Stylized Facts and Other Empirical Evidence on Firm Dynamics, Business Cycle and Growth

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In this paper, we bring together in a systematised fashion the scattered empirical evidence relating firm dynamics and both short-run and long-run macroeconomic dynamics. There are numerous studies that focus on firm-level data while controlling for macroeconomic conditions, which cover a considerable range of variables, industries and countries. From these studies it has emerged what is by now a rather robust set of empirical regularities, or stylized facts, about entry, exit, growth and the size distribution of firms. On the contrary, the literature that focus explicitly on the interplay between firm dynamics and the business cycle is roughly confined to the US experience and to the cyclical properties of firm entry and exit, whereas systematic studies about the relationship between firm dynamics and economic growth are almost non-existent whatsoever.

Keywords: empirical evidence, firm dynamics, business cycle, economic growth

JEL Classification: L11

1 Introduction

The main goal of this paper is to bring together in a systematised fashion the scattered empirical evidence relating firm dynamics and both short-run and long-run macroeconomic dynamics. There are numerous studies that focus on firm-level data while controlling for macroeconomic conditions, which cover a considerable range of variables, industries and countries. From these studies it has emerged what is by now a rather robust set of empirical regularities, or stylized facts, about entry, exit, growth and the size distribution of firms. On the contrary, the literature that focus explicitly on the interplay between firm dynamics and the business cycle is roughly confined to the US experience and to the cyclical properties of firm entry and exit, whereas systematic studies about the relationship between firm dynamics and economic growth are almost non-existent whatsoever.

It is noteworthy to mention that the analysis of firms' behaviour has often been constrained by the lack of cross-country comparability of the underlying data, which may explain the lack of studies of this sort. On the other hand, the empirical evidence offered in the literature comes, in some cases, from simple tabulations of data on firm dynamics, or from case studies with hardly any statistical treatment, whereas in others it results from more structured econometric and time series analysis. This state-of-affairs becomes apparent in the lines that follow.

The rest of the paper comprises four sections. The next lists the main stylized facts that have emerged from a large number of studies using firm-level data with respect to entry, exit, growth and the size distribution of firms. Section 3 presents some empirical regularities pertaining to firm dynamics over the business cycle. Section 4 lists specific empirical evidence on the behaviour of firm dynamics over large time spans, over the industry life cycle and also across countries. We conclude with section 5.

2 Stylized facts from firm-level data

This section draws heavily from the list of stylized facts about firm dynamics summarised by Klette and Kortum (2004, p. 989) and Cabral (2007); see references therein.[1]

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[1] The first empirical studies about firm dynamics were strongly motivated by Gibrat (1931)'s seminal work, and the hypothesis known as Gibrat's law or the Law of Proportionate Effect that supported Gibrat's purely statistical

1. In a given year, entry and exit occur simultameously, with entry and exit rates being highly correlated across industries. Firms that enter and firms that exit are smaller than average incumbent size.

2. Smaller firms have a lower probability of survival, but those that survive tend to have higher growth rates than larger firms, especially for overall small size levels (for larger firms growth rates tend to be unrelated to firm size).

3. Younger firms have a lower probability of survival, but those that survive tend to have higher growth rates than older firms.

4. The variance of growth rates is lower for larger firms.

5. The size distribution of firms is highly skewed, with the pattern of right-skewness suggesting that there are proportionally more small firms than large firms with respect to the lognormal distribution.

6. The productivity levels tend to be higher for larger firms.

   The remaining stylised facts presented in this section are related specifically to firm R&D, innovative output and patterns of R&D investment, as described by Klette and Kortum (2004).

7. Productivity and R&D across firms are positively related, whereas productivity growth is not strongly related to firm R&D.

8. Patents and R&D are positively related both across firms at a point in time and across time for given firms.

9. R&D intensity is independent of firm size.

10. The distribution of R&D intensity is highly skewed, and a considerable fraction of firms report zero R&D.

11. Differences in R&D intensity across firms are highly persistent.

12. Firm R&D investment follows essentially a geometric random walk.

According to the studies cited by Jovanovic (1993) and Klepper and Thompson (2005), one could yet add three points to the list above:

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model. However, as very well noted by Caves (1998), the modern list of stylised facts is essencially a list of exceptions to and extensions of Gibrat's law.

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- Diversification (measured as the number of industries in which a firm maintains establishments) and R&D intensity across firms are positively related.

- Larger firms are more diversified than smaller firms.

- Older firms are more diversified than younger firms.

Note, however, that the first two empirical observations above combined together may conflict with stylized fact 9.[2]

3 Firm dynamics and the business cycle

As noted by Caves (1998, p. 1958), the "studies of intertemporal entry-exit linkages" - as those that support the empirical evidence described in section 2 - usually "control for macroeconomic conditions in various ways and degrees". However, one may be interested in studying explicitly the interplay between the business cycle and the dynamics of firm entry, exit and growth. Some recent papers explore this avenue, but the reported evidence concerns almost exclusively firm entry and exit in the US. The list of empirical results presented below is chiefly based on Lewis (2006) and the references therein. These papers use, in general, Hodrick-Prescott filtered data and mainly calculate cross-correlations between variables of interest. The main point is that the number of firms varies (procyclically) over the business cycle.

1. Net entry (measured as net business formation, i.e., the difference between new incorporations and failures) and real profits comove, and both are strongly procyclical. The correlation between net entry and output (measured by real GDP) ranges over the interval 0.50-0.70. Net entry tends to lead output and profit expansions by one quarter.

2. Entry (measured as new incorporations) is procyclical; its correlation with output ranges over the interval 0.35-0.50; its correlation with output growth has been calculated around 0.28 (see Campbell , 1998). Entry tends to lead output by one quarter; however, it tends to lag output growth by one quarter (see Campbell , 1998).

3. Similar to capital investment, entry and net entry are more volatile than output over the cycle.

4. Entry covaries positively with total factor productivity growth (see Campbell , 1998).

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[2]Yet, Jovanovic (1993) recognises that the positive relation between R&D intensity and diversification is stronger than the one between R&D intensity and firm size.

5. Exit is countercyclical; its correlation has been calculated around -0.40 with respect to output (see Devereux et al , 1996) and -0.70 with respect to output growth (see Campbell , 1998). Exit is coincident with output movements (see Devereux et al , 1996), but it tends to lag output growth by two quarters (see Campbell , 1998).

6. Net entry responds positively and significantly to expansionary monetary policy shocks, as estimated by a 5-variable recursive VAR (see Lewis , 2006; Bergin and Corsetti , 2005).

7. Firm size (measured as employment per firm) and product diversification (measured as the ratio of primary industry payrolls to total company payrolls or the number of four-digit manufacturing categories in which the companies operate) move together, in a procyclical fashion, leading to product space expansions during upturns (Jovanovic , 1993). The number of firms varies procyclically, but with less variation than firm size (Jovanovic , 1993).

Related to this evidence on the cyclical properties of net business formation are the findings from the research on labour market dynamics, in particular on job creation and job destruction due to the births and deaths of plants. A key stylized fact in this literature is that job destruction varies more over time than job creation, meaning that job turnover moves countercyclically. In a much cited study, Davis and Haltiwanger (1992) report that the correlation with net employment growth in the US is of -0.57. Konings (1995) cites several plant-level panel data studies that show that there exists a large amount of gross job creation and gross job destruction at all phases of the business cycle and even within narrowly defined sectors, with evidence for the US, UK, Germany, Italy and other European countries (see references in the paper). The author reports the yearly gross job flow rates for the UK and discusses its cyclical properties. He finds that gross job reallocation, the sum of job creation and destruction, is countercyclical, reflecting the fact that fluctuations in the job destruction rate are far more pronounced than fluctuations in the job creation rate. Interestingly, Campbell (1998) also reports that firm exit rate varies more (higher standard deviation over time) than firm entry rate, according to data for the US.

4 Firm dynamics and economic growth

This section is an attempt to summarise the empirical evidence about firm dynamics set in the context of economic growth, as the literature on this topic is sparce at the best and lacks systematic nature. We organise the existing evidence around three topics. The more structured analysis comes

from the literature on industry life cycle, which we present first. The second topic lists time-series evidence over long time horizons, whereas the last reports some cross-country evidence.

4.1 Industry life cycle

An important line of research on firm dynamics tracks entrants to determine their subsequent growth and mortality rates along the industry life cycle. The stylized facts reported below are drawn from Klepper (1996). This author lists six empirical regularities (see references therein) concerning how entry, exit, market structure and technological change vary from the birth of technologically progressive industries through maturity.

1. At the beginning of the industry, the number of *entrants* may rise over time or it may attain a peak at the start of the industry and then decline over time, but in both cases the number of entrants eventually becomes small.

2. The number of *producers* grows initially and then reaches a peak, after which it declines steadily despite continued growth in industry output.

3. Eventually the rate of change of the *market shares* of the largest firms declines and the leadership of the industry stabilizes.

4. The diversity of *competing versions* of the product and the number of major product innovations tend to reach a peak during the growth in the number of producers and then fall over time.

5. Over time, producers devote increasing effort to process relative to product innovation.

6. The most recent entrants account for a disproportionate share of product innovations, during the period of growth in the number of producers.

4.2 Time series evidence

This second topic gathers scattered empirical evidence with respect to the behaviour of firm and industry-related variables over long time horizons, larger than the typical business cycle, trying to devise secular trends.

1. Industry firm-size distributions appear to be stable over time (Klepper and Thompson , 2005).

These distributions remain relatively unchanged even though there is substantial shifting of relative position within each distribution as firms grow and decline.[3]

2. Relative firm size is mean reverting over long time horizons, although not over short horizons (Klepper and Thompson , 2005), in the sense that there is a tendency for large firms to decline and small firms to grow relative to one another[4] - the Galtonian regression-to-the-mean phenomenon (see Baldwin , 1995, ch. 5).

3. Differences in entry between industries do not persist for very long, although there is a very large cross-section (industry-level) variation in entry. Rates of entry are rarely high or persistently low over time in particular industries, but, rather, entry seems to come in bursts that are not highly synchronized across industries (Geroski , 1995).[5]

4. Historically, absolute firm size (employment per firm) and product diversification have moved together. They followed the secular increase in the capital-labour ratio over almost all of the past century, but from the 1980s onwards firm size and diversification have both declined. (Jovanovic , 1993).[6] However, this movement has not been homogeneous across countries (see van Ark and Monnikhof , 1996).

5. The number of firms and establishments in manufacturing exhibited an upward trend over almost all of the past century (see Maddison , 1994).

6. Time series data shows a positive correlation between industry turnover and the process of productivity growth (Cabral , 2007).

As far as the evolution of the number of incumbent firms is concerned, the main focus in the literature has been on the industry-level data. For example, according to Klepper and Thompson (2005), the

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[3]As noticed by Caves (1998, p. 1976), the processes described by stylized facts 1, 2 and 4, in section 2 above, are "typically consistent with the size distribution of firms (concentration) being stable over time".

[4]These authors note that mean reverting in firm size is rightly what one would expect from a model combining a stationary firm-size distribution (see fact 1 in this subsection) and persistent churning of firms (see fact 1 in section 2, above). However, this may be at odds with fact 3 in subsection 4.1.

[5]This piece of evidence reports us back to the industry life cycle approach. See stylized fact 1, in subsection 4.1, above.

[6]A decline in establishment size is also reported by Carlsson (1989) for the period 1972-1982 in several industries and countries. The author avances a couple of hypothesis to explain this finding: (i) "de-glomeration" or specialization, that is, the selling-off or disinvestment of non-core businesses in order to free up scarce resources (particularly management time) to defend and nurture core business activities - the perception of a tougher and more uncertain business climate after the mid-1970s than during the 1960s and early 1970s is an important motive, but the "back-to-basics" movement can also be viewed as a result of the recognition that the conglomerate merger wave of the earlier decades had simply gone too far; (ii) the emergence of new computer-based technology which improves the quality and productivity of small or medium scale production relative to standardized mass-production techniques which dominated for the previous 150 years.

laser industry experienced a steady growth in the number of producers over time, while Klepper and Simons (1997) report that certain industries, such as autos, tires, and television receivers, experienced extremely sharp shakeouts in the number of producers as they aged despite robust growth in total production. This evidence reports us back to the industry life cycle approach (see subsection 4.1, above). Carlsson (1989) finds an increase in the total number of establishments (US, Japan and 6 European countries) in manufacturing over a 10-year period (1973-1983). Yet, this is too short a period to identify a long-term trend, respects to manufacturing only, and describes establishments instead of firms; moreover, the number of establishments decreased in 4 of those 8 countries. Maddison (1994) presents a far longer time-series data set but which is confined to the number of establishments in US manufacturing. According to this author, this number increased from 205 thousand to 355 thousand (a growth rate of 73%) between 1899 and 1986, whereas the average US manufacturing establishment rose in size from 24 to 54 employees (a growth rate of 125%). Interestingly, the author also reports that GDP per person employed rose almost fourfold over that period, the proportion of people with higher education rose ninefold, and the stock of machinery and equipment per person employed rose about fifteenfold. These findings seem to be at odds with the reference to the capital-labour ratio in fact 4, presented just above. In contrast, Ehrlich (1985) finds a "relative stability of establishment sizes" in a long time-series data base (1900-1970) concerning manufacturing in the U.S., Japan and eight European countries. However, this stability is far more evident in the after-World War II period. Overall, the author concludes that "growth and contraction of establishments sizes cancel each other out over some longer period" (Ehrlich , 1985, p. 285).

With respect to econometric studies that explicitly analyse the link between firm size distribution and economic growth, the examples are scarce. Lucas (1978) attempts to link firm size distribution (more rigorously, the firm average size - employment per firm) to economic growth, measured by the growth in GNP per capita, by resorting to time-series data over the period 1900-1970. The data covers various sectors, and not only manufacturing. The results "show a clear and accurately measured effect of GNP per capita on average firm size. The estimated elasticity is in the range 0.8-1.0. The independent effect of trend on firm size [introduced as a simple means of correcting for labour improving quality over time] is negative, with firm size declining (GNP held fixed) at annual rate of about 0%-2.5%. Together, these two variables do an excellent job of accounting for the secular behaviour of firm size (however measured), and for large-scale cyclical movements (mainly the Great Depression)" (Lucas , 1978, p. 521). Following a different approach, Shaffer (2006) explores the

empirical association between economic growth (measured by the growth rates of median household income) and initial firm/establishment size at the country level, therefore explicitly testing for the theoretical prediction of a causal link running from firm/establishment size to economic growth. The findings indicate that smaller establishments in each of the four sectors studied are significantly and robustly associated with faster subsequent growth of median household income.

4.3 Cross-country evidence

The analysis of cross-country evidence has been hindered by several conceptual issues, as well as by measurement problems induced by cross-country differences in coverage, unit of observation, classification of activity and data quality (see, e.g., Bartelsman et al , 2003, and Bartlesman et al , 2005). Nevertheless, it is possible to present some empirical evidence, as referred to in some literature of firm dynamics.

1. The pattern of right-skewness of the firm size distribution is common to several countries, despite the significant differences in size and level of economic development (Cabral , 2007).

2. Summary measures such as the k-firm concentration ratio take on similar values in the same industry in different countries (Klepper and Thompson , 2005). The relative weight of firms with fewer than 20 employees also shows a very low degree of dispersion between countries of different sizes and levels of GDP per capita (see Bartelsman et al , 2003).

3. The average size of incumbents varies widely across sectors and countries. It is generally smaller in most European countries than in the United States due to differences in both the sectoral composition of the economy and within-industry peculiarities. (see Bartelsman et al , 2003). Smaller countries tend to have a size distribution skewed towards smaller firms, but the average size of firms does not map precisely with the overall dimension of the country, the underlying technological level of the industry or its degree of maturity (see Bartlesman et al , 2005).[7]

4. The evolution of the firm size distribution of a given cohort, very skewed at birth but gradually becoming more symmetric, is common to several countries (Cabral , 2007).

5. The turnover processes show very little qualitative difference among countries. According to

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[7]Using the data on firm size reported by Bartelsman et al (2003), together with OECD data on national accounts, we find that the coefficient of correlation between the average firm size and GDP level is of 0.5 (0.38 if we exclude US from the sample), whereas between average firm size and GDP per capita is of 0.14.

Caves (1998), less developed countries appear to exhibit more turnover associated with their concentration on activities with smaller sunk costs. Yet, Bartlesman et al (2005) report that the level of turnover varies across countries roughly independently from either the level or the growth rate of GDP per capita.

6. Large countries tend to have a larger number of firms and lower concentration rates than small countries, whereas countries with larger rates of entry tend to exhibit a smaller number of firms (Sherer and Ross , 1990).

7. Barries to entry tend to be smaller in more developed countries (Cabral , 2007).

5 Concluding Remarks

While it is rather easy to put in a nutshell the relevant empirical evidence relating firm dynamics and the business cycle, the matters get complicated when we search for empirical evidence set in the context of economic growth, whatever the chosen approach - cross-country or time-series analysis. Evidence is limited and not seldom unclear. At best, the reported evidence in section 4 gives us the idea that, once a minimum threshold of development is surpassed, and provided we get sufficiently aggregated data in order to abstract from movements connected to industry life-cycle specificities, both the dimension and the level of development of an economy are weakly connected to the characteristics of the observed firm size distribution and firm turnover.

As Bartlesman et al (2005) points out, the evidence of significant cross-country differences in firm characteristics, their market dynamics and post-entry performance must be explained not only by differences in sectoral composition of the economy but also by "salient differences in market characteristics and in business environment" (Bartlesman et al , 2005, p. 38), which may differ from country to country, even when levels of development are identical. Nevertheless, one cannot overlook the conceptual and measurement problems that still plague this sort of analysis. In spite of recent developments, sponsored by international organisations such as OECD and the World Bank (see, e.g., Bartelsman et al , 2003, and Bartlesman et al , 2005), the lack of statistical comparability is still a serious constraint on cross-country comparisions.

The alternative approach, which exploites the time variation within countries, allows to remove the country-specific measurement error. But this approach is only useful if sufficiently long time series are available, covering at least two complete business cycles. However, the longer the time series, the

higher the probability of facing changes in the concepts and methodology adopted by the statistical system within each country, which implies that the measurement error in a country can no longer be taken as time invariant.[8]On the other hand, one must take into account that development and growth processes at the country level are not homogeneous over time. Structural changes happen in a continuous time scale and industry and firm-level indicators are sensitive to them. The literature on industry life-cycle helps to shed some light on this. Surely, the use of aggregate data at the highest level possible should help to mitigate this problem, but deep strutural changes should be expected to show up even at that level.

For the case of countries with mature market economies, a simple exercise of growth accounting may help to clear ideas. In the very long-run (even if not in a steady-state), one should expect that:

- The number of firms in the economy grows at roughly the growth rate of the population.

- The average firm size measured by employment per firm is roughly unchanged.

- The average firm size measured by sales per firm grows roughly at the rate of growth of TPF plus the rate growth of the capital-labour ratio times the capital elasticity in the production function; in the steady state, average firm size grows as much as GDP per capita and capital-labour ratio.

These predictions may serve as broad guidelines for future research on the topic of firm dynamics and economic growth.

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[8]The studies conducted by Lucas (1978) and Maddison (1994) are good examples of this. But, of course, one may argue that this is still a minor problem when compared to those issues afflicting cross-country comparisions.

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