Risk, variety and volatility: growth, innovation and stock prices in early industry evolution*

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Abstract. The paper studies the patterns of volatility in firm growth rates and stock prices during the early phase of the life-cycle of an old economy industry, the US automobile industry from 1900–1930, and a new economy industry, the US PC industry from 1974–2000. In both industries, firm growth rates are more volatile in the period in which innovation is the most "radical". This is also the period in which stock prices are more volatile. The comparison sheds light on the co-evolution of industrial and financial volatility and the relationship between this co-evolution and mechanisms of Schumpetarian creative destruction. Results provide insight into the debate on whether the statistical behavior of firm growth rates is well represented by Gibrat's Law.

Keywords: Growth rates – Stock prices – Innovation – Volatility

JEL Classification: L11, 030, G12

1 Introduction

The paper studies patterns of volatility in firm-specific growth rates and stock prices during the early phase of the life-cycle of an old economy industry, the US automobile industry from 1900–1930, and a new economy industry, the US PC industry from 1974–2000. The firm level analysis builds on and supports the industry level analysis found in Mazzucato (2002). Results shed light on the co-evolution of growth rate volatility and stock price volatility and the relationship between this co-evolution and mechanisms of Schumpetarian creative destruction.

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In so doing, it adds new insights to the literature on Gibrat's law and firm growth (i.e. whether firm growth rates follow a random walk). The question explored is not whether Gibrat's law holds or not but under which conditions it is most likely to hold.

After reviewing data sources in Section 2, Section 3 studies industrial volatility in both industries by focusing on the statistical properties of firm-level growth rates. Both absolute and *relative growth* rates are explored, with the latter being more central to an evolutionary analysis of change (Dosi and Nelson, 1994). The null hypothesis on the unit root tests is that growth rates follow a random walk. In Section 4, statistical tests are used to study the volatility of firm-level stock prices and dividends. Results indicate that, for most firms, stock prices are most volatile during the same decades in which relative growth rates (e.g. market shares) are most volatile. In Section 5, innovation dynamics in the two industries are used to interpret these patterns of volatility: in both industries the decades in which relative growth rates and stock prices were the most volatile were the same decades in which innovation was the most radical and competence-destroying (Tushman and Anderson, 1986). Building on this result, Section 6 uses panel data analysis to test whether in the early phase of the industry life-cycle, changes in firm stock prices are related to variables describing industrial instability more so than in the mature phase. The firm-level results confirm the industry level results in Mazzucato (2002) where changes in industry structure (e.g. number of firms, entry/exit rates, concentration, etc.) and innovation are related to changes in stock price volatility.

2 Data

The study focuses on the US market for automobiles and personal computers (including both domestic and foreign producers). The firm-level and industry-level data is annual. Sales are measured in terms of annual units of automobiles (cars and trucks) and personal computers (all microcomputers:desktops and notebooks) produced. In both industries, units produced follow the same general qualitative dynamic as that of net sales in dollars but is preferred due to its greater precision (sales figures are affected by idiosyncratic accounting items).

Automobiles. Individual firm units and total industry units from 1904–1999 were collected from annual editions of *Wards Automotive Yearbooks* (first editions with data starting in 1904 were published in 1924). Although firm-level units were collected for only 8 domestic firms and 5 foreign firms (the first foreign firms entered in 1965), the *total* industry sales include the units shipped by all existing firms (e.g. in 1909 that includes the output of 271 firms). Firm stock prices and dividends figures were collected from annual editions of *Moody's Industrial Manual*. Industry-specific per share data was collected from the *Standard and Poor's Analyst*