expansion of the power terms, yields a parabolic dependence of the sectoral growth variance on the logarithmic sectoral size ("Quadratic Scaling"):

$$\sigma^2 = \alpha_0 + \alpha_1 \log S_{t-1} + \alpha_2 (\log S_{t-1})^2 \tag{11}$$

where the coefficients depend upon the β_i's, the ρ_{ij}'s, and the θ_i's (their formulations are in Appendix A).

Industry concentration and the strength of cross-correlation between company growth rates determine the properties of the volatility-size relationship. Specifically, if $\rho_{ij} \geq 0$, $\forall\ i = 1, ..., n$, then $\alpha_1 < 0$ and $\alpha_2 > 0$: the parabola described by (11) points upwards - the growth performance of medium-sized sectors is more stable than that of small and large sectors. Interestingly, if $\rho_{ij} < 0$ for some i, there exist distributions of cross-correlations and of market shares, such that (i) the parabola points downwards (medium-sized sectors are the most volatile), (ii) the volatility-size relation is linear, or (iii) it disappears (More on this in Appendix A).

Tables 1 and 2 display the values of the scaling exponent - estimated from Eq. 10 ("Power Law Scaling") - for value-of-shipments and for value-added data, respectively, for each year between 1959 and 1996. The estimated scaling exponents tend to fluctuate between -0.20 and -0.10. More precisely, the average scaling exponent for value-of-shipments is -0.1438, with a standard deviation of 0.0613. The respective figures for the value-added growth are -0.1811 and 0.0597. In Fig. 3 and 4 (left panels), linear fits are superimposed to the scatterplots of log-standard deviations against log-sizes, for two representative years (1969 and 1985). These results are in the range of the values so often found in the firm growth literature. Power-law scaling is thus a common property of growth rates at both the firm and sectoral levels of observation, at least at a first approximation.

Estimates of Eq. 11 ("Quadratic Scaling") are also reported in Tables 1 and 2. The α_1 coefficients are always negative and significantly different from zero, whereas α_2 values are significantly negative in 11 (gvs) or 12 years (gva) out of 38. Notably, negative α_2 are never observed after the early '80s. Moreover, magnitudes of α_2 are higher in the same period. As an implication, in the '60s and '70s the volatility-size relationship looked roughly linear and downward-sloping, with an inflection often switching between convex and concave. Afterwards, a clearer U-shaped relationship is detected, such that larger sectors are slightly more volatile than medium-sized ones, which in turn are far less volatile than the smallest.

3.3 The distribution of sectoral growth rates

In this subsection, we study the distribution of sectoral growth rates year by year. The empirical density function of sectoral growth rates g_t is modelled by means of the Subbotin family (see Subbotin, 1923), which was first introduced in economics by Bottazzi and Secchi (2003a). The Subbotin probability density function reads:

$$f(g_t) = \frac{1}{2ab^{1/b}\Gamma(1+\frac{1}{b})} e^{-\frac{1}{b}\left|\frac{g_t-\mu}{a}\right|^b} \tag{12}$$

where b is a shape parameter, and $\Gamma(.)$ is the gamma function. The Subbotin reduces to a Laplace if $b = 1$, and to a Gaussian if $b = 2$.[6] As b gets smaller, the density becomes fatter-tailed and more sharply peaked.

[6]Further cases are: degenerate ($b = 0$), and continuous Uniform ($b = \infty$).

This model has been chosen for it generalizes the Laplace distribution, which was shown to provide an excellent fit to the empirical density function of corporate growth rates by Bottazzi and Secchi (2003a,b; 2006).

The Subbotin model is very useful because of its flexibility: it can detect whether sectoral growth rates depart from the Gaussian benchmark. Indeed, one may expect Gaussian densities to emerge from the aggregation of a large number of companies. Suppose the size of a firm is driven by the following process:

$$S_{it} = S_{i,t-1} e^{g_{it}} \tag{13}$$

Summing over firms and multiplying and dividing by S_{t-1} yields

$$S_t = S_{t-1} \sum_{i=1}^{n} \theta_{i,t-1} e^{g_{it}} \tag{14}$$

The sectoral growth rate is defined as $g_t \equiv \log \frac{S_t}{S_{t-1}}$; that is:

$$g_t = \log \sum_{i=1}^{n} \theta_{i,t-1} e^{g_{it}} \tag{15}$$

Building on Marlow (1967), the sectoral growth rate is asymptotically Normal (for $n \to \infty$) if (i) $\theta_i = \theta$, $\forall\ i$, and (ii) $g_{it} \sim$ i.i.d. However, market shares are generally heterogeneous, due to industry concentration. Market shares may rather follow a skewed distribution. Moreover, as implied by the model in Bottazzi and Secchi (2003a, 2006), explaining the Laplace distribution of firms growth rates requires that the postulate of independence be relaxed. In fact, their model is crucially based on the assumption that firms compete over a finite set of growth opportunities. If a firm grows more, some others must grow less. Summing up, there are reasons to expect that the distribution of sectoral growth rates departs from a Normal distribution, more so when industry concentration is high, and when the constraint upon the set of opportunities is binding.

This given, we run a Maximum Likelihood estimation procedure 38 times (years from 1959 to 1996) over samples composed of 458 sectors.[7] The esti-

[7]In light of the negative result on strong-form stationarity, it seems preferable not to pool observations across years. Estimates are done using the Subbotools developed by Giulio Bottazzi (see Bottazzi, 2004, for documentation).

mated shape coefficients b of the Subbotin are reported in Tables 3 and 4, along with standard errors.[8]

The estimated shape parameters b for the value added growth rates gva reveal interesting information on the distribution dynamics. Tables 3 shows that, for the variable gvs, the estimated b's are scattered around a value slightly larger than 1: the mean b is 1.0782, with a standard deviation of 0.2067. Estimates are larger during the '70s (1.1892 on average), and closer to the Laplacian value of 1 in the other decades (averages of 1.0788 in the '60s, 1.0592 in the '80s, 1.0048 in the '90s). Hence, the distribution of sectoral value-of-shipments growth rates gvs departs from the Normal, and tends to follow a Laplace law, more so in the most recent years.

In Table 4, the average b over the whole sample period is equal to 1.1031, with a standard deviation of 0.1722. However, the shape parameters are on average higher during the '60s and '70s than in the following decades (respectively, 1.1980 and 1.1737 vs. 0.9811 and 1.0529). Fig. 5 and 6 show examples of fitted distributions for some years. Differences in the shape are noticeable. These results signal that a Laplace law provides a good description of the distribution of sectoral value added growth rates mainly during the '80s and the '90s. In the decades before, sectoral growth processes were characterized by less extreme fluctuations, with distributions which lay between the Laplace and the Gaussian.

As observed in the previous subsection, the sectoral growth rates are not i.i.d.: their variance depends on the sectoral size. Hence, the evidence of heavy tails in sectoral growth may be a statistical artifact due to the mixture of different, possibly non-heavy-tailed processes. Therefore, we also fit the empirical density functions of the following rescaled version of sectoral growth rates:

$$\widetilde{g_{it}} = \frac{g_{it}}{e^{\widehat{\beta_0}+\widehat{\beta} s_{it}}} \tag{16}$$

where $\widehat{\beta_0}$ and $\widehat{\beta}$ are the estimated Power Law Scaling coefficients. Fig. 7 shows that, although Subbotin shape coefficients for rescaled growth rates are slightly higher than before rescaling, differences in point estimates are rather small. As an implication, heavy tails in sectoral growth seem to reveal some more fundamental economic mechanism, well beyond statistical aggregation phenomena.

[8] The normalization of log-sizes allows to restrict the position parameter μ to zero.

Results of this section have partially confirmed the firm-level evidence for the whole sample of 458 4-digit U.S. manufacturing sectors. Furthermore, they have thrown light on the time evolution of the value-added growth, characterized by an increasing weight of extreme events.

4 Groupwise properties

The foregoing analysis has been carried out under the implicit assumption that all sample observations for a given year are drawn from a common distribution. While such an assumption yields quite a large sample, sectors as diverse as "Tanks and tank components" (SIC 3795) and "Dolls and stuffed toys" (SIC 3492) need not be driven by similar techno-economic dynamics, and therefore, one wonders whether the corresponding statistical properties are different, too, and in turn, whether the detected regularities on sectoral growth robustly hold.

Sectors can be classified along two different lines, among the many. A first classification is based on the nature of the output. Sectors can produce durable or nondurable consumption goods, intermediate goods, or investment goods. Intermediate goods can be seen as consumption by firms (e.g. materials), whereas durable consumption goods are in a way investments made by households. This classification yields subsamples of sizes, respectively, of 101, 116, 128, and 115 observations per year.[9]

Second, the taxonomy developed by Pavitt (1984) identifies four categories according to the different characteristics of technological trajectories (Dosi, 1982, 1988). The following groups are defined: supplier dominated (2-digit SIC codes 22, 23, 24, 25, 26, 27, 30, 31; 141 obs. per year); scale intensive (2-digit SIC codes 20, 21, 32, 33, 34, 37; 161 obs. per year); specialized supplier (2-digit SIC codes 35, 38, 39; 85 obs. per year); science based (2-digit SIC codes 28, 29, 36; 71 obs. per year).[10]

The analysis previously performed on all sectors pooled together is now repeated separately on each subsample.

[9]See Appendix B for lists of the sectors included in each groups.

[10]The classification used here is available at http://www.esrc.ac.uk.

4.1 Sectoral size distributions

Whole sample properties of the log-size distributions are, broadly speaking, confirmed within subsamples. Again: (i) Kolmogorov-Smirnov tests cannot reject the null of log-size normality; (ii) mean log-sizes are increasing with a slow-down after 1970; (iii) the distribution narrows down in the '60s/'70s and spreads out afterwards; (iv) skewness is rather close to zero; (v) values of the kurtosis lay rather close to 3.

Though, some group-wise specificities are worth noting. First, size distributions tend to be leptokurtic (kurtosis above 3) in sectors within the "intermediate goods" and "investment goods" groups, and platykurtic (kurtosis below 3) in the durable and nondurable consumption goods sectors. Second, within the Pavitt taxonomy, scale-intensive sectors and (in part) science-based sectors are the only ones showing some slightly heavy tails.

4.2 Scaling relationships

The analysis of more homogeneous sub-samples wipes away the clear volatility-size scaling pattern observed on the whole sample of 458 sectors.[11] Signs and magnitudes of the regression slopes change year after year: the feeling is that no stable relationship exists between size of the sectors and volatility of their growth rates. More specifically, negative slopes of the size-variance relationship are observed in nondurable consumption, intermediate goods, and supplier dominated sectors. In durable consumption and scale intensive sectors, the growth volatility is decreasing in size mainly after the '70s. In the other sectors (investment goods, specialized supplier, science based) the scaling relationship is basically absent, especially in the most recent decades.

4.3 Sectoral growth distributions

Let us now consider the distributional properties of sectoral growth within the groups defined above. Mean shape coefficients tend to lie between 1.0 and 1.5. The highest values (indicating shorter tails) regard investment goods and specialized-supplier sectors. The lowest (longer tails) refer to nondurable consumption goods and scale-intensive sectors. Notice, however, that estimates

[11]Estimates of the scaling exponents are based on 10 to 20 bins. These numbers are lower than the corresponding ones for whole sample scaling estimates (20 to 80 bins). This is due to smaller sample sizes.

of b for investment goods, specialized suppliers and science-based sectors are rather noisy: standard errors are between 35 and 40% of the point estimate. Overall, it seems that no stable distributional shape can be associated with sectoral growth within groups. However, we have established that sectoral growth is characterized by heavy tails even after considering relatively homogeneous groups of sectors.

5 Discussion and conclusions

In this paper, we have documented the distributional and scaling properties of the growth rates of U.S. industrial 4-digit sectors, using an extensive dataset of 458 sectors, covering 38 years between 1959 and 1996. With the only partial exception of Castaldi and Dosi (2004), the present study is the first attempt in this direction. Let us briefly summarize the main facts detected in the whole sample analysis of this paper.

Sectoral size. The logarithmic size of 4-digit sectors is driven by a unit-root process in about 97% of sectors, and is approximately distributed according to a Lognormal law.

Sectoral growth. Sectoral growth rates are stationary, but not identically distributed. Distributions belonging to the Subbotin family provide a good approximation to the underlying process. In the whole sample analysis, the Subbotin shape coefficient is most often below 2, a clear sign of heavy tails: values tend to range between 1.0 (Laplace) and 1.5. Laplacian values are found most often in the last two decades of the sample (1980s and 1990s): extreme fluctuations have become increasingly relevant over time.

Volatility-size relationships. The volatility of growth rates depends negatively on the sectoral size. Power law scaling regressions yield estimates of the scaling exponent in the range -0.20,-0.10, with some time variation. Estimates of an alternative, quadratic scaling equation show that, while in the '60s and '70s the variance-size relation was downward-sloping and approximately linear, in the last two decades a U-shaped pattern has appeared: larger sectors are slightly more volatile than medium-sized ones, though small sectors remain the most volatile.

These results bear interesting relationships with the established stylized facts on company growth. In drawing this map, we will explicitly refer also to the existing theoretical explanations of the main firm growth phenomena.

A *first* remarkable fact is that, despite the aggregate nature of sectoral variables, extreme fluctuations in sectoral growth rates have a much higher probability to occur, than under a Gaussian process - suggesting an approximation with a heavy-tailed distribution. What we observe in our dataset is a persistent variability of the sectoral growth rates and its increase over time. In other words, we have found evidence of a persistent unevenness of the growth process of the U.S. manufacturing sectors.

As noticed in Section 3.3, the statistical properties of sectoral growth rates crucially depend on (i) the distribution of market shares, and on (ii) whether the growth rates of companies within the same sector are independent. The growth rate of a sector with a large number of equally-sized firms, whose dynamics are independent, would be approximately Normal. In an economy with homogeneous technological adoption rates, the growth impulse due to the arrival of a pervasive technological shock - like the semiconductor and the ICT revolutions - would spread evenly across sectors, and all deviations from the average would be purely random, consistently with a Gaussian phenomenon (see Harberger's 1998 "yeast vision"). According to the alternative "mushrooms vision" (Harberger, 1998), sectors expand mainly because of numerous ("1001") small, idiosyncratic causes. The related assumption of weak interdependencies between firms and sectors would give rise to Gaussian tails, too.

The conditions mentioned above are, however, pretty unrealistic. A sufficiently right-skewed distribution of market shares would perhaps spoil the convergence to Normality. Therefore, an industry with few large corporates and a fringe of small firms is not supposed to perform Gaussian dynamics. Further, competitive pressure over a finite set of profit opportunities, coupled with self-reinforcing dynamics in opportunity-catching, implies that firm growth paths are not independent, and the emergence of a Laplace growth distribution (Bottazzi and Secchi 2003a, 2006). Hence, the very same conditions behind the Laplace shape of firm growth densities may be behind the heavy-tailed nature of sectoral growth rates. Another interpretation is that, in presence of a pervasive new technology, such as a GPT, heterogeneities and lags in adoption processes, together with the entailed learning and imitation efforts, impose structure to the sectoral growth distribution, create inter-firm correlations, and broaden the growth fluctuations (see the model in Napoletano, Roventini and Sapio, 2004). All these considerations may be seen as a preliminary explanation of the heavy-tailed nature of sectoral growth rates.

Within this framework, the evidence of increasingly Laplacian growth rates over time may be interpreted as follows. A first possibility is that the degree of market concentration may have increased more or less uniformly (or at least on average) in most of the sectors. However, phenomena such as the ICT revolution and liberalization processes cast doubts on this. Second, the interdependence between firm-level innovative capabilities, as well as the cumulativeness of their knowledge, may have become stronger over time.

The arrival of the ICTs revolution has changed the traditional sources of knowledge and has increased enormously the role of intangible assets in the production processes. However the adoption and the productive use of the ICTs in firms has not been immediate and direct: it requires substantial upfront investment for its adoption, high costs of learning in use, high levels of complementary investments in hardware and software, and changes in the firm organizational structure (Bresnahan and Greenstein, 2001; Freeman and Louca, 2001). This adaptation process is highly idiosyncratic, hence it demands different gestation periods and makes the productivity gains different from firm to firm. The increasing share of software in ICTs in the last decade may suggest that investments in adaptation process has become greater over time (OECD, 2002). This is consistent with the increasing weight of extreme events in the sectoral growth processes after the 1970s.

A *second* piece of evidence concerns the size-variance relationship. Strikingly, whole sample estimates of a power law scaling regression yield values which are very close to those detected in company growth. In this paper, it has been shown that, if all firms in a sector are characterized by the same scaling exponent, then the power law scaling carries over at the sectoral level. In such a case, explaining the evidence of sectoral power law scaling reduces to finding a reasonable generating mechanism for scaling at the firm level. As mentioned in Section 3.2, Amaral et al. (2001) have proposed an explanation based on imperfect fulfillment of growth decisions in hierarchical organizations, while the analysis in Bottazzi (2001) implies an interpretation related to diversification patterns. Both explanations, however, are based on processes which are most likely firm-specific. Different firms can be endowed with different organizational structures, even within the same sector; modes of diversification may vary across firms; and the opportunities for diversification may not be available to all firms in the same extent. In such a case, one can assume that some cross-firm heterogeneity exists in the scaling behavior of growth volatilities. As it has been shown, this breaks the symmetry between the firm- and sectoral-level empirical properties: a U-shaped pattern emerges, more clearly in the '80s and '90s.

According to preliminary theoretical investigations, what we have called *quadratic scaling* implies that their cross-correlations (in absolute value) between firm growth rates are bounded from above. Such a bound is decreasing in the degree of cross-firm heterogeneity of scaling exponents. If firms within a sector are very heterogeneous in terms of their organizational structure, or in their diversification strategies and opportunities, then scaling coefficients differ very much. If this is the case, the U-shaped volatility pattern emerges if cross-correlations between company growth rates are very low. This is what could have occurred in the '80s and in the '90s. The agenda for future research includes also verifying this conjecture.

The results discussed above maybe due to the aggregation of many heterogeneous sectors. In order to address the robustness of our results, we have also analyzed the statistical properties of sectoral growth within rather homogeneous subgroups. A first classification is based on the nature of the product: durable consumption, non-durable consumption, intermediate goods, and investment goods. A second draws on Pavitt's (1984) taxonomy (supplier-dominated, scale-intensive, specialized supplier, and science based). Some of the results uncovered in our whole sample analysis are robust - specifically, random walk of size, and Subbotin growth rates. However, the scaling of growth variances disappears in some subgroups - namely, investment goods, specialized supplier, and science-based.

The results presented in this paper should be seen as a bridge to further investigations, which may uncover interesting specificities of the dynamics of manufacturing sectors. Further applications of the method employed in this paper will cover other countries (e.g. other OECD countries), as well as other definitions of sectoral growth rates. Specifically, statistical analyses of growth rates over longer time spans may yield a clearer picture of long-run sectoral dynamics. Finally, more work needs to be done on finding the most appropriate sectoral taxonomies (perhaps also with data-driven procedures), and on carefully mapping statistical properties and techo-economic characteristics of sectors driven by different technological trajectories.

References

[1] Amaral L.A.N., S.V. Buldyrev, S. Havlin, P. Maass, M.A. Salinger, H.E. Stanley, and M.H.R. Stanley, 1997, "Scaling Behavior in Economics: the Problem of Quantifying Company Growth", *Physica A* 244: 1-24.

[2] Amaral L.A.N., P. Gopikrishnan, V. Plerou, and H.E. Stanley, 2001, "A Model for the Growth Dynamics of Economic Organizations", *Physica A* 299: 127-136.

[3] Arora A., R. Landau, and N. Rosenberg, 1998, *Chemicals and Long-Term Economic Growth: Insights from the Chemical Industry*. John Wiley and Sons.

[4] Bartelsman E.J., and W. Gray, 1996, "The NBER Manufacturing Productivity Database", NBER Technical Working Paper 205.

[5] Bottazzi G., 2001, "Firm Diversification and the Law of Proportionate Effect", LEM Working Paper 2001-01, Sant'Anna School of Advanced Studies, Pisa, Italy.

[6] Bottazzi G., 2004, "Subbotools: A Reference Manual", LEM Working Paper 2004-14, Sant'Anna School of Advanced Studies, Pisa, Italy.

[7] Bottazzi G., A. Coad, N. Jacoby, and A. Secchi, 2005, "Corporate Growth and Industrial Dynamics: Evidence from French Manufacturing", LEM Working Paper 2005-21, Sant'Anna School of Advanced Studies, Pisa, Italy.

[8] Bottazzi G., and A. Secchi, 2003, "Why are Distributions of Firm Growth Rates Tent-Shaped?", *Economics Letters* 80: 415-420.

[9] Bottazzi G., and A. Secchi, 2003, "Common Properties and Sectoral Specificities in the Dynamics of US Manufacturing Companies", *Review of Industrial Organization* 23: 217-232.

[10] Bottazzi G., and A. Secchi, 2006, "Explaining the Distribution of Firms Growth Rates", *RAND Journal of Economics*, forthcoming.

[11] Bresnahan T., S. Greenstein, D. Brownstone, and K. Flamm, 1996, "Technical Progress and Co-Invention in Computing and in the Uses of

Computers", *Brookings Papers on Economic Activity. Microeconomics* 1996: 1-83.

[12] Bresnahan T., and S. Greenstein, 2001, "The Economic Contribution of Information Technology: Towards Comparative and User Studies", *Journal of Evolutionary Economics* 11: 95-118.

[13] Bresnahan T., and M. Trajtenberg, 1995, "General Purpose Technologies: "'Engines of Growth?"", *Journal of Econometrics* 65: 83-108.

[14] Buldyrev S.V., L.A.N. Amaral, S. Havlin, H. Leschhorn, P. Maass, M.A. Salinger, H.E. Stanley, and M.H.R. Stanley, 1997, "Scaling Behavior in Economics. II. Modeling of Company Growth", *J. Phys. I* (France) 7(4): 635-650.

[15] Castaldi C., and G. Dosi, 2004, "Income Levels and Income Growth. Some New Cross-Country Evidence and Some Interpretative Puzzles", LEM Working Paper 2004-18, Sant'Anna School of Advanced Studies, Pisa.

[16] David P.A., 1990, "The Dynamo and the Computer: An Historical Perspective on the Modern Productivity Paradox", *American Economic Review* 80 (2): 355-361.

[17] David P.A., 2000, "Understanding Digital Technology's Evolution and the Path of Measured Productivity Growth: Present and Future in the Mirror of the Past", in Brynjolfsson E. and B. Kahin (eds.), *Understanding the Digital Economy: Data, Tools, and Research.* Cambridge, MA: MIT Press.

[18] David P.A., and G. Wright, 2003, "General Purpose Technologies and Surges in Productivity: Historical Reflections on the Future of the ICT Revolution", in David P.A. and M. Thomas (eds.), *The Economic Future in Historical Perspective.* Oxford: Oxford University Press for The British Academy.

[19] Dosi G., 1982, "Technological Paradigms and Technological Trajectories", *Research Policy* 11: 147-162.

[20] Dosi G., 1988, "Sources, Procedures, and Microeconomic Effects of Innovation", *Journal of Economic Literature* 26 (3): 1120-1171.

[21] Dosi G., C. Freeman, R. Nelson, G. Silverberg, and L. Soete (eds.), 1988, *Technical Change and Economic Theory.* London: Francis Pinter, and New York: Columbia University Press.

[22] Dosi G., 2005, “Statistical Regularities in the Evolution of Industries. A Guide through some Evidence and Challenges for the Theory”, LEM Working Paper 2005-17, Sant’Anna School of Advanced Studies, Pisa, Italy.

[23] Freeman C., and F. Louca, 2001, *As Time Goes By: From the Industrial Revolutions to the Information Revolution*, Oxford University Press.

[24] Freeman C., and C. Perez, 1988, “Structural Crisis of Adjustment: Business Cycles and Investment Behavior”, in Dosi G., C. Freeman, R. Nelson, G. Silverberg, and L. Soete (eds.), *Technical Change and Economic Theory.* London: Francis Pinter, and New York: Columbia University Press.

[25] Harberger A.C., 1998, “A Vision of the Growth Process”, *American Economic Review* 88: 1-32.

[26] Helpman E. (ed.), 1998, *General Purpose Technologies and Economic Growth.* Cambridge, MA: MIT Press.

[27] Lipsey R. G., C. Bekar, and K. I. Carlaw, 1998, “What Requires Explanation” and “The Consequences of Changes in GPTs”, in Helpman E. (ed.), *General Purpose Technologies and Economic Growth.* Cambridge, MA: MIT Press.

[28] Marlow N.A., 1967, “A Normal Limit Theorem for Power Sums of Independent Random Variables”, *Bell Systems Technical Journal* 46: 2081-2082.

[29] Napoletano M., A. Roventini, and S. Sapio, 2004, “Yeast vs. Mushrooms: A Note on Harberger’s ”A Vision of the Growth Process”, LEM Working Paper 2004-03, Sant’Anna School for Advanced Studies, Pisa, Italy.

[30] OECD, 2002, “OECD Information Technology Outlook ICTs 2002”, Paris: OECD.

[31] Pavitt, K. (1984), "Sectoral Patterns of Technical Change: Towards a Taxonomy and a Theory", *Research Policy* 13: 343-373.

[32] Rosenberg N., 1976, *Perspectives on Technology*, Cambridge, UK: Cambridge University Press.

[33] Rosenberg N., 1982, *Inside the Black Box: Technology and Economics*, Cambridge, UK: Cambridge University Press.

[34] Rosenberg N., and M. Trajtenberg, 2001, "A General Purpose Technology at Work: The Corliss Steam Engine in the late 19th Century", NBER working paper n. 8485.

[35] Stanley M.H.R., L.A.N. Amaral, S.V. Buldyrev, S. Havlin, H. Leschorn, P. Maass, M.A. Salinger and H.E. Stanley, 1996, "Scaling Behavior in the Growth of Companies", *Nature* 379: 804.

[36] Subbotin, 1923, "On the Law of Frequency of Error", *Matematicheskii Sbornik* 31: 296-301.

Appendix A: Derivation of the quadratic scaling equation

Consider Eq. 8:[12]

$$\sigma^2 = k^2 \sum_{i=1}^{n} \theta_i^{2(1-\beta_i)} S^{-2\beta_i} + k^2 \sum_{i,j=1; i \neq j}^{n} \rho_{ij} \theta_i^{1-\beta_i} \theta_j^{1-\beta_j} S^{-\beta_i-\beta_i} \tag{17}$$

Taylor expansion about $\beta_i = 0$, $\forall\ i = 1, ..., n$, allows to express the power terms as follows:

$$S^{-2\beta_i} \approx 1 - 2\beta_i \log S + 2\beta_i^2 (\log S)^2$$

$$S^{-\beta_i-\beta_j} \approx 1 - (\beta_i + \beta_j) \log S + \frac{1}{2}(\beta_i + \beta_j)^2 (\log S)^2$$

Let us plug the above approximations in (8). This yields:

[12] Time subscripts are omitted for simplicity.

$$\sigma^2 \approx \alpha_0 + \alpha_1 \log S + \alpha_2 (\log S)^2$$

that is, a quadratic relationship between the sectoral growth rate variance and the logarithmic size of the sector. Given the positive-valued vector

$$\vec{\theta}' = [\theta_1^{1-\beta_1} \dots \theta_n^{1-\beta_n}]$$

the coefficients equal quadratic forms ($k = 1, 2, 3$):

$$\alpha_k = \vec{\theta}' A_k \vec{\theta}$$

The associated matrices are as follows:

$$A_0 = \begin{bmatrix} 1 & \rho_{12} & \rho_{13} & \dots & \rho_{1n} \\ \rho_{21} & 1 & \rho_{23} & \dots & \rho_{2n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \rho_{n1} & \rho_{n2} & \rho_{n3} & \dots & 1 \end{bmatrix}$$

(therefore A_0 equals the inter-firm correlation matrix)

$$A_1 = -\begin{bmatrix} 2\beta_1 & (\beta_1+\beta_2)\rho_{12} & \dots & (\beta_1+\beta_n)\rho_{1n} \\ (\beta_1+\beta_2)\rho_{21} & 2\beta_2 & \dots & (\beta_2+\beta_n)\rho_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ (\beta_1+\beta_n)\rho_{n1} & (\beta_2+\beta_n)\rho_{n2} & \dots & 2\beta_n \end{bmatrix}$$

and

$$A_2 = \begin{bmatrix} 2\beta_1^2 & 0.5(\beta_1+\beta_2)^2\rho_{12} & \dots & 0.5(\beta_1+\beta_n)^2\rho_{1n} \\ 0.5(\beta_1+\beta_2)^2\rho_{21} & 2\beta_2^2 & \dots & 0.5(\beta_2+\beta_n)^2\rho_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 0.5(\beta_1+\beta_n)^2\rho_{n1} & 0.5(\beta_2+\beta_n)^2\rho_{n2} & \dots & 2\beta_n^2 \end{bmatrix}$$

The shape of the parabola describing the volatility-size relationship is determined by the sign of α_2. If $\alpha_2 > 0$, the relationship is U-shaped: a decreasing branch corresponding to small sectors, and an increasing one for larger sizes. This, in turn, requires that the matrix A_2 is positive definite.

Consider, for simplicity, the case $n = 2$. The determinant of the A_2 matrix is positive if

$$|\rho_{12}| < \frac{4\beta_1\beta_2}{(\beta_1+\beta_2)^2} < 1 \tag{18}$$

Because $2\beta_1^2 > 0$, this is enough to establish the positive definiteness of A_2. On the contrary, if $|\rho_{12}| \geq \frac{4\beta_1\beta_2}{(\beta_1+\beta_2)^2}$, then the matrix is indefinite, and no clear prediction can be done on the sign of α_2. Therefore, in a duopoly, if cross-firm correlations are mild, then we observe that the relationship between sectoral growth variance and sectoral size is U-shaped. How much mild, it depends on the values of the firm-specific scaling coefficients. Notice that this is a sufficient, but not a necessary condition. As a conjecture, a correlation threshold may be defined also for cases $n > 2$, yet to be analyzed.

Here are some numerical examples (again for $n = 2$): with $\beta_1 = -0.20$, $\beta_2 = -0.10$, the threshold $\rho^* \frac{4\beta_1\beta_2}{(\beta_1+\beta_2)^2} < 1$ equals $\frac{0.08}{0.09} \approx 0.8889$; with $\beta_1 = -0.30$, $\beta_2 = -0.05$: the threshold equals $\frac{0.06}{0.1225} \approx 0.4898$; finally, with $\beta_1 = \beta_2$, the threshold equals 1 (namely, $\alpha_2 > 0$ regardless of the values of cross-correlation coefficients).

Appendix B: Tables and plots

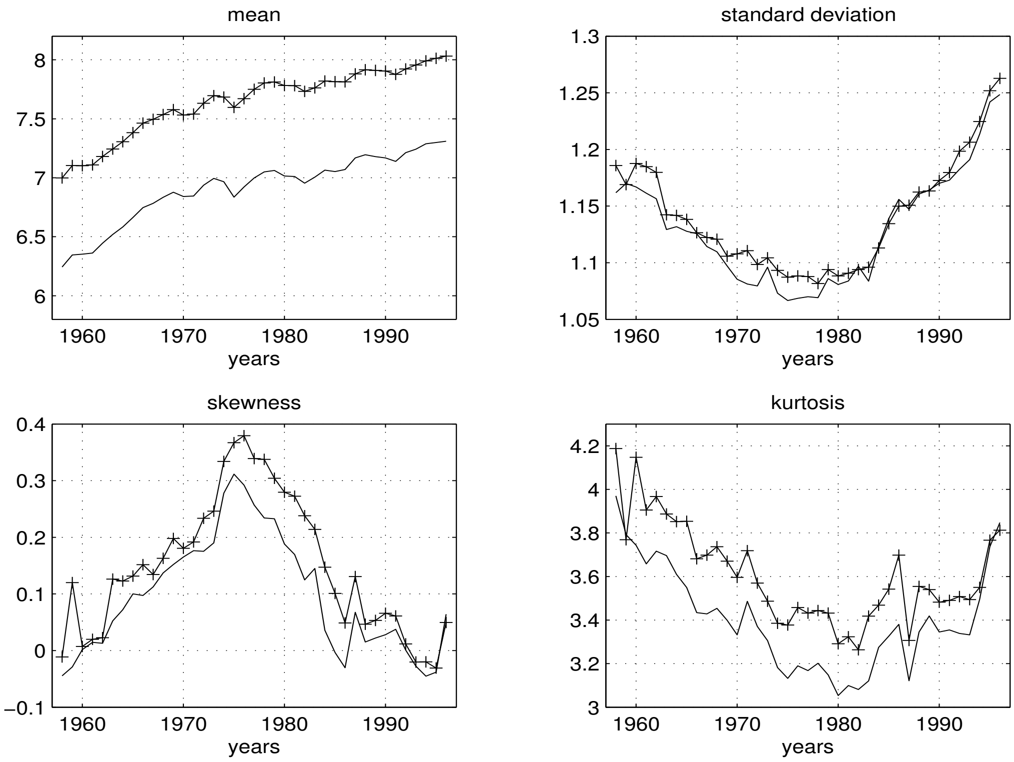

Figure 1: Time evolution of the moments of the cross-sectoral logarithmic value-added (continuous lines) and value-of-shipments distributions (crossed lines).

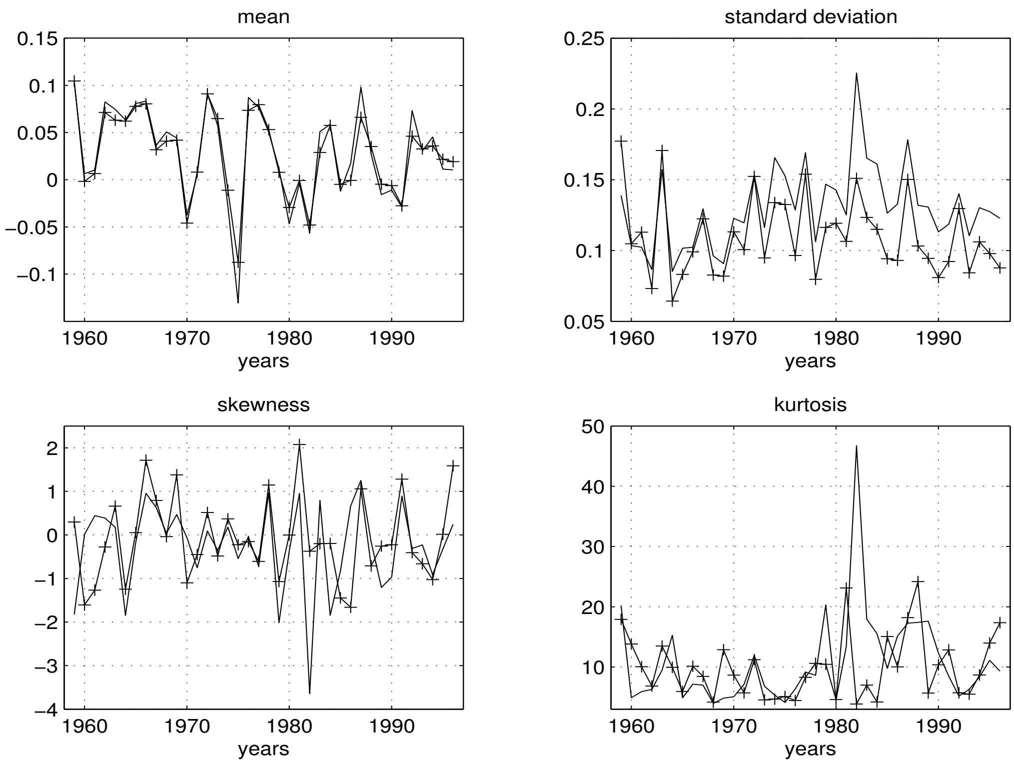

Figure 2: Time evolution of the moments of the cross-sectoral distributions of value-added (continuous lines) and value-of-shipments (crossed lines) growth rates.

Table 1: Estimated OLS coefficients of the power-law and quadratic scaling relationships, for the value-of-shipments 1-year growth rates. Estimates are based on a 20-bins binning procedure. *: non-significant at the 95% level.

Years	**Power-law scaling**			**Quadratic scaling**			
	β_0	β	R^2	α_0	α_1	α_2	R^2
1959	-0.9684	-0.1819	0.1768	0.0209	-0.0058	-0.0017	0.2300
1960	-1.5953	-0.1199	0.1140	0.0095	-0.0030	0.0014	0.2552
1961	-1.3320	-0.1622	0.0303	0.0099	-0.0028	0.0001	0.3843
1962	-1.4240	-0.1733	0.1502	0.0065	-0.0030	0.0011	0.1044
1963	-1.1415	-0.1330	0.0049	0.0228	-0.0041	-0.0007	0.2927
1964	-1.1610	-0.2214	0.2637	0.0074	-0.0027	-0.0003	0.2312
1965	-0.9167	-0.2245	0.4328	0.0104	-0.0038	-0.0003	0.4084
1966	-1.1239	-0.1826	0.3486	0.0109	-0.0036	-0.0003	0.2785
1967	-0.7480	-0.2061	0.3127	0.0157	-0.0055	0.0007	0.2472
1968	-1.7222	-0.0966	0.1168	0.0090	-0.0018	0.0004	0.1351
1969	-1.2851	-0.1779	0.2977	0.0080	-0.0023	-0.0005	0.2835
1970	-0.9655	-0.1730	0.2791	0.0123	-0.0061	0.0030	0.5999
1971	-1.4997	-0.1026	0.1525	0.0141	-0.0022	-0.0002	0.1750
1972	-0.9431	-0.1588	0.1603	0.0205	-0.0048	-0.0004	0.1586
1973	-0.4925	-0.2531	0.3783	0.0103	-0.0074	0.0034	0.3146
1974	-0.2146	-0.2454	0.5486	0.0261	-0.0088	-0.0012	0.5349
1975	-1.3844	-0.0777	0.2845	0.0236	-0.0041	-0.0006	0.3360
1976	-0.8040	-0.1975	0.1391	0.0134	-0.0071	0.0026	0.1517
1977	0.1744	-0.3042	0.5212	0.0290	-0.0125	-0.0005*	0.3550
1978	-0.9888	-0.1973	0.2814	0.0105	-0.0041	0.0003	0.4310
1979	-0.3057	-0.2558	0.3006	0.0224	-0.0078	-0.0020	0.1746
1980	-0.9615	-0.1581	0.3358	0.0148	-0.0068	0.0033	0.3650
1981	-0.9728	-0.1767	0.1791	0.0141	-0.0057	0.0012	0.2579
1982	-0.5148	-0.1692	0.1081	0.0493	-0.0214	-0.0003	0.1302
1983	-1.7137	-0.0426	0.0224	0.0188	-0.0047	0.0035	0.0117
1984	-0.3033	-0.2477	0.4500	0.0194	-0.0116	0.0032	0.5619
1985	-0.5519	-0.2286	0.1267	0.0141	-0.0074	0.0017	0.1181
1986	-1.2849	-0.1277	0.1011	0.0132	-0.0037	0.0014	0.0338
1987	-0.4238	-0.2121	0.5276	0.0220	-0.0126	0.0044	0.6132
1988	-0.5218	-0.2399	0.4564	0.0100	-0.0082	0.0043	0.2931
1989	-0.1839	-0.2900	0.5355	0.0062	-0.0144	0.0093	0.6792
1990	-0.7718	-0.2137	0.3292	0.0074	-0.0088	0.0055	0.5007
1991	-0.8956	-0.1932	0.2118	0.0109	-0.0057	0.0019	0.2780
1992	-0.8481	-0.1695	0.4095	0.0165	-0.0075	0.0026	0.5312
1993	-0.8000	-0.2129	0.1880	0.0107	-0.0048	0.0011	0.4247
1994	-1.0767	-0.1545	0.4520	0.0117	-0.0047	0.0030	0.5624
1995	-1.1901	-0.1469	0.4538	0.0106	-0.0038	0.0015	0.6356
1996	-1.8233	-0.0538	0.0205	0.0118	0.0004	0.0021	0.4211

Table 2: Estimated OLS coefficients of the power-law and quadratic scaling relationships, for the value-of-shipments 1-year growth rates. Estimates are based on a 20-bins binning procedure. *: non-significant at the 95% level.

Years	**Power-law scaling**			**Quadratic scaling**			
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1961	-1.3320	-0.1622	0.3893	0.0099	-0.0028	0.0001	0.3758
1962	-1.4240	-0.1733	0.3864	0.0065	-0.0030	0.0011	0.4274
1963	-1.1415	-0.1330	0.1688	0.0228	-0.0041	-0.0007	0.1102
1964	-1.1610	-0.2214	0.3890	0.0074	-0.0027	-0.0003	0.1873
1965	-0.9167	-0.2245	0.4343	0.0104	-0.0038	-0.0003	0.4434
1966	-1.1239	-0.1826	0.4802	0.0109	-0.0036	-0.0003	0.3430
1967	-0.7480	-0.2061	0.4526	0.0157	-0.0055	0.0007	0.3263
1968	-1.7222	-0.0966	0.2080	0.0090	-0.0018	0.0004	0.2382
1969	-1.2851	-0.1779	0.5056	0.0080	-0.0023	-0.0005	0.4238
1970	-0.9655	-0.1730	0.5097	0.0123	-0.0061	0.0030	0.6873
1971	-1.4997	-0.1026	0.1507	0.0141	-0.0022	-0.0002	0.0937
1972	-0.9431	-0.1588	0.2671	0.0205	-0.0048	-0.0004	0.1720
1973	-0.4925	-0.2531	0.6449	0.0103	-0.0074	0.0034	0.6904
1974	-0.2146	-0.2454	0.5613	0.0261	-0.0088	-0.0012	0.4164
1975	-1.3844	-0.0777	0.1314	0.0236	-0.0041	-0.0006	0.1799
1976	-0.8040	-0.1975	0.4487	0.0134	-0.0071	0.0026	0.5800
1977	0.1744	-0.3042	0.4665	0.0290	-0.0125	-0.0005	0.3259
1978	-0.9888	-0.1973	0.3299	0.0105	-0.0041	0.0003	0.2612
1979	-0.3057	-0.2558	0.4154	0.0224	-0.0078	-0.002	0.1129
1980	-0.9615	-0.1581	0.3268	0.0148	-0.0068	0.0033	0.5435
1981	-0.9728	-0.1767	0.2645	0.0141	-0.0057	0.0012	0.1830
1982	-0.5148	-0.1692	0.2058	0.0493	-0.0214	-0.0003*	0.0798
1983	-1.7137	-0.0426	0.0195	0.0188	-0.0047	0.0035	0.0892
1984	-0.3033	-0.2477	0.4620	0.0194	-0.0116	0.0032	0.2949
1985	-0.5519	-0.2286	0.5863	0.0141	-0.0074	0.0017	0.4999
1986	-1.2849	-0.1277	0.2501	0.0132	-0.0037	0.0014	0.2042
1987	-0.4238	-0.2121	0.4330	0.0220	-0.0126	0.0044	0.5099
1988	-0.5218	-0.2399	0.4981	0.0100	-0.0082	0.0043	0.7324
1989	-0.1839	-0.2900	0.6311	0.0062	-0.0144	0.0093	0.7148
1990	-0.7718	-0.2137	0.4567	0.0074	-0.0088	0.0055	0.7003
1991	-0.8956	-0.1932	0.4069	0.0109	-0.0057	0.0019	0.4271
1992	-0.8481	-0.1695	0.3692	0.0165	-0.0075	0.0026	0.4769
1993	-0.8000	-0.2129	0.3646	0.0107	-0.0048	0.0011	0.4704
1994	-1.0767	-0.1545	0.2787	0.0117	-0.0047	0.0030	0.4582
1995	-1.1901	-0.1469	0.3830	0.0106	-0.0038	0.0015	0.4691
1996	-1.8233	-0.0538	0.0289	0.0118	0.0004	0.0021	0.1613

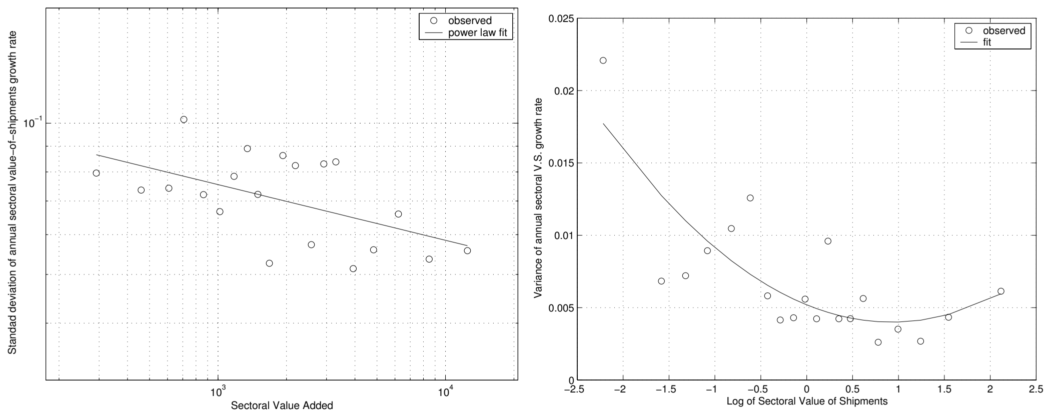

Figure 3: The volatility of sectoral value-of-shipments growth rates is decreasing in sectoral size. Left panel: scatterplot of the log-standard deviation of growth rates vs. log-size, and linear regression fit, for the year 1969 ($b = -.111 \pm .002$). Right panel: scatterplot of the variance of growth rates vs. log-size, for the year 1995. Estimates are based on a 20-bins binning procedure.

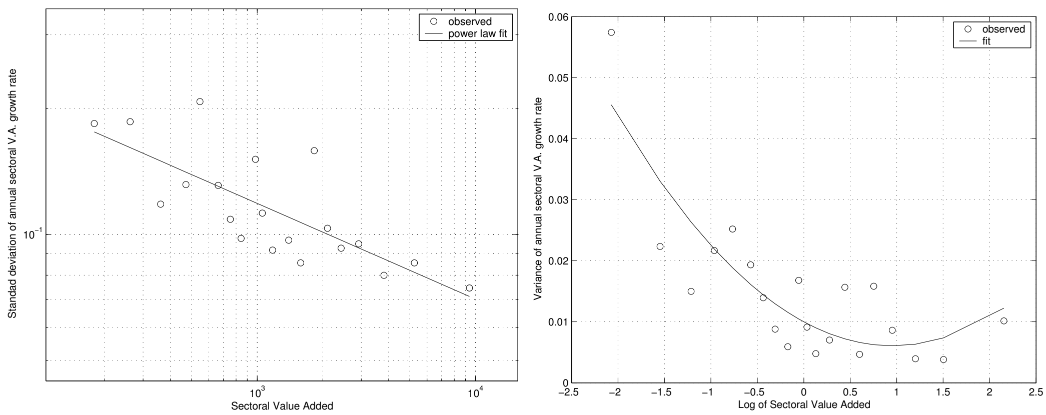

Figure 4: The volatility of sectoral value-added growth rates is decreasing in sectoral size. Left panel: scatterplot of the log-standard deviation of growth rates vs. log-size, and linear regression fit, for the year 1985 ($b = -.229 \pm .003$). Right panel: scatterplot of the variance of growth rates vs. log-size, for the year 1988. Estimates are based on a 20-bins binning procedure.

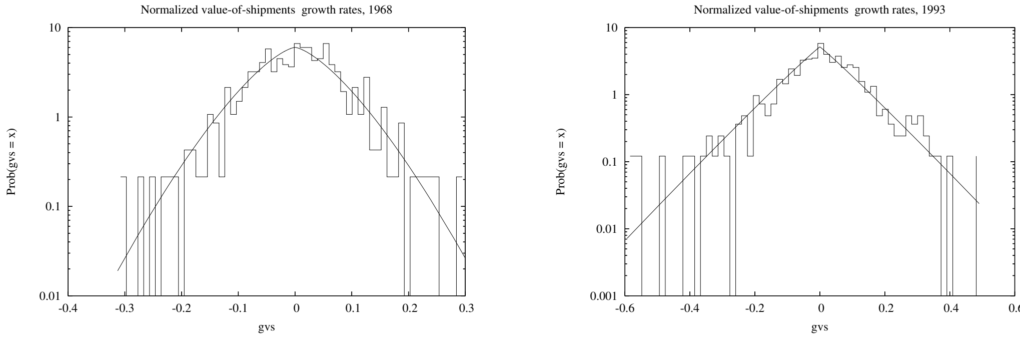

Figure 5: Empirical density and Subbotin fit, value-of-shipment growth rates for 1968 ($b = 1.4255$; left panel) and 1993 ($b = 1.0104$; right panel).

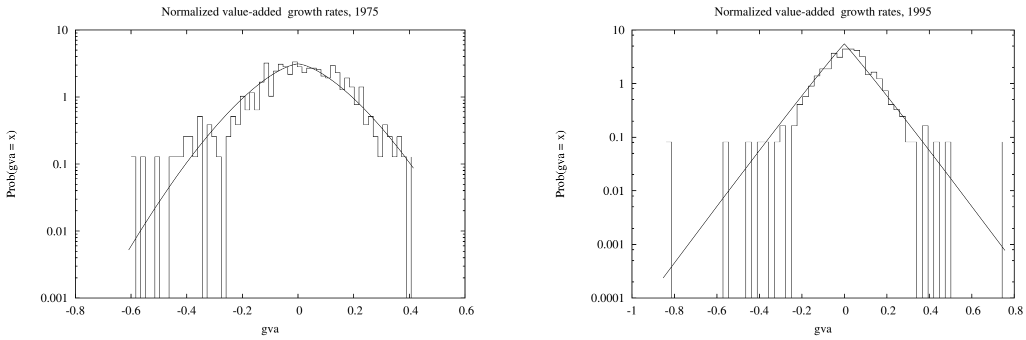

Figure 6: Empirical density and Subbotin fit, value-added growth rates for 1975 ($b = 1.5112$; left panel) and 1989 ($b = 1.0381$; right panel).

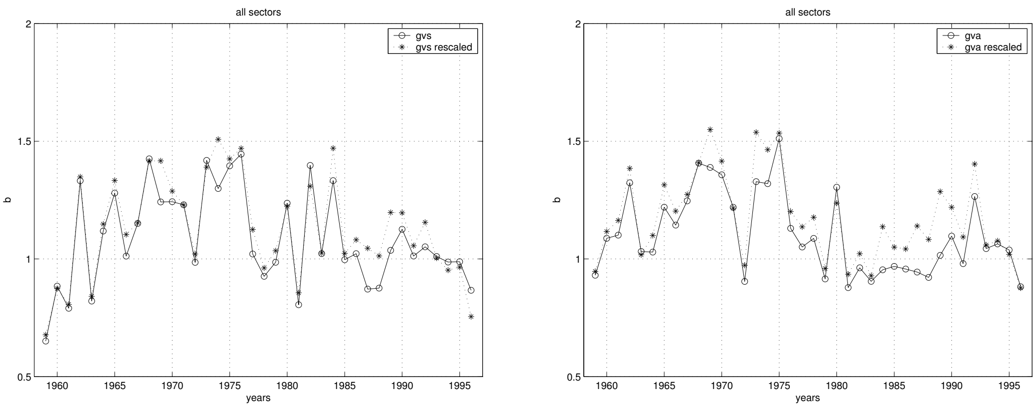

Figure 7: Estimated b parameters. Left panel: gvs. Right panel: gva.

Table 3: Estimated Subbotin shape parameter b, 1-year growth rates of value-of-shipments from 1959 to 1996, for all sectors and sector groups. Standard errors are reported. Point estimates with * are two standard errors away from 1.

Years	All sectors		Nondurable cons.		Durable cons.		Intermediate		Investments	
	point est.	std.err.	point est.	std.err.	point est.	std.err.	point est.	std.err.	point est.	std.err.
1959	0.6510*	0.0521	0.6933*	0.1199	1.0870	0.1910	0.9358	0.1533	0.4977*	0.0756
1960	0.8842	0.0748	0.6571*	0.1126	1.2645	0.2304	0.9841	0.1629	0.8828	0.1477
1961	0.7905*	0.0654	0.7314*	0.1277	0.7428*	0.1207	0.9785	0.1618	0.7789	0.1272
1962	1.3323*	0.1238	1.4135	0.2854	1.3768	0.2563	1.5991*	0.2986	1.1879	0.2122
1963	0.8210*	0.0684	0.7445	0.1304	1.1412	0.2028	1.0759	0.1817	0.6344*	0.0999
1964	1.1187	0.0996	1.3825	0.2775	1.0101	0.1746	1.5935*	0.2973	0.9378	0.1588
1965	1.2799*	0.1177	1.4664	0.2990	1.1182	0.1978	1.9398*	0.3833	1.1485	0.2035
1966	1.0121	0.0881	1.3490	0.2691	1.0291	0.1786	0.8957	0.1454	1.1967	0.2142
1967	1.1508	0.1031	1.0622	0.1999	0.8986	0.1515	1.3124	0.2325	2.0486*	0.4255
1968	1.4255*	0.1348	1.2061	0.2339	1.2532	0.2278	1.5849	0.2952	1.8360*	0.3688
1969	1.2423*	0.1134	1.6995	0.3610	0.9680	0.1658	1.1854	0.2048	2.3326*	0.5050
1970	1.2431*	0.1135	1.8060*	0.3905	1.0555	0.1842	1.8048*	0.3490	1.3806	0.2561
1971	1.2301*	0.1120	0.9721	0.1795	1.0712	0.1876	1.5393	0.2844	1.7453*	0.3454
1972	0.9856	0.0853	1.1366	0.2173	0.8961	0.1510	1.0688	0.1802	1.3693	0.2535
1973	1.4185*	0.1340	0.8574	0.1542	1.6203	0.3153	1.8502*	0.3604	1.7173*	0.3383
1974	1.2995*	0.1200	0.9408	0.1725	1.4165	0.2657	1.2945	0.2285	1.6475*	0.3207
1975	1.3955*	0.1312	1.1320	0.2162	1.7235*	0.3413	1.7383*	0.3324	1.3215	0.2424
1976	1.4454*	0.1372	0.9800	0.1812	1.5473	0.2972	1.6276*	0.3055	2.2153*	0.4716
1977	1.0211	0.0890	1.2002	0.2325	1.1463	0.2039	1.1986	0.2076	0.8315	0.1374
1978	0.9260	0.0791	0.8792	0.1589	1.2225	0.2209	1.3306	0.2365	0.7696	0.1253
1979	0.9857	0.0853	1.5193	0.3128	1.1895	0.2135	0.9223	0.1506	0.9796	0.1675
1980	1.2367*	0.1128	1.5103	0.3104	1.1567	0.2062	1.2615	0.2213	1.4582	0.2745
1981	0.8055	0.0669	0.8806	0.1593	1.2309	0.2228	0.8692	0.1402	0.6329*	0.0997
1982	1.3973*	0.1314	1.6500	0.3476	1.3103	0.2409	1.1747	0.2025	2.1529*	0.4542
1983	1.0227	0.0892	1.0604	0.1995	1.2057	0.2171	1.4926	0.2735	1.1156	0.1963
1984	1.3327*	0.1238	1.1080	0.2106	1.6506*	0.3229	1.3448	0.2397	1.4684	0.2769
1985	0.9970	0.0865	0.6819*	0.1176	1.8397	0.3714	0.9155	0.1493	1.1333	0.2002
1986	1.0225	0.0892	1.1725	0.2259	1.2144	0.2190	1.1391	0.1949	0.8255	0.1363
1987	0.8718	0.0735	0.6809*	0.1174	1.0866	0.1909	0.7885	0.1248	1.1389	0.2014
1988	0.8760	0.0739	0.9341	0.1710	1.2751	0.2328	0.7189*	0.1119	0.8404	0.1392
1989	1.0366	0.0907	1.3055	0.2582	0.9922	0.1708	0.8982	0.1459	1.3797	0.2559
1990	1.1261	0.1004	1.2787	0.2516	1.0424	0.1814	1.5663	0.2908	1.1244	0.1983
1991	1.0125	0.0881	0.8161	0.1454	1.0014	0.1727	1.1494	0.1971	1.2821	0.2334
1992	1.0517	0.0923	1.0553	0.1984	0.8387	0.1395	1.2230	0.2129	1.1477	0.2033
1993	1.0104	0.0879	0.9712	0.1792	0.9003	0.1519	1.3472	0.2403	1.0807	0.1888
1994	0.9870	0.0854	1.0120	0.1885	1.0928	0.1923	1.0186	0.1699	0.9503	0.1614
1995	0.9883	0.0856	1.3316	0.2647	0.8924	0.1502	1.3471	0.2402	1.0465	0.1815
1996	0.8669	0.0730	1.2356	0.2411	1.2425	0.2254	0.9488	0.1558	0.6463*	0.1021

Table 4: Estimated Subbotin shape parameter b, 1-year growth rates of value added from 1959 to 1996, for all sectors and sector groups. Standard errors are reported. Point estimates with * are two standard errors away from 1.

Years	**All sectors**		**Nondurable cons.**		**Durable cons.**		**Intermediate**		**Investments**	
	point est.	std.err.	point est.	std.err.	point est.	std.err.	point est.	std.err.	point est.	std.err.
1959	0.9310	0.0796	0.8741	0.1578	1.2818	0.2343	1.4548	0.2647	0.7987	0.1310
1960	1.0879	0.0962	0.7549	0.1325	1.1071	0.1953	1.0529	0.1769	2.0859*	0.4357
1961	1.1014	0.0977	0.8801	0.1591	0.9515	0.1623	1.5809	0.2943	1.1930	0.2134
1962	1.3234*	0.1227	1.2860	0.2534	1.5757	0.3042	1.3102	0.2320	1.2426	0.2244
1963	1.0318	0.0902	1.0479	0.1967	1.3275	0.2448	1.2032	0.2086	0.7744	0.1263
1964	1.0292	0.0899	0.8290	0.1482	0.9425	0.1605	1.9164*	0.3773	0.9682	0.1651
1965	1.2198	0.1109	0.7636	0.1344	1.2746	0.2327	1.8688	0.3651	1.3120	0.2402
1966	1.1438	0.1024	0.9602	0.1768	0.9863	0.1696	1.1045	0.1876	1.8192*	0.3645
1967	1.2468*	0.1139	1.3401	0.2668	1.1087	0.1957	1.3574	0.2426	1.3951	0.2595
1968	1.4068*	0.1326	1.1849	0.2288	1.4060	0.2632	1.2801	0.2253	1.8890*	0.3827
1969	1.3887*	0.1304	1.2675	0.2488	1.2592	0.2291	1.2518	0.2191	1.9288*	0.3933
1970	1.3574*	0.1267	1.6224	0.3401	1.2615	0.2297	1.4317	0.2594	1.4224	0.2660
1971	1.2195	0.1108	1.0312	0.1928	1.0784	0.1891	1.2464	0.2180	2.2208*	0.4732
1972	0.9044	0.0768	0.9971	0.1851	0.8968	0.1511	0.9635	0.1588	1.0124	0.1743
1973	1.3283*	0.1233	0.9476	0.1740	1.4145	0.2652	1.3768	0.2469	2.0671*	0.4305
1974	1.3201*	0.1224	1.0426	0.1954	1.4090	0.2639	1.2692	0.2229	1.5605	0.2992
1975	1.5112*	0.1452	1.6850	0.3571	1.6685*	0.3274	1.3858	0.2490	1.4756	0.2786
1976	1.1299	0.1008	0.7544	0.1324	1.3145	0.2418	1.1184	0.1905	2.4978*	0.5531
1977	1.0507	0.0922	1.0109	0.1882	1.4898	0.2832	1.6139*	0.3022	0.8138	0.1340
1978	1.0874	0.0962	0.9196	0.1678	1.3914	0.2597	1.5988*	0.2986	0.8109	0.1334
1979	0.9153	0.0780	0.9543	0.1755	1.4350	0.2701	0.9033	0.1469	0.7599	0.1235
1980	1.3046*	0.1206	1.3401	0.2668	1.2764	0.2331	1.2986	0.2294	1.4317	0.2681
1981	0.8784	0.0742	0.7817	0.1381	1.1670	0.2085	1.0997	0.1866	0.7752	0.1264
1982	0.9624	0.0828	1.3253	0.2631	1.0725	0.1879	0.9752	0.1611	1.5780	0.3035
1983	0.9050	0.0769	1.0166	0.1895	1.3410	0.2480	0.7829	0.1238	1.1969	0.2142
1984	0.9537	0.0819	0.7551	0.1326	1.0958	0.1929	0.9546	0.1570	1.4379	0.2696
1985	0.9686	0.0835	0.9138	0.1665	1.1114	0.1963	0.9342	0.1530	1.0879	0.1904
1986	0.9570	0.0823	0.8257	0.1474	1.2231	0.2210	0.8703	0.1404	1.1257	0.1986
1987	0.9442	0.0809	0.8226	0.1468	1.0907	0.1918	0.8221	0.1312	1.2106	0.2173
1988	0.9216	0.0786	0.7418	0.1298	2.1976*	0.4687	0.8341	0.1335	1.0221	0.1764
1989	1.0153	0.0884	0.9629	0.1774	1.2274	0.2220	0.8381	0.1342	1.3139	0.2407
1990	1.0969	0.0972	1.1606	0.2230	0.9607	0.1643	1.5900	0.2964	1.0439	0.1810
1991	0.9803	0.0847	0.8535	0.1534	0.8933	0.1504	0.9643	0.1589	1.3373	0.2460
1992	1.2653*	0.1160	1.2894	0.2542	1.2811	0.2342	1.4624	0.2665	1.1545	0.2048
1993	1.0441	0.0915	0.9233	0.1686	0.8849	0.1487	1.3019	0.2302	1.2383	0.2235
1994	1.0638	0.0936	1.0504	0.1972	1.1227	0.1988	1.3820	0.2481	0.9114	0.1535
1995	1.0381	0.0908	1.3643	0.2729	0.9154	0.1549	1.0315	0.1726	1.1161	0.1965
1996	0.8817	0.0745	0.6364*	0.1085	1.1514	0.2050	0.9677	0.1596	0.9297	0.1572

Table 5: Estimated Subbotin shape parameter b, 1-year growth rates of value added from 1959 to 1996, for Pavitt groups. Standard errors are reported. Point estimates with * are two standard errors away from 1.

Years	**Supplier dominated**		**Scale intensive**		**Specialized supplier**		**Science based**	
	point est.	std.err.	point est.	std.err.	point est.	std.err.	point est.	std.err.
1959	1.3118	0.2188	1.2055	0.1842	0.7104*	0.1338	0.7087*	0.1460
1960	0.9306	0.1434	1.1476	0.1733	1.9506	0.4682	0.9910	0.2180
1961	0.9618	0.1492	1.3563	0.2135	1.2154	0.2561	0.9408	0.2047
1962	1.8012*	0.3277	1.2565	0.1940	1.1265	0.2331	2.3070*	0.6388
1963	1.0370	0.1635	1.1059	0.1656	1.2147	0.2560	0.8366	0.1777
1964	1.3647	0.2299	0.8663	0.1231	1.2865	0.2750	1.1235	0.2542
1965	1.1343	0.1826	1.3072	0.2038	2.2588*	0.5677	1.0221	0.2264
1966	1.0269	0.1616	1.1638	0.1764	1.4391	0.3166	1.4665	0.3549
1967	1.4599	0.2504	1.1289	0.1698	1.8994	0.4522	1.0943	0.2462
1968	1.5580*	0.2720	1.1354	0.1711	1.8456	0.4356	1.3070	0.3069
1969	1.3560	0.2281	1.3387	0.2100	1.6489	0.3766	1.4718	0.3565
1970	1.1788	0.1915	1.8909*	0.3267	1.3565	0.2939	1.2941	0.3031
1971	1.1024	0.1763	0.9957	0.1456	2.1276*	0.5246	3.0845*	0.9433
1972	0.9645	0.1497	0.9447	0.1366	0.9505	0.1894	0.9072	0.1959
1973	1.3587	0.2287	1.1274	0.1696	3.4170*	0.9913	1.2431	0.2883
1974	1.2196	0.1997	1.3072	0.2038	1.5525	0.3487	1.3611	0.3229
1975	2.3614*	0.4676	1.6039*	0.2642	1.1632	0.2426	1.4493	0.3496
1976	1.2850	0.2132	0.9132	0.1311	2.1786*	0.5413	1.5249	0.3729
1977	1.4263	0.2431	0.8891	0.1270	1.0965	0.2255	1.6405	0.4094
1978	1.4122	0.2401	1.0610	0.1574	0.8444	0.1642	1.3926	0.3324
1979	0.8926	0.1363	0.8581	0.1217	1.0214	0.2067	1.4388	0.3464
1980	1.3502*	0.2268	1.3470	0.2117	1.0568	0.2155	1.6061	0.3985
1981	1.3069*	0.2178	0.6989*	0.0954	0.8915	0.1753	0.9031	0.1948
1982	1.1221	0.1802	1.0467	0.1548	2.3282*	0.5909	1.8121	0.4655
1983	0.8632	0.1309	0.9382	0.1355	1.0867	0.2231	1.5352	0.3761
1984	1.0825	0.1724	0.8143	0.1143	1.5236	0.3405	1.3264	0.3126
1985	1.1916	0.1940	0.8145	0.1143	1.1911	0.2498	1.1208	0.2535
1986	1.1590	0.1875	0.8586	0.1218	1.2120	0.2553	0.8543	0.1822
1987	1.0921	0.1742	0.7931	0.1108	1.0740	0.2198	1.2793	0.2988
1988	2.0224*	0.3811	0.7343*	0.1011	1.0734	0.2197	0.9011	0.1943
1989	1.1856	0.1928	0.8601	0.1220	1.3224	0.2846	1.1417	0.2594
1990	0.9972	0.1559	1.2141	0.1859	1.0783	0.2209	1.4379	0.3461
1991	1.0394	0.1640	1.0314	0.1520	1.1358	0.2355	0.7781	0.1630
1992	1.8132*	0.3306	1.4056	0.2233	0.8821	0.1731	1.1638	0.2656
1993	0.9673	0.1502	1.0442	0.1543	1.4195	0.3112	1.2152	0.2802
1994	1.2092	0.1976	1.0046	0.1472	0.9482	0.1888	1.4705	0.3561
1995	0.8950	0.1367	1.2932	0.2011	1.2243	0.2585	0.9925	0.2184
1996	0.8191	0.1230	0.8512	0.1205	1.0334	0.2097	0.9404	0.2046

Table 6: Estimated Subbotin shape parameter b, 1-year growth rates of value-of-shipments from 1959 to 1996, for Pavitt groups. Standard errors are reported. Point estimates with * are two standard errors away from 1.

Years	Supplier dominated		Scale intensive		Specialized supplier		Science based	
	point est.	std.err.	point est.	std.err.	point est.	std.err.	point est.	std.err.
1959	0.9244	0.1422	0.9314	0.1343	0.5474*	0.0989	0.3796*	0.0717
1960	1.0850	0.1728	0.9352	0.1349	0.8798	0.1725	0.8251	0.1748
1961	0.7032*	0.1027	0.9314	0.1343	1.0396	0.2112	0.5994*	0.1201
1962	1.5240*	0.2644	1.4973*	0.2420	1.0297	0.2088	1.7596	0.4481
1963	0.9590	0.1487	0.8632	0.1225	1.0579	0.2158	0.5732*	0.1141
1964	1.4942	0.2579	1.0585	0.1569	1.0812	0.2217	1.1068	0.2496
1965	1.1790	0.1915	1.3570	0.2136	2.5785*	0.6771	1.0908	0.2452
1966	1.2484	0.2056	0.9894	0.1445	1.1224	0.2321	0.8982	0.1936
1967	1.1011	0.1760	1.1535	0.1744	2.0603*	0.5029	0.9005	0.1942
1968	1.6279*	0.2877	1.1273	0.1695	1.7309	0.4009	2.1672*	0.5881
1969	1.1229	0.1803	1.4240	0.2270	1.3873	0.3023	1.4487	0.3494
1970	1.2021	0.1962	1.4125	0.2247	1.4165	0.3104	1.4734	0.3570
1971	1.1251	0.1807	1.0361	0.1529	2.0666*	0.5050	1.5457	0.3794
1972	1.0191	0.1601	0.9784	0.1425	1.3017	0.2791	1.0644	0.2379
1973	1.5476*	0.2697	1.2766	0.1979	1.2711	0.2569	1.0409	0.2315
1974	1.2406	0.2040	1.2666	0.1959	1.4532*	0.1367	1.3941	0.3328
1975	1.7102*	0.3065	1.2496	0.1927	1.5545*	0.1060	2.0445	0.5448
1976	1.3407	0.2248	1.4931*	0.2411	2.0729*	0.1054	1.5093	0.3681
1977	1.4910	0.2571	0.8430	0.1191	1.0290	0.1233	1.4693	0.3557
1978	1.0896	0.1737	1.1397	0.1719	0.7467*	0.0633	1.0033	0.2213
1979	0.9657	0.1499	0.8203	0.1153	1.1767	0.0922	1.3815	0.3290
1980	1.1503	0.1858	1.5195*	0.2465	0.8201*	0.0882	2.2620*	0.6223
1981	1.2424	0.2044	0.6780*	0.0921	0.8902	0.0754	0.7760	0.1625
1982	1.4627	0.2510	1.4473	0.2318	3.5333*	0.1954	0.9435	0.2054
1983	1.3832	0.2339	0.9948	0.1455	1.0396	0.1321	2.7115	0.7925
1984	1.3792	0.2330	1.2982	0.2021	1.4477*	0.1074	1.3656	0.3243
1985	1.4942	0.2579	0.8005	0.1120	1.1490	0.0807	1.0085	0.2227
1986	1.2608	0.2082	0.8596	0.1219	1.0701	0.0586	1.1196	0.2532
1987	1.2454	0.2050	0.7635*	0.1059	0.8306	0.0938	0.8918	0.1919
1988	1.2815	0.2125	0.6630*	0.0897	0.9282	0.0718	0.8936	0.1924
1989	0.9182	0.1410	0.9635	0.1399	1.5700*	0.0931	1.0604	0.2368
1990	0.9517	0.1473	1.4913*	0.2407	1.3762*	0.0730	0.9964	0.2195
1991	1.1267	0.1810	1.1188	0.1680	1.1191	0.0802	0.7259	0.1502
1992	1.1997	0.1957	1.1766	0.1788	0.8993	0.0936	0.9274	0.2012
1993	0.8997	0.1376	0.9931	0.1452	1.1450*	0.0589	1.2777	0.2983
1994	1.0045	0.1573	0.8982	0.1285	1.2891*	0.0740	0.9975	0.2198
1995	0.8458	0.1278	1.3397	0.2102	1.3300*	0.0786	0.7995	0.1684
1996	1.0459	0.1652	0.9180	0.1320	0.7823*	0.0591	0.7660	0.1600

Table 7: List of SIC 4-digit sectors within the group "nondurable consumption goods".

SIC code	denomination	SIC code	denomination
2011	Meat packing plants	2754	Commercial printing, gravure
2013	Sausages and other prepared meats	2759	Commercial printing, n.e.c.
2015	Poultry slaughtering and processing	2761	Manifold business forms
2021	Creamery butter	2771	Greeting cards
2022	Cheese, natural and processed	2782	Blankbooks and looseleaf binders
2023	Dry, condensed, and evaporated dairy products	2789	Bookbinding and related work
2024	Ice cream and frozen desserts	2791	Typesetting
2026	Fluid milk	2796	Platemaking services
2032	Canned specialties	2833	Medicinals and botanicals
2033	Canned fruits and vegetables	2834	Pharmaceutical preparations
2034	Dehydrated fruits, vegetables, and soups	2835	Diagnostic substances
2035	Pickles, sauces, and salad dressings	2836	Biological products, except diagnostic
2037	Frozen fruits and vegetables	2841	Soap and other detergents
2038	Frozen specialties, n.e.c.	2842	Polishes and sanitation goods
2041	Flour and other grain mill products	2843	Surface active agents
2043	Cereal breakfast foods	2844	Toilet preparations
2044	Rice milling	2851	Paints and allied products
2045	Prepared flour mixes and doughs	3411	Metal cans
2046	Wet corn milling	3412	Metal barrels, drums, and pails
2047	Dog and cat food	3851	Ophthalmic goods
2048	Prepared feeds, n.e.c.	3951	Pens and mechanical pencils
2051	Bread, cake, and related products	3952	Lead pencils and art goods
2052	Cookies and crackers	3953	Marking devices
2053	Frozen bakery products, except bread	3955	Carbon paper and inked ribbons
2061	Raw cane sugar	2121	Cigars
2062	Cane sugar refining	2131	Chewing and smoking tobacco
2063	Beet sugar	2141	Tobacco stemming and redrying
2064	Candy and other confectionery products	2611	Pulp mills
2066	Chocolate and cocoa products	2621	Paper mills
2067	Chewing gum	2631	Paperboard mills
2068	Salted and roasted nuts and seeds	2652	Setup paperboard boxes
2074	Cottonseed oil mills	2653	Corrugated and solid fiber boxes
2075	Soybean oil mills	2655	Fiber cans, drums, and similar products
2076	Vegetable oil mills, n.e.c.	2656	Sanitary food containers
2077	Animal and marine fats and oils	2657	Folding paperboard boxes
2079	Edible fats and oils, n.e.c.	2671	Paper coated and laminated, packaging
2082	Malt beverages	2672	Paper coated and laminated, n.e.c.
2083	Malt	2673	Bags: plastics, laminated, and coated
2084	Wines, brandy, and brandy spirits	2674	Bags: uncoated paper and multiwall
2085	Distilled and blended liquors	2675	Die-cut paper and board
2086	Bottled and canned soft drinks	2676	Sanitary paper products
2087	Flavoring extracts and syrups, n.e.c.	2677	Envelopes
2091	Canned and cured fish and seafoods	2678	Stationery products
2092	Fresh or frozen prepared fish	2679	Converted paper products, n.e.c.
2095	Roasted coffee	2711	Newspapers
2096	Potato chips and similar snacks	2721	Periodicals
2097	Manufactured ice	2731	Book publishing
2098	Macaroni and spaghetti	2732	Book printing
2099	Food preparations, n.e.c.	2741	Miscellaneous publishing
2111	Cigarettes	2752	Commercial printing, lithographic

Table 8: List of SIC 4-digit sectors within the group "durable consumption goods".

SIC code	denomination	SIC code	denomination
2211	Broadwoven fabrics mills, cotton	2517	Wood television and radio cabinets
2221	Broadwoven fabrics mills, manmade fiber and silk	2519	Household furniture, n.e.c.
2231	Broadwoven fabrics mills, wool	2521	Wood office furniture
2241	Narrow fabrics mills	2522	Office furniture, except wood
2251	Womens hosiery, except socks	2531	Public building and related furniture
2252	Hosiery, n.e.c.	2541	Wood partitions and fixtures
2253	Knit outerwear mills	2542	Partitions and fixtures, except wood
2254	Knit underwear mills	2591	Drapery hardware and blinds and shades
2257	Weft knit fabrics mills	2599	Furniture and fixtures, n.e.c.
2258	Lace and warp knit fabrics mills	3021	Rubber and plastics footwear
2259	Knitting mills, n.e.c.	3111	Leather tanning and finishing
2261	Finishing plants, cotton	3131	Footwear cut stock
2262	Finishing plants, manmade	3142	House slippers
2269	Finishing plants, n.e.c.	3143	Mens footwear, except athletic
2273	Carpets and rugs	3144	Womens footwear, except athletic
2281	Yarn spinning mills	3149	Footwear, except rubber, n.e.c.
2282	Throwing and winding mills	3151	Leather gloves and mittens
2284	Thread mills	3161	Luggage
2295	Coated fabrics, not rubberized	3171	Womens handbags and purses
2296	Tire cord and fabrics	3172	Personal leather goods, n.e.c.
2297	Nonwoven fabrics	3199	Leather goods, n.e.c.
2298	Cordage and twine	3221	Glass containers
2299	Textile goods, n.e.c.	3231	Products of purchased glass
2311	Mens and boys suits and coats	3421	Cutlery
2321	Mens and boys shirts	3423	Hand and edge tools, n.e.c.
2322	Mens and boys underwear and nightwear	3425	Saw blades and handsaws
2323	Mens and boys neckwear	3429	Hardware, n.e.c.
2325	Mens and boys trousers and slacks	3482	Small arms ammunition
2326	Mens and boys work clothing	3483	Ammunition, except for small arms, n.e.c.
2329	Mens and boys clothing, n.e.c.	3484	Small arms
2331	Womens, misses, and juniors blouses and shirts	3489	Ordnance and accessories, n.e.c.
2335	Womens, misses, and juniors dresses	3631	Household cooking equipment
2337	Womens, misses, and juniors suits and coats	3632	Household refrigerators and freezers
2339	Womens, misses, and juniors outerwear, n.e.c.	3633	Household laundry equipment
2341	Womens and childrens underwear	3634	Electric housewares and fans
2342	Brassieres, girdles, and allied garments	3635	Household vacuum cleaners
2353	Hats, caps, and millinery	3639	Household appliances, n.e.c.
2361	Girls and childrens dresses and blouses	3651	Household audio and video equipment
2369	Girls and childrens outerwear, n.e.c.	3652	Prerecorded records and tapes
2371	Fur goods	3661	Telephone and telegraph apparatus
2381	Fabrics dress and work gloves	3663	Radio and tv communications equipment
2384	Robes and dressing gowns	3669	Communications equipment, n.e.c.
2385	Waterproof outerwear	3695	Magnetic and optical recording media
2386	Leather and sheep-lined clothing	3751	Motorcycles, bicycles, and parts
2387	Apparel belts	3861	Photographic equipment and supplies
2389	Apparel and accessories, n.e.c.	3873	Watches, clocks, watchcases, and parts
2391	Curtains and draperies	3911	Jewelry, precious metal
2392	Housefurnishings, n.e.c.	3914	Silverware and plated ware
2393	Textile bags	3915	Jewelers materials and lapidary work
2394	Canvas and related products	3931	Musical instruments
2395	Pleating and stitching	3942	Dolls and stuffed toys
2396	Automotive and apparel trimmings	3944	Games, toys, and childrens vehicles
2397	Schiffli machine embroideries	3949	Sporting and athletic goods, n.e.c.
2399	Fabricated textile products, n.e.c.	3961	Costume jewelry
2511	Wood household furniture	3965	Fasteners, buttons, needles, and pins
2512	Upholstered household furniture	3991	Brooms and brushes
2514	Metal household furniture	3995	Burial caskets
2515	Mattresses and bedsprings	3999	Manufacturing industries, n.e.c.

Table 9: List of SIC 4-digit sectors within the group “intermediate goods”.

SIC code	denomination	SIC code	denomination
2411	Logging	3275	Gypsum products
2421	Sawmills and planing mills, general	3281	Cut stone and stone products
2426	Hardwood dimension and flooring mills	3291	Abrasive products
2429	Special product sawmills, n.e.c.	3292	Asbestos products
2435	Hardwood veneer and plywood	3295	Minerals, ground or treated
2436	Softwood veneer and plywood	3296	Mineral wool
2439	Structural wood members, n.e.c.	3297	Nonclay refractories
2441	Nailed wood boxes and shook	3299	Nonmetallic mineral products, n.e.c.
2448	Wood pallets and skids	3312	Blast furnaces and steel mills
2449	Wood containers, n.e.c.	3313	Electrometallurgical products
2491	Wood preserving	3315	Steel wire and related products
2812	Alkalies and chlorine	3316	Cold finishing of steel shapes
2813	Industrial gases	3317	Steel pipe and tubes
2816	Inorganic pigments	3321	Gray and ductile iron foundries
2819	Industrial inorganic chemicals, n.e.c.	3322	Malleable iron foundries
2821	Plastics materials and resins	3324	Steel investment foundries
2822	Synthetic rubber	3325	Steel foundries, n.e.c.
2823	Cellulosic manmade fibers	3331	Primary copper
2824	Organic fibers, noncellulosic	3334	Primary aluminum
2861	Gum and wood chemicals	3339	Primary nonferrous metals, n.e.c.
2865	Cyclic crudes and intermediates	3341	Secondary nonferrous metals
2869	Industrial organic chemicals, n.e.c.	3351	Copper rolling and drawing
2873	Nitrogenous fertilizers	3353	Aluminum sheet, plate, and foil
2874	Phosphatic fertilizers	3354	Aluminum extruded products
2875	Fertilizers, mixing only	3355	Aluminum rolling and drawing, n.e.c.
2879	Agricultural chemicals, n.e.c.	3356	Nonferrous rolling and drawing, n.e.c.
2891	Adhesives and sealants	3357	Nonferrous wiredrawing and insulating
2892	Explosives	3363	Aluminum die-castings
2893	Printing ink	3364	Nonferrous die-castings, except aluminum
2895	Carbon black	3365	Aluminum foundries
2899	Chemical preparations, n.e.c.	3366	Copper foundries
2911	Petroleum refining	3369	Nonferrous foundries, n.e.c.
2951	Asphalt paving mixtures and blocks	3398	Metal heat treating
2952	Asphalt felts and coatings	3399	Primary metal products, n.e.c.
2992	Lubricating oils and greases	3441	Fabricated structural metal
2999	Petroleum and coal products, n.e.c.	3442	Metal doors, sash, and trim
3011	Tires and inner tubes	3443	Fabricated plate work (boiler shops)
3061	Mechanical rubber goods	3444	Sheet metal work
3069	Fabricated rubber products, n.e.c.	3449	Miscellaneous metal work
3081	Unsupported plastics film and sheet	3451	Screw machine products
3082	Unsupported plastics profile shapes	3452	Bolts, nuts, rivets, and washers
3083	Laminated plastics plate, sheet, and profile shapes	3462	Iron and steel forgings
3084	Plastics pipe	3463	Nonferrous forgings
3085	Plastics bottles	3465	Automotive stampings
3086	Plastics foam products	3466	Crowns and closures
3087	Custom compounding of purchased plastics resins	3469	Metal stampings, n.e.c.
3088	Plastics plumbing fixtures	3471	Plating and polishing
3089	Plastics products, n.e.c.	3479	Metal coating and allied services
3211	Flat glass	3491	Industrial valves
3229	Pressed and blown glass, n.e.c.	3492	Fluid power valves and hose fittings
3241	Cement, hydraulic	3493	Steel springs, except wire
3251	Brick and structural clay tile	3494	Valves and pipe fittings, n.e.c.
3253	Ceramic wall and floor tile	3495	Wire springs
3255	Clay refractories	3496	Miscellaneous fabricated wire products
3259	Structural clay products, n.e.c.	3497	Metal foil and leaf
3261	Vitreous plumbing fixtures	3498	Fabricated pipe and fittings
3262	Vitreous china table and kitchenware	3499	Fabricated metal products, n.e.c.
3263	Semivitreous table and kitchenware	3544	Special dies, tools, jigs, and fixtures
3264	Porcelain electrical supplies	3545	Machine tool accessories
3269	Pottery products, n.e.c.	3566	Speed changers, drives, and gears
3271	Concrete block and brick	3592	Carburetors, pistons, rings, and valves
3272	Concrete products, n.e.c.	3593	Fluid power cylinders and actuators
3273	Ready-mixed concrete	3594	Fluid power pumps and motors
3274	Lime	3724	Aircraft engines and engine parts

Table 10: List of SIC 4-digit sectors within the group “investment goods”.

SIC code	denomination	SIC code	denomination
2431	Millwork	3599	Industrial machinery, n.e.c.
2434	Wood kitchen cabinets	3612	Transformers, except electronic
2451	Mobile homes	3613	Switchgear and switchboard apparatus
2452	Prefabricated wood buildings	3621	Motors and generators
2493	Reconstituted wood products	3624	Carbon and graphite products
2499	Wood products, n.e.c.	3625	Relays and industrial controls
3052	Rubber and plastics hose and belting	3629	Electrical industrial apparatus, n.e.c.
3053	Gaskets, packing, and sealing devices	3641	Electric lamp bulbs and tubes
3431	Metal sanitary ware	3643	Current-carrying wiring devices
3432	Plumbing fixture fittings and trim	3644	Noncurrent-carrying wiring devices
3433	Heating equipment, except electric	3645	Residential lighting fixtures
3446	Architectural metal work	3646	Commercial lighting fixtures
3448	Prefabricated metal buildings	3647	Vehicular lighting equipment
3511	Turbines and turbine generator sets	3648	Lighting equipment, n.e.c.
3519	Internal combustion engines, n.e.c.	3671	Electron tubes
3523	Farm machinery and equipment	3672	Printed circuit boards
3524	Lawn and garden equipment	3674	Semiconductors and related devices
3531	Construction machinery	3675	Electronic capacitors
3532	Mining machinery	3676	Electronic resistors
3533	Oil and gas field machinery	3677	Electronic coils and transformers
3534	Elevators and moving stairways	3678	Electronic connectors
3535	Conveyors and conveying equipment	3679	Electronic components, n.e.c.
3536	Hoists, cranes, and monorails	3691	Storage batteries
3537	Industrial trucks and tractors	3692	Primary batteries, dry and wet
3541	Machine tools, metal cutting types	3694	Engine electrical equipment
3542	Machine tools, metal forming types	3699	Electrical equipment and supplies, n.e.c.
3543	Industrial patterns	3711	Motor vehicles and car bodies
3546	Power-driven handtools	3713	Truck and bus bodies
3547	Rolling mill machinery	3714	Motor vehicle parts and accessories
3548	Welding apparatus	3715	Truck trailers
3549	Metalworking machinery, n.e.c.	3716	Motor homes
3552	Textile machinery	3721	Aircraft
3553	Woodworking machinery	3728	Aircraft parts and equipment, n.e.c.
3554	Paper industries machinery	3731	Ship building and repairing
3555	Printing trades machinery	3732	Boat building and repairing
3556	Food products machinery	3743	Railroad equipment
3559	Special industry machinery, n.e.c.	3761	Guided missiles and space vehicles
3561	Pumps and pumping equipment	3764	Space propulsion units and parts
3562	Ball and roller bearings	3769	Space vehicle equipment, n.e.c.
3563	Air and gas compressors	3792	Travel trailers and campers
3564	Blowers and fans	3795	Tanks and tank components
3565	Packaging machinery	3799	Transportation equipment, n.e.c.
3567	Industrial furnaces and ovens	3812	Search and navigation equipment
3568	Power transmission equipment, n.e.c.	3821	Laboratory apparatus and furniture
3569	General industrial machinery, n.e.c.	3822	Environmental controls
3571	Electronic computers	3823	Process control instruments
3572	Computer storage devices	3824	Fluid meters and counting devices
3575	Computer terminals	3825	Instruments to measure electricity
3577	Computer peripheral equipment, n.e.c.	3826	Analytical instruments
3578	Calculating and accounting equipment	3827	Optical instruments and lenses
3579	Office machines, n.e.c.	3829	Measuring and controlling devices, n.e.c.
3581	Automatic vending machines	3841	Surgical and medical instruments
3582	Commercial laundry equipment	3842	Surgical appliances and supplies
3585	Refrigeration and heating equipment	3843	Dental equipment and supplies
3586	Measuring and dispensing pumps	3844	X-ray apparatus and tubes
3589	Service industry machinery, n.e.c.	3845	Electromedical equipment
3596	Scales and balances, except laboratory	3993	Signs and advertising specialties
		3996	Hard surface floor coverings, n.e.c.