TURBULENCE IN INDUSTRIAL POPULATIONS: THE CASE OF THE ITALIAN GRAPHIC PAPER INDUSTRY

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ABSTRACT

Significant and persistent flows of entry and exit, that is, turbulence, are a common feature of most industries, across countries and over time. By means of a new database for the Italian graphic papermaking industry between 1964 and 2004, this research inquires into the extent and character of entry and exit in an industry where innovation in products and processes has been incremental and largely predictable and, therefore, unlikely to be the main driving force of firm turbulence.

The first part of the thesis deals with methodological issues concerning compilation of the thesis' database, which records, annually, plants' and firms' major demographic events, attributes and proprietary linkages, thus allowing comparison between the dynamics of plants and firms throughout the reference period. Special attention was given to avoid measurement distortions that would have risen from using business register administrative files.

The second part focuses on what factors are more likely to affect survival prospects of plants and firms. Using logistical analysis, econometric results confirm that plant exit has been determined by efficiency of its equipment, diversification strategy of the proprietary firm and, unexpectedly, its organizational history. Using survival analysis, econometric results reveal that the risk of exit for firms is lowered by pursuit of external growth strategies (acquisition of plants), concentration of production into graphic paper and being equipped with modern machinery.

The third part examines the effects of firm turbulence on the evolution of concentration in the industry. The data show that acquisitions have been an important source of turnover among the leading companies and that a significant portion of the leading companies has been relatively new. The analysis also indicates that at least some turbulence has led to instability of market shares among the leading firms.

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure Page

ACKNOWLEDGEMENTS

This dissertation for me has been an odyssey as much into life as into scholarship. Having picked it up and put it down for ten years, like a Penelope weaving and unweaving her tapestry, I have attempted to depict the dynamics of entry and exit using the Italian papermaking industry as my matrix. The picture presented here is the result of many trials and as many errors.

The fabric of my chosen tapestry consists of many threads from contributors far too numerous and diverse to whom to pay tribute. Without the perseverance of my tutor, Stephen Davies, I would never have completed the thesis. Throughout more years than I should like to remember, he has helped guide my course, despite our sometimes divergent directions and with the delays such a distant journey has entailed.

In the three years needed to collect data from a myriad of sources scattered across the Italian landscape, I have come to owe so much to so many archivists, trade unionists and, most importantly, papermakers. Without them, this thesis would have lacked authenticity. One, however, deserves a special mention, a lifelong paper mill worker from Cartiere Meridionali. A man who loved his Cartiere, Bruno Ceroli patiently offered insights that tutored me in the ins and outs of corporate ties and proprietary changes.

Balancing the demands of a full-time job with those of a student working a thousand miles from her university has been challenging, often to the point of despairing that I would ever reach my Ithaca. Among the many who generously lent their time, advice and encouragement, I am particularly grateful to Katharina Guttenbrunner, Silvia Fedeli and Shahid Sattar.

Finally, what Italian odyssey would be complete without the role of *la famiglia*? I owe a particular debt of gratitude to Robert, who shared with me the strain by listening with love and patience to my laments and putting my frustrations into perspective. This dissertation is, to all intents and purposes, the result of my parents' lifetime commitment to their daughter's education. Now, as my mother has put it, with her flourish of operatic coloratura, she can finally rest in peace. Amen!

CHAPTER 1
INTRODUCTION

Traditional theory accords exit and entry conditions a fundamental role in market structure as they determine the nature of potential competition between incumbents and would-be entrants. From this conceptual perspective, it is apparent that net entry is an important indicator of the toughness of competition, with an expected negative correlation between net entry and concentration levels. Yet, theory is rather vague concerning the relationship between net entry and turbulence[1], for net entry could be compatible, mathematically, with different amounts of actual gross entry and exit flows. How should one conceptually interpret situations such as those characterised by high entry and exit flows but negligible net entry? Do they indicate that the market is more competitive as the high levels of turbulence would suggest or less competitive as the low levels of net entry seems to indicate? If the latter is correct, does it mean that much of turbulence is irrelevant, at least, with respect to competition? And, if so, why has the market not developed mechanisms that would lead to a better alignment of turbulence to net entry flows?

This conceptual elusiveness is felt all the more in the face of mounting empirical evidence that points to the concurrent existence of high turbulence flows and small amounts of net entry. This thesis investigates the extent and character of turbulence and its impact on the market structure dynamics, through the means of a longitudinal case study.

The following section clarifies the context and scope of my research, provides a brief description of the methodology employed to construct the

[1] The terminology employed in connection with market entry and exit is not universally adopted and some divergences exist. In the literature of entry and exit, the term turbulence has come to denote “the flux created in an industry’s total composition by flows of births and deaths” (Beesley and Hamilton, 1984, p. 220). Though widely adopted, this usage is not universal (see section C.2). Throughout the thesis, turbulence indicates the sum of gross entry and exit.

database for quantitative analysis and, finally, outlines the thesis structure and main results.

1.1 The Context and Scope of the Thesis

Since Edwin Mansfield (1962) emphasized the lack of even crude answers to the quantitative effects of various factors on rates of entry and exit and, more generally, on the dynamic processes governing an industry's structure, a copious amount of empirical evidence on market entry and exit (turbulence) has been accumulated[2]. Data show that "entry appears to be relatively easy, but survival not" (Geroski, 1995). Across different industries, countries and times, analysis of longitudinal census-based databases at three-, four- and five-digit ISIC levels usually reveals that:

- Entry and exit occur simultaneously and higher-than-average entry rates[3] are associated with higher-than-average exit rates;
- Net entry rates and entry penetration rates[4] are modest;
- A remarkable percentage of new firms do not survive their first decade. However, those entrants that survive grow faster than incumbents and, as cohorts of new firms enter markets year-after-year, they account for increasingly larger percentages of the whole population of sellers.

Against these empirical regularities, the traditional view of entry and exit as equilibrating forces appears to be an incomplete account of the phenomenon

[2] Since the seminal work of Dunne, Roberts and Samuelson (1989) on patterns of firm entry and exit in the United States' manufacturing industries, a multitude of studies have been conducted so far, including the work by Baldwin (1995) on entry and exit in Canada, the studies by Geroski (1991), and the latest OECD studies on comparative analysis of firm demographics and survival for OECD countries (OECD, 2003 and Bartelsman *et al*., 2005). Excellent surveys on this vast empirical literature have been provided by Siegfried and Evans (1994), Geroski (1995), Sutton (1997) and Caves (1998).

[3] Entry(exit) rate is defined as the ratio of number of total entering firms(exiting firms) to total number of firms that exist in the industry in a given year.

[4] Rate of entry penetration is defined as the ratio of total amount of gross sales attained by entrants to total industry sales.

because one should not see such persistent high levels of turbulence. In the face of this evidence, scholars have begun to develop the idea that firm entry is the mechanism through which industrial populations churn. As the market is the proving ground where, through competition, selection of the fittest occurs, entry represents the channel through which new business ideas challenge and, if successful, displace well-established models of conducting business. Since selection requires a variety of alternatives from which to choose, this fact can justify why entry *per se* is fundamental to the evolution of markets: it is the seedbed for innovation.

Can turbulence be explained only on the basis of a reservoir of potential new business ideas? Innovators can be found among entrants as well as among incumbents. As Baumol (2004) noted, major breakthroughs have tended to come from small new enterprises, while incremental improvements that multiply capacity or increase reliability and user-friendliness have been in the realm of larger established firms. This suggests that turbulence, as a seedbed for innovation, is likely to be a feature of industries in their initial stages but should be expected less in mature industries.

Furthermore, not all entrants are innovative, and those who are may not be as abundant as policy-makers may believe. There are enough new firms that are created and operate without introducing anything innovative in their *modus operandi*. Firms are heterogeneous with different degrees of efficiency and are able to learn about their own level of efficiency only once they started producing (Jovanovic, 1982). If comparatively more efficient than rivals, they survive and grow. Otherwise, they wind down their operations and exit. Entry occurs because the market has no *a priori* means to pick future winners.

In approaching the issue of what drives turbulence, it might be fruitful to begin by assuming that turbulence has an impact on the competitive situation but that not all types of entrants and exitors are likely to have equal effects on the competitive situation. There are a variety of other reasons that guide

would-be firms to enter an industry and those reasons may not stem from the Schumpeterian notion of creative destruction. At times, entrants appear because they see an opportunity for immediate financial gains or, simply, because they have miscalculated demand. At other times, it is because they find attractive the opportunity to replace an incumbent who has decided to exit or they consider diversification into new sectors a vital strategy, whether or not they introduce innovation. Similarly, incumbents leave because of financial problems or simply, in the case of family companies, the founder and/or heirs decide not to continue the business. Corporations may leave because of the strategic interest to focus on their core business and the like.

The central proposition in this dissertation is that turbulence, which includes any sort of entry and exit[5], affects the competitive situation because, first of all, it alters the configuration of the population of the industry and, by doing so, is likely to change strategic behaviour among competitors. Thus, my hypothesis is that it is the routes taken by entrants and exiting firms to acquire, assemble and dissolve their resources endowments that help explain why turbulence is such a pervasive phenomenon and how, through it, market structures are differently affected.

Without undermining the significance of turbulence as an agent of change, in this thesis I shall focus on those circumstances where turbulence is expected to be minimal and not primarily driven by innovation in products and processes or by significant demand variations. By concentrating on an environment where it is unlikely that turbulence is driven by innovation and demand shocks, one can start to address the nature of that portion of turbulence that seems far from being the engine of competition and is the most elusive for theoretical understanding. Policy implications are not negligible. Instead of looking at buoyant entry rates as an indicator of the

[5] In defining entry, Bain specifies that exclusions of expansion by established firms, acquisitions of existing production capacity by new legal entities, whether by purchase from pre-existing firms, and reorganisations involving a change of corporate name and structure or through other means are “in some degree arbitrary, since the introduction of a new owner of old capacity may constitute a distinct change in a competitive situation, and since expansion of an established competitor may, from the standpoint of another established firm, have about the same significance as entry of a new firm with new capacity” Bain (1956) p. 5.

vitality of markets, the thesis proposition suggests that policy-makers should focus on the dynamics of the various sorts of entry and, even more, exit, to obtain some indication of the degree of competition in markets.

1.2 The Empirical Approach

Given the scope of this thesis, a longitudinal case study approach has been chosen[6]. The case study concerns the graphic segment of the Italian papermaking industry from 1964 to 2004. This choice allows one to focus on an industry that experienced neither substantial changes in demand nor introduction of breakthrough innovations during the period under consideration, while being able to trace individual stories of firms with a reasonable degree of accuracy.

In fact, the fundamentals of modern papermaking have remained the same since the nineteenth century, when mechanical paper machines and the use of wood as the main fibre source were introduced. Since then, technical advances have taken the form of improvements in the width and speed of paper machines, the most important component of a paper mill. Such advances have been largely predictable. Furthermore, because paper mills are special-purpose facilities with no alternative use should they prove uneconomic, capital investments are strategic decisions that, once undertaken, restrict further moves for many subsequent years.

As this approach lacks the breadth of many longitudinal census-based studies on turbulence, there is the underlying concern that the research findings may be specific to this particular case study. However, I believe that the advantages of this approach may outweigh the disadvantages. In fact, the highest degree of disaggregation at which the previous longitudinal census-based databases are available is generally four-digit ISIC level. At this level, industries are agglomerates that encompass enterprises engaged

[6] See Geroski (2001) for an overview of the advantages of this methodology

primarily in the same or similar kinds of economic activity but, often, at different stages of the manufacturing process. Consequently, the boundaries of a census-based industry are likely to be too broad, masking the actual degree of competition and its eventual impact on market structure. Furthermore, this database permits linking enterprises over time through the plants that they have operated. This is a novelty among databases generally used for the study of firm demography, at least, among those that I discovered. This feature is the fundamental tool that makes it possible to compare the dynamics of turbulence at plant level versus those at firm level.

1.3 The Structure of the Thesis

The thesis is structured into three main parts. The first deals with some methodological issues concerning compilation of longitudinal databases and problems that may arise in measuring entry and exit flows. Specifically, Chapter 2 reviews measurement issues that compilation of a longitudinal dataset on entry and exit generally entails, while Chapter 3 delves into the extent to which firms can be identified with the reporting units of registered company or enterprise. The chapter assesses measurement differences and highlights the extent to which entry and exit dynamics of the Italian graphic paper industry are in line with the stylised facts described in the literature. The analysis reveals that turbulence is characteristic of the sector but, had registered companies been used as unit of observation instead of enterprises, the amount of turbulence observed would have been nearly double.

Having clarified the nature and scope of the thesis' datasets, the second part focuses on what factors were more likely to have affected survival prospects of plants and firms. It highlights differences in the mechanisms through which such factors have exerted their influence. This part begins with Chapter 4, which summarises the demographic changes in the populations of plants and firms over the second half of the twentieth century. Despite expansion of the

sector, data reveals a steady contraction of its populations to the extent that, by 2004, only half of those existing in 1964 were still in operations. While contraction in the number of plants was mainly caused by a steady shutdown of less efficient production sites, that in the number of firms was accompanied by a moderate turbulence throughout the period. Entry of new firms and exit of old ones occurred continuously, steadily churning the population. In view of these dynamics, Chapters 5 and 6 study plant exit and firm survival in terms of a mixture of plant characteristics and firm attributes. Using logistical analysis, econometric results confirm that plant exit was determined by efficiency of its equipment and, to a lesser extent, by the diversification strategy of the owning firm. Unexpectedly, the econometric results provide also statistical support for the role of plants' organisational histories. The data reveals that plants that had undergone ownership and registration transfers in the last 25 years of their existence were less likely to exit. Turning to firm survival, the risk of exit seems to be lowered by pursuit of external growth strategies (acquisitions of plants), concentration of production into graphic paper and being equipped with modern, larger paper machines. Unexpectedly, duration analysis does not provide support for the repeatedly observed size-age dependence in firms. However, other authors have observed this peculiarity in the case of the Italian manufacturing sector.

The third part of the thesis examines the effects that firm turbulence had on evolution of concentration. Chapter 7 analyses turnover changes among the largest firms from 1964 to 2004 revealing slower turnover at plant level compared to that at firm level. Most plants that were ranked among the largest in 1964 continued to be so 40 years later. By contrast, firms' market dominance was often eroded over time. Like in a matching game, new firms appeared and established ones grew by acquiring existing plants in an attempt to gain market dominance. Drawing on the previous analysis, Chapter 8 offers some points for further research.

The thesis includes three appendices. Appendix A is a technical note on economics of modern papermaking, which describes the basic demand and

supply conditions in the industry. It is intended to explain some of the sector dynamics and rationale for inclusion of specific variables in the econometric analysis. Appendix B presents a brief account of consumption and production in the Italian paper industry, with special emphasis on the graphic segment after World War II. Appendix C lists all the variables used in the quantitative analysis. Additional data tables are grouped together in Appendix D.

CHAPTER 2

DESIGN AND COMPILATION OF THE DATABASE

2.1 Introduction

The study of industrial demography requires databases that capture the life trajectories of individual firms and plants over time, recording chronologically the proprietary changes that shape the configuration of industrial populations and market concentration. Such a database was not available at the time of writing. It had to be compiled by weaving together information from the trade's publications, historical studies, administrative records and telephone conversations. The result is a novel longitudinal micro-database for the Italian graphic paper industry that records, annually, plants' and firms' major demographic events, attributes and proprietary linkages from 1964 to 2004.

Assembling the database was a complex endeavour because information needed to be gathered from a multitude of sources, which were designed for purposes different from those of this study. Thus, no standard procedures could be applied. There were, though, some precedents that provided guidance on methodological issues: the early frame of the NBER Enterprise Microdata sub-project (Lipsey, 1978); the Canadian census-based Longitudinal Manufactures Research File (Baldwin and Gorecki, 1989; Baldwin, 1995); the American Longitudinal Research Database (LRD) (McGuckin and Pascoe, 1988); and, recently, the Organisation for Economic Co-operation and Development (OECD) Entrepreneurship Indicators Project, under which OECD and Eurostat developed a framework for regular, harmonised measurement of entrepreneurial activities in their member countries (EU-OECD, 2007). In addition, a number of articles[1] provided critical assessments of potential measurement biases, mostly associated with commercial data sources.

[1] Including Aldrich *et al*. (1989), Birley (1984), Busenitz and Murphy (1996), Johnson and Conway (1997), Kallenberg *et al*. (1990), Mason (1983), Murphy (2000) and Williams (1993).

This chapter details compilation of the thesis' database, explaining the methodological solutions adopted. Section 2 outlines the scope of the database and section 3 discusses definitional issues concerning the firm. Section 4 reviews the units of observation generally used for measuring the firm and specifies the thesis' approach. Section 5 describes the data sources and summarises the steps undertaken in collecting the data and organising it into a database.

2.2 Industrial Demographic Frames

Compilation of databases for the study of industrial populations over time begins with definition of entry and exit, demarcation of the population of interest and specification of time horizon. Since the advent of longitudinal census-based datasets in the mid-1980s, these aspects have been largely discussed[2] and scholars have reached a substantial agreement on definitions and their limitations. The thesis' dataset adopts their schematisation.

2.2.1 Market Entry and Exit

An entry is defined as the appearance of a firm in a given market, with an exit as one's disappearance. Firm entries and exits are prompted by a limited, countable number of basic demographic events: foundations of new firms, cessations of old ones and expansions/conversions of existing businesses from their original production lines to different ones (Baldwin, 1995).

Borrowing from demographic methods (Hinde, 1998), these events can be represented as transitions made by individual firms between four states: not yet born, alive and in a population X, alive and in another population Y, and dead (Figure 2.1).

[2] Primary methodological discussions on longitudinal databases include McGuckin (1989), Baldwin and Gorecki (1989) and Baldwin (1995).

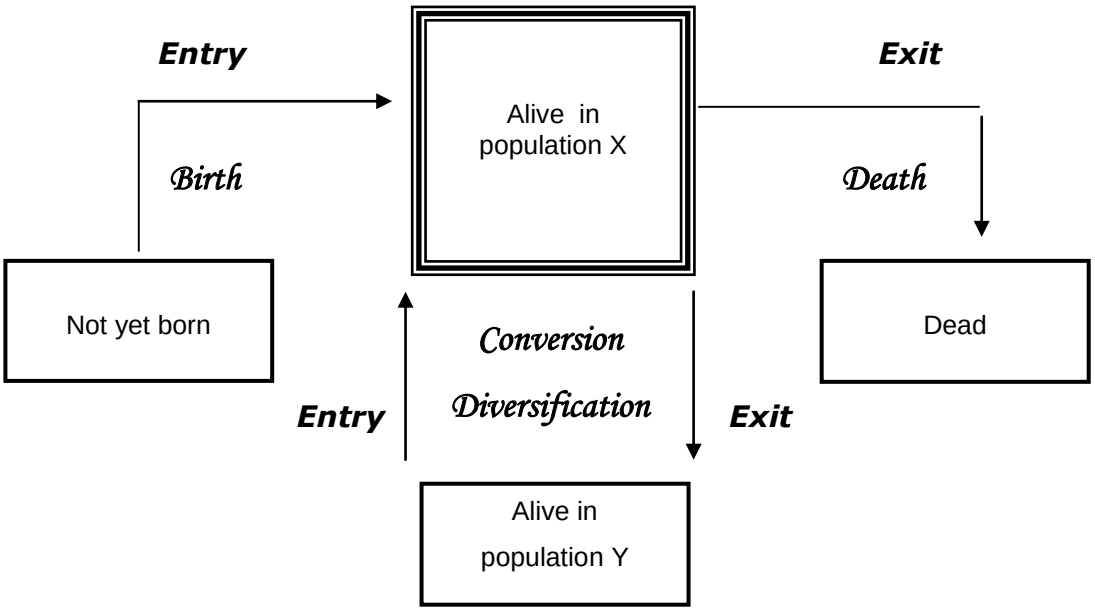

Figure 2.1: Multi-state representation of events of corporate demography

Within this frame, a firm entry in population X can occur because of a transition from not yet born state to alive (birth) or a migration from alive in population Y to alive in population X while continuing to be in population Y (diversification) or leaving population Y (conversion). Similarly, exit can occur because of a transition from alive to dead (death) or from alive in population X to alive in population Y (conversion). This applies to plants, with no substantial differences.

Firm entry by birth is called *de-novo*, or new-to-the-world, entry and is distinguished from entry by conversion/diversification, which is known as *de-alio* [3], or new-to-the-industry, entry. The reason for this distinction lies in differences in resource endowments and motivations that *de-novo* entrants exhibit compared to *de-alio* ones at the entry stage. These initial differences are generally believed to have a significant impact on performance of new firms, especially during their first years of activity.

[3] Carroll *et al*. (1996) and Khessina and Carroll (2008).

By contrast, the distinction between exit by death and conversion is rarely considered in the literature, although the choice of a specific exit route may be the result of different survival strategies and affected by specific firm characteristics (Schary, 1991 and Manjón-Antolín and Arauzo-Carod, 2008). Dissolution of a firm can occur through voluntary liquidation or bankruptcy and can be accompanied by concomitant shutting down of its production site(s) or their sale or a mixture of the two.

2.2.2 Industrial Populations

Units of analysis

The database uses two basic units of analysis[4]: plant and firm. A plant is defined as the production unit that engages, under a single ownership or control, in one, or predominantly one, kind of activity at a single location. The terms establishment, production site, factory and mill are used interchangeably with that of plant. A firm is a specialised organisation bringing together factors of production and transforming them into goods and services to be exchanged in the market (Magill, 1997, p. 546). As such, a firm is the economic entity that groups together all plants under common ownership.

The chief interest among scholars in this field rests on firms because they are the entities that decide whether to enter or exit as well as when to construct a new plant or close an old one or invest in its upgrading. While agreeing with this view, the thesis considers both units of analysis, as there are also important feedback effects from plant to parent firm.

[4] The unit of analysis is the entity that is being studied. It is distinct from the notion of unit of observation, which is the entity for which information is collected and recorded. Although it is desirable that the unit of analysis coincides with the unit of observation, this is not always possible. In those cases—as for the firm—where coincidence cannot be ensured, the best possible approximation is to be sought. The issue of identifying the most appropriate observation unit for the firm is discussed in detail in Chapter 3.

First, in capital-intensive industries, plants are special-purpose facilities with limited alternative use should they prove uneconomical. This implies that the ability of a firm to change its core activities is minimal in the short run. If a plant is uneconomical, the firm is likely to be locked in and its performance be negatively affected until further investment or closure. Thus, the causal influence runs from plant to firm. Secondly, plants and firms are bound together by ownership linkages that change over time. If a plant is profitable, the parent firm has the option to exit by selling it and, thus, recover part of the initial capital investment. This circumstance represents an opportunity for a potential firm to enter the industry. Again, the life trajectories of plants help to document growth-strategies of firms from their foundation to dissolution.

Although rare in studies of firm turbulence[5], organizing the thesis' database in terms of plants and firms was the fundamental tool that made possible to study the nature of industrial rurbulence and ensure data accuracy.

Sample industry

Selection of the graphic segment of the Italian paper industry has been motivated by aggregation suitability, representativeness, relevance and availability of data.

Industrial populations are aggregated in terms of markets or industries. Although the two terms are often used interchangeably in the empirical literature on entry and exit, they do not necessarily lead to the identification of the same population[6]. Industries are groups of firms that produce similar or identical products using analogous production techniques, whereas markets are meetings of suppliers and consumers (Samuelson and Nordhaus, 1997). In principle, studies of firms' mobility should be conducted in the context of markets, since competition arises among suppliers seeking to serve the same set of customers (demand-side substitution), rather than among firms

[5] The most notable study that analyses demographic turnover at both plant and firm levels is Baldwin (1995).

[6] A critical account of the implications of using a market view, as opposed to an industrial view, in studying the competitive process is provided by Geroski (1998).

using similar techniques but offering different products. But a firm's decision to diversify into a given product market is often affected by its existing technology (supply-side substitution). It is, therefore, fundamental to maintain a close concordance between market and industry in studies of firm mobility as it facilitates estimation of the impact of technological factors on firm's survival. In this context, the graphic segment of the paper industry presents a substantial concordance between industry and market boundaries. On demand-side substitution, graphic paper is used as a medium for written communication and does not have a ready substitute. On supply-side substitution, all producers apply the same technology and their machinery is designed specifically for graphic grades. Thus, the graphic segment of the paper industry can be regarded as an independent market where suppliers are competitors. A note of caution is, however, necessary. The graphic segment is not a homogeneous product market. There are several product niches within it, and papermakers are not all actual competitors because they specialised in a limited number of paper grades[7] within their respective segments. Yet, they are all potential rivals. Should they find it profitable to move to another niche within their segment, they can do so with a relatively modest investment in adjusting their equipment to the new grades. Demand- and supply-side substitution is discussed in more detail in Appendix A.

With respect to the industry's representativeness, the selected industry should, in principle, exemplify behavioural patterns common to a wider group of industries. With this in mind, empirical literature on the industry life cycle (Gort and Klepper, 1982) suggests that, during the mature phase of an industry, compressed profit margins drive less efficient producers out of the market increasing sharply exit rates. Moreover, cross-section studies (Siegfried and Evans, 1994) have repeatedly found that the cost of fixed capital required to operate a minimum efficient scale plant has a strong negative effect on entry. The graphic paper industry seems to satisfy these conditions. The Italian paper industry is mature and highly capital-intensive.

[7] A paper grade is a class of paper identified as having the same fibre, colour, additive, and chemical composition and manufactured to the same physical and mechanical characteristics.

Technological advances are incremental, predictable and readily available to all papermakers since innovation primarily originates outside the industry, mainly from few worldwide manufacturers of paper machines. Appendix A provides a detailed account of the technical features of papermaking, capital requirements and technological innovation.

As to relevance, the paper industry is one of the oldest industries in Italy, dating back to the Middle Ages. Since the Second World War, it has been a niche sector. According to Balliano and Lanzetti (1976, p. 11), the share of the paper industry in total MVA[8] was 1.3 per cent in 1969 and 1.2 in 1972. Today, it represents about 0.87 per cent[9]. Within the European context, however, the Italian graphic paper industry accounts for a significant, though decreasing, market share. In 1968, Italian production of graphic paper represented some 12.2 per cent of European total production[10]. By 2001, the share had declined to 4.5[11].

Finally, compilation of a database requires availability of data whose access and hand-matching handling are practicable. The graphic paper industry satisfied this requirement. It is well-documented in the trade's magazines and publications, with an uninterrupted time series of relevant economic variables from 1964 to 2004. The reconstruction of plant and firm life trajectories generated a few hundred profiles. One might have considered the entire paper industry with its four segments—graphic, packaging, sanitary and industrial papers—so as to compare potential divergences in entry and exit patterns. However, this was beyond time limitation and ready availability of data sources for this study. To provide an idea of the task, in 1964 alone, there were 566 companies and 640 plants[12] in the whole paper industry, of which two thirds were small-scale operations producing less than 1,000

[8] As the data on paper production is expressed in tonnes whereas manufacturing value added (MVA) in monetary terms, it has been impossible to calculate the industry's share in total manufacturing.
[9] See IPI, *Industria della carta e cartone*. Retrieved from www.riditt.it/documenti/Carta.pdf on 18 September 2008.
[10] Calculation based on data published in OECD, *The Pulp and Paper Industry in the OECD Member Countries and Finland 1967-68,* Table II, p.28.
[11] Calculation based on data published in CEPI, *10 Year Statistical Summary*, 2002.
[12] Assocarta, *Annuario delle cartiere d'Italia 1964*.

tonnes annually. To gather information on all firms and plants would have been formidable requiring visits to each municipal archive of defunct small enterprises.

2.2.3 Time Horizon

Traditionally, research on market entry and exit has mainly used two quantitative methodologies. The original—widely applied until the end of the 1970s—was cross-section econometric analysis at industry level [13]. An annual entry or net entry rate was regressed on a number of basic industry characteristics across a broad range of sectors. This approach had the merit of revealing main economy-wide relations, as the focus was on inter-industry differences. But, it also had some undesirable limitations. It ignored intra-industry differences.

The reaction to these limitations was the use of longitudinal or panel data econometrics, which have come to dominate empirical work on market entry and exit since the early 1990s. By combining the cross-section and time dimensions, longitudinal or panel datasets record individual subjects over a period of time and allow for heterogeneity in the micro units. As McGuckin (1989, 1995) argued, the typical assumption of homogeneity of individual firms constituting aggregates in cross-section analyses of entry and exit is often inadequate. Firm-specific variables, such as ownership, activity and location, are too often considered as time-invariant, although they do change over time with significant impact on the firm's performance and, therefore, survival. Moreover, panel data allow a better analysis of dynamic adjustments.

As my objective is to study long-term evolution of a market, the thesis takes the approach of a longitudinal case study of a particular industry observed over several decades. By tracing a significant portion of the history of competing firms and their plants, it provides sufficient data to make sound

[13] Examples of this approach include Orr (1974), Deutsch (1975) and Chappell *et al*. (1990).

inferences about market dynamics while minimising the risk that such dynamics might reflect the vagaries of the moment. As Geroski and Mata stressed, "developing longitudinal case studies to study how markets evolve is well worth the effort" (2001, p. 1000).

2.3 Refining Definitions of Units of Analysis

Intuitively, entry and exit can be measured by counting appearance and disappearance of units into and from a market during a given period. While this basic rule is sufficient to identify entry and exit of plants, it becomes problematic at firm level. This is because of the many-faceted nature of a firm, which comprises production facility, legal personality[14] and ownership. What constitutes an entering, continuing or exiting firm depends crucially on the researcher's specification of newness, independence and inception *vis-à-vis* these three dimensions[15].

Newness

In principle, there are as many definitions of being new as there are combinations of which aspect of a firm—legal personality, ownership and plant location—is new. Discontinuity in one or more of these three aspects distinguishes a new firm (entrant) from a continuing (incumbent) or an exiting one (exitor or leaver[16]). Each definition has advantages and disadvantages, its use in some degree arbitrary depending on the scope of the research.

At one extreme, a firm can be regarded as new only if it is an entirely new business that has been set-up from scratch. In this case, entry involves the combined appearance of a new legal personality, new owner and new plant.

[14] Legal personality, also referred to as artificial or juristic personality, is the status of an artificial entity that the law treats as if it were a natural person (human) and accords specific rights and duties. Corporations are examples of juristic persons. Depending on the country's jurisdictions, partnerships may or not be granted some degree of legal personality.

[15] For a discussion of definitional difficulties in the empirical research on firm creation, see Mason (1983).

[16] In the literature, there is no standard antonym of "entrant". The term "exitor" or "leaver" are often used to indicate the exiting firm.

This is the approach used by Bain in his renowned work on barriers to competition. The author defines entry as "establishment of an independent legal entity, new to the industry…and… the concurrent building or introduction by the new firm of physical production capacity that was not used for production in the industry prior to the establishment of the new firm" (1956, p. 5). While recognising that acquisition of existing production capacity by a new owner may constitute a distinct change in a competitive situation, Bain excludes it from evaluation of entry barriers because it does not affect the overall production capacity of an industry.

At the other extreme, a firm might be thought as new if it involves merely a new legal personality, brought about by any administrative modification such as a change in its legal form or an internal reorganization. By and large, scholars seem to agree that a new firm that is simply the reorganization of an old one under a new name and structure should not be regarded as new, since it hardly involves a significant recombination of resources[17]. The total amount of the industry's production capacity as well as its distribution by ownership remains unaltered leaving the competitive scene unchanged.

Between these two extremes, there are situations where a new business is regarded as such when two of the three elements are new. Nowadays, with the shift of research attention from entry barriers to firm mobility, the majority of scholars[18] regard entry as the emergence of a new owner with a new agglomeration of plants, regardless of whether such plants are newly built and/or acquired.

In compiling the thesis' database, I followed the latter. A firm was qualified as new (entrant) if a new cluster of plants were controlled by a new-to-the-world or new-to-the-industry owner (see Section 2.2.1), regardless of the status of its plants and the legal personality to which they were associated. The status of its plant or plants at the time when the new owner entered the market,

[17] This approach has been adopted in the *EU-OECD Manual on Business Demography Statistics* (2007).
[18] Baldwin (1995) provides one of the most exhaustive accounts in this respect.

however, qualified the entry mode. A new owner could have entered by plant construction, (greenfield entry) or by plant acquisition. Whether the new owner started operation under a new legal unit (registered company) or an existing one was inessential to definition of an entrant.

Independence

In studies of competition, a firm is regarded as a self-contained economic entity, which takes its decisions autonomously without involvement of any other firms. Being autonomous is a relative concept, for there are many formal and informal inter-company affiliations that render control more concentrated than one would gauge from a first glance at company directories and business registers.

First, some companies are linked together through subsidiary-parent relationships, whose nature varies considerably. At one extreme, there are cases in which a parent company confines its role primarily to that of a stockholder, allowing a subsidiary to act independently under direction of its own board. At the other, a parent may exercise such strong control over the subsidiary by, for example, commingling funds, interchanging employees, sharing office facilities and the like, that the distinction between parent and subsidiary as separate independent corporations becomes blurred. In principle, all subsidiaries operating in a given market should be regarded as part of the same firm, regardless of the degree of autonomy conferred in them. In practice, this procedure often yields incomplete results because subsidiary-parent relationships are not necessarily traceable in administrative databases or commercial directories[19].

[19] Even in the case of Dun and Bradstreet files, which include codes for the establishment, parent and ultimate parent company, Lipsey (1978) found that many establishments in multi-plant firms lacked parent and ultimate parent codes. However, the Longitudinal Manufactures Research File based on the Canadian Census of Manufactures identifies all establishments under common ownership (Baldwin and Gorecki, 1989). More generally, subsidiaries are treated as independent firms as long as they are assigned a different identification code.

Secondly, companies are interconnected through linkages such as control of family groups, participation of financial intermediaries and interlocking directorates (Scherer and Ross, 1990). Although widespread and lawful, these practices raise questions about the independence of board decisions and, in turn, actual degree of competition among firms. However, adjusting data to take into consideration these linkages is extremely difficult because this kind of information is not easily retrievable and, even if it were, there is no definition of how much control is acceptable until competition is *de facto* decreased.

In Italy, these linkages are reckoned to be substantial[20]. The trade's directories, magazine articles and sector studies have provided ample information about subsidiary-parent relationships and family groups, allowing identification of firms as economic entities grouping all plants under the same ownership. But to collect information on composition of boards of directors over time proved unmanageable. Therefore, the potential impact of interlocking directorates on competition has not been pursued.

Inception

Entry timing has been the subject of intense debate among scholars in entrepreneurship research and organisational ecology, since the creation of a firm is regarded as a process, rather than a discrete event. Birley (1984) identifies eight different points in time at which the firm can be said to exist[21] and notes that the process can take several years. The most popular approaches are to equate the start-up date with date of registration of the legal entity (business registers), recruitment of first full-time employee (employment surveys or national employment insurance files) or first payment of taxes (VAT files). None is optimal. Listings by registration dates

[20] In a recent study of Italian corporate interlocking directorates between 1952 and 1972, Rinaldi and Vasta (2005) found that the average number of interlocks per company in the manufacturing sector had decreased from 7.2 in 1960 to 5.4 in 1972, which compares with an average for the whole economy of 8.5 and 5.9.

[21] The eight starting points suggested by Birley (1984) are: (1) the owner makes the decision to start, (2) first date when the owner becomes self-employed, (3) incorporation date, (4) establishment of a bank account, (5) acquisition of premises and equipment, (6) receipt of the first sale order, (7) first payment of taxes, and (8) recruitment of first full-time employee.

may include firms that are not necessarily actively trading[22]; listings by first full-time employee exclude those firms without any employees or with part-time and self-employed labour; and listings by first payment of taxes excludes those firms whose annual turnover is below a certain threshold.

In the research database, the issue of timing has been resolved by assuming date of start of activity as start-up date and, if unavailable, date of foundation. Similarly, date of exit was assumed to be date of cessation of activity in the case of voluntary liquidation or date of receivership in that of bankruptcy.

2.4 From Definition to Measurement

In compiling a dataset, a crucial aspect is to ascertain the degree of concordance between the reporting unit of the data source that the researcher intends to use and the unit of analysis of the research itself. Discrepancies between the two are likely to lead to substantial measurement biases of the phenomenon under investigation. Compilation of databases at firm level is a case in point. This section outlines, first, the methodology used in business registers to record business data and, then, discusses the thesis' approach to counting plants and firms.

Before turning to the methodological question of suitable measurements for the firm, I clarify the notions of unit of analysis, statistical unit and/or unit of observation. The unit of analysis is the entity that is being studied; the statistical unit, also referred to as analytical unit, is the real or artificially constructed unit for which statistics are compiled; and the unit of observation, also referred to as reporting unit, is the entity for which information is collected and recorded [23] generally by institutional and commercial organizations. Statistical units can be units of observation or created by

[22] Some registered companies are legal devices (shell companies) set up for administrative reasons or formed by company agents for off-the-shelf sales at a later date. In this context, Mason (1983) quotes a study by Scott, which found that 23 per cent of all companies registered in Scotland in 1969 had never traded.

[23] See *OECD Glossary of Statistical Terms*, 2007 Retrieved from http://stats.oecd.org/glossary on 23 June 2010.

statisticians, often by splitting or combining observation units through estimation and imputation.

2.4.1 Statistical Units in Business Registers

In Europe, one of the main sources of business data is the business register. As described in the EU Recommendations Manual (2003), the conceptual model underlying the organization of information in business registers is centred around three fundamental entities: enterprise, local unit and legal unit[24].

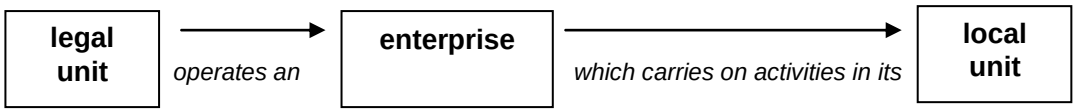

Figure 2.2: Relationship among enterprise, legal unit and local unit

Local unit refers to a specific site that engages in one main productive activity, such as workshop, factory, office and the like[25]. Legal unit refers to an entity, recognized by law, which has the right to conduct business in its own name, is capable of owning goods and assets, incurring liabilities and entering into contracts, as well as it may be sued and taxed. It coincides with the common notion of a registered company (herein referred to as "company"). Enterprise refers to "the smallest combination of legal units, that is, an organizational unit producing goods or services, which benefits from a certain degree of autonomy in decision-making, especially for the allocation of its current resources. An enterprise carries out one or more activities at one or more locations" (Council Regulation EEC No. 696/93 of 15 March 1993).

[24] In principle, business registers also include a fourth statistical unit: the enterprise group, which is the entity that groups together all enterprises under common ownership or control. However, most European Statistical Offices are still examining implementation methodologies in this respect.

[25] The Council Regulation on Community states, "a local unit is an enterprise or part thereof (e.g. a workshop, factory, warehouse, office, mine or deport) situated in a geographically identified place. At or from this place, economic activity is carried out for which—save for certain exceptions—one or more persons work (even if only part-time) for one and the same enterprise" (European Union Manual, 2003, p. 60).

In this context, a legal unit provides the legal basis for an enterprise to operate. The relationship between a legal unit and an enterprise can be as simple as one enterprise to one legal unit or more intricate, where an enterprise consists of a number of legal units. With rising complexity in the business world, the latter configuration has become increasingly more frequent.

Being defined as the organizational unit producing goods or services, the enterprise is the statistical unit that best approximates the firm. Unfortunately, most business registers[26], including the Italian one, collect information mainly for legal and local units, but not for enterprises. In this regard, Hult (2001) notes, "The enterprise unit is not recorded in all [European] Business Registers. …[Even when] the method refers to enterprises, in reality the treatment is done to legal units." (p. 7). Therefore, use of data on local units to count firms was potentially problematic. The next section details the approach adopted.

2.4.2 Thesis' Approach

Lack of records at enterprise level constituted a major limitation[27] in the use of the Italian Business Register for compilation of the thesis' database. However, such limitation was tractable.

If a firm is viewed as a cluster of plants under common ownership, constructing its empirical counterpart is essentially the problem of grouping together all plants or companies, which are owned by the same entity, under a unique identifier, that is, the enterprise. To achieve such result, what is needed is to trace all proprietary linkages between plants and companies at any time during a given period.

[26] For an overview of business demographic data by OECD country, see Bartelsman *et al.* (2003).

[27] Exceptions are Baldwin and Gorecki (1989) and Baldwin (1995), who provide detailed accounts of validation of identifiers in administrative datasets. In addition, the Eurostat-OECD Manual on business demography statistics (2008) describes the typology of events during the life of enterprises and how they are dealt with in business registers.

I followed this approach. The result is a database structured around three statistical/observation units: plant (or establishment), company and enterprise. Figure 2.3 illustrates the relationships between the thesis' units of analysis and its statistical/observation units.

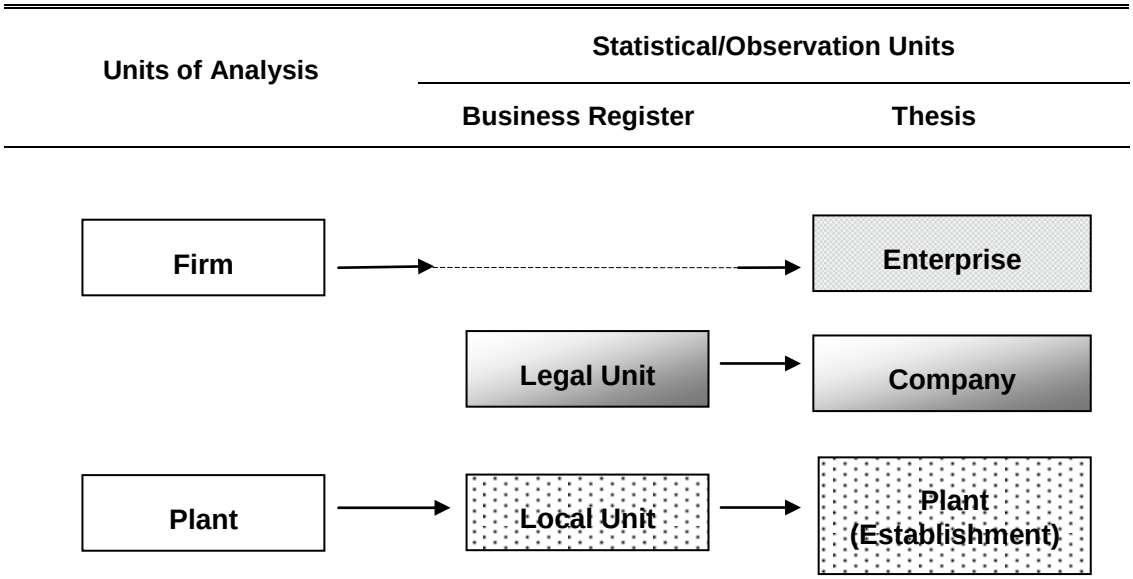

Figure 2.3: Units of analysis vs. units of observation

Identification of plants and companies was straightforward. The Italian Business Register records systematically all local units[28] specifying their major use as well as all legal units with their registration number. The trade's yearbooks usually report information on production sites including addresses and telephone numbers. Such information proved crucial in tracing plants as well as detecting errors.

On the contrary, detection of ownership/control linkages was lengthy, since such linkages had to be discovered from magazine articles, industrial studies and direct interviews with company's staff or management. However, I believe that cross-referencing among sources virtually annulled attribution errors in this respect.

[28] The Italian Business Register records the location of the legal entity as headquarters, regardless of whether or not it houses production facilities. This implies that plants could be reported as headquarters or simply local units. However, description of the main activity carried out at each local unit resolves most questions.

Although the thesis does not analyse survival of companies nor market dynamics at their level, information on foundation and dissolution of legal entities was accurately recorded for each plant and enterprise. The reason was twofold. First, it allowed accurate assessment of measurement biases that could have arisen if the legal unit had been used as a proxy for the firm (Chapter 3). Secondly, it allowed accounting for administrative reorganizations of enterprises and plants, which firms use, at times, to increase their chances of survival (Chapters 5 and 6).

2.5 Thesis' Database

2.5.1 Typology of Databases

There are a number of public and private sources from which longitudinal datasets on industrial demographics can be assembled. On the commercial side, there are buying guides, telephone directories, company reports from credit rating agencies and membership directories of chambers of commerce. These sources have the advantage of being public, though purchase of listings and auxiliary information can prove rather expensive. They often provide auxiliary information on product lines, equipment and other economic information, and frequently specify headquarters, branches and subsidiaries.

On the public side, there are various longitudinal micro-level datasets based on administrative sources, such as business registers, social security files, employment registers, national censuses of manufactures, sales tax files and other statistical surveys. Following efforts by various public administrations to deregulate external access to data, these files have become the primary source of demographic data since the mid-1980s. They are comprehensive, spatially disaggregated, machine readable and reasonably up-to-date. However, their access has to be negotiated. Administrative records are generally confidential in nature, with their use strictly regulated by privacy and statistical laws. In general, no statistical information at firm level can be provided if there is any possibility to identify the single firm from publicly

available sources[29]. An additional crucial weakness concerns the data unit, which is generally defined at finer levels than required by most industrial studies (Kalleberg *et al*., 1990 and Baldwin and Gorecki, 1989). This can be a major problem, which is discussed in detail in the next section.

Coverage and timeliness of databases varies considerably across sources, countries and sectors. Although it is commonly recognised that selection of the data source has a substantial bearing on the identification of the population of interest, few studies have systematically addressed the issue. Even those[30] that have cannot provide more than general guidelines because they refer to the United States, which has a greater selection of reliable and comparable data sources than most other countries in the West. Nevertheless, these studies point to the same conclusion: no data source is definitely superior to another, so its selection should be carefully evaluated on the basis of the research focus. In this respect, Kalleberg *et al*. (1990) stated, "the most general conclusion we draw about representativeness is that tolerably representative samples can be drawn from several ... sources…. One way to see this in terms of bias is that no dummy variable for a source accounts for more that 3 percent of the variance in age … and 2 percent of the variance in size" (p. 683). Although appealing, this suggestion can rarely be pursued as there are few instances when scholars have access to multiple databases.

2.5.2 Italian Sources

In the Italian context, there are official and commercial sources, both with strengths and weaknesses. As a result, none could be selected as the

[29] An OECD (1998) study provides a useful overview of the confidentiality requirements for access to administrative micro-data in the OECD countries in the late 1990s. Since then, it is likely that improvements have occurred in some countries. But, even so, confidentiality requirements still limit access to information on the trade and legal names of businesses.

[30] One of the first scholars, who investigated what data source best identified businesses, was Birley (1984). By comparing the magnitude and characteristics of samples drawn from Dun and Bradstreet's Dun's Market Indicator files (DMI), Country Unemployment (ES202) files and telephone directories, the author concluded, "the major variable to affect the reliability of the data base identified is the source itself" (p. 67).

primary source. Nevertheless, all provided some useful information for the compilation of the thesis' dataset at plant and firm levels as well as the time series of the industry's evolution over the period studied.

On the official side, the National Statistical Office (ISTAT) provides census data on the total number of companies and establishments at 4-digit ISIC level for 1971, 1981, 1991 and 2001. It also provides, commercially, the annual figures of companies and plants from 1996 to 2001 as well as total number of entries and exits from 1999 to 2001. These can be disaggregated by employment size, geographical location and legal form. The National Institute of Social Security (INPS) records social security payments for employees by companies. Since all Italian companies are compelled to transfer such payments to INPS on a regular basis, appearance and retirement of identification codes have been used by several scholars to identify entry and exit in the Italian manufacturing and service sectors. The Business Register maintains administrative files for each company founded and operating in Italy recording all administrative and statutory changes that have occurred during their lifetime. All companies are compelled to register within 30 days from their constitution or within the terms prescribed by the civil codex as well as to notify the Register all subsequent statutory modifications. By structure[31], it is a centralised electronic repository of information, which provides, on commercial bases, lists of continuing and exiting registered businesses by registration number, commercial name, location of headquarters and local units, NACE class of activity and dates of business founding, registration, liquidation, bankruptcy and closure. On request, historical company profiles (*visura storiche*) can be consulted on-line.

[31] In its current form, the Italian Business Register was established by law no. 580 of 23 December 1993, which called for the merger of the former register for incorporated companies (*Registro delle società*) with that of small businesses (*Registro delle ditte*). Prior to the establishment of the Business Register, the *Registro delle società* was maintained by the commercial sections of provincial courts (*Cancellerie Commerciali dei Tribunali*), whereas the *Registro delle ditte* by the provincial chambers of commerce.

Unfortunately, none of these administrative databases could be used as primary sources for the compilation of the thesis' database. The ISTAT census publishes aggregate data at ten-year intervals and for the whole paper industry, rather than at individual level and the graphic segment alone. INPS would not provide data due to confidentiality, whereas the listings of the Business Register are not accurate. The major drawbacks of the Business Register are that the basic reporting unit is the registered company (the legal unit), there is no trace of companies that closed before the 1980s as electronic consolidation[32] of company information dates back to the early 1990s and specification of principal activity is often incorrect. However, it did prove an invaluable source for ascertaining or checking companies' demographic events, once the list of all papermakers had been compiled.

On the commercial side, a number of directories by the Italian association of pulp and papermakers (ASSOCARTA), the Ente Nazionale per la Cellulosa e per la Carta (ENCC) and Paperloop have provided comprehensive annual lists of paper plant and companies, with technical information on production. The fundamental directories are the *Annuario delle cartiere d'Italia,* 1964, 1970, 1976 and *International Pulp & Paper Directory*, 1989-2002, which contain information on location, plants, type of production, machinery and annual capacity. In addition, *Cellulosa e Carta* published a monthly list of companies that had entered and exited the industry and, as a supplement to its monthly issues, an annual list of all papermaking companies. Although more accurate in reporting actual competitors in the industry, these lists suffer from numerous spelling mistakes in company names, which have required double checking across all sources to avoid incorrect entries or exits, and do not specify the type of paper produced.

In addition, the trade's magazine, *Industria della carta,* and FAO's *Pulp and Paper Capacity* have provided time-series data for the industry's production, capacity, trade and consumption. Several scholarly studies as well as

[32] Files of companies that ceased operations before the 1980s are unavailable, electronically. They can be consulted only at provincial courts or chambers of commerce.

surveys conducted by ASSOCARTA and ENCC have also provided data on the evolution of the industry's structure.

2.5.3 Compilation of the Thesis' Database

With no access to official census-based datasets or already compiled ones, a different strategy had to be pursued. The construction of the research databases had to be based by weaving together information from a multitude of different sources, from the trade's magazines and directories to business register's profiles, company reports, history books and telephone conversations. Given the length of assembling information and inputting it in an electronic format, I decided to confine the database to the graphic segment of the paper industry. Although the number of observations is limited to 78 plants, 74 firms and 117 registered companies, the set of observations represents the entire population rather than a mere sample.

The compilation of the longitudinal case study progressed in stages. It started by assembling a list of all paper mills and corresponding companies producing graphic paper in Italy in 1964. The source was the *1964 Annuario delle cartiere d'Italia* by Assocarta, which was a comprehensive and accurate account of all Italian paper companies and their plants in operation in 1964. Since the *Annuario* explicitly indicates grade class or classes of paper produced by each company, it was relatively straightforward to identify those companies and plants that manufactured graphic paper only or in combination with other kinds in 1964. This list was, then, integrated by adding all new plants engaged in production of graphic paper that had been listed in subsequent editions of the *Annuario*, *Cellulosa e Carta* and, from 1989 to 2004, in the *Pulp and Paper International Directory*.

Once the lists of all plants and registered companies that operated at any time between 1964 and 2004 were complete, individual pre-organised profiles of plants were prepared collating information from a multitude of different sources. An example of a plant profile is reproduced in Table D.1 in Appendix D. Each plant profile contained three major sections. The

demographic section included a brief account of the history of the plant and information on mill location, date of construction and eventual closure. The technical section detailed principal activity, type of operation, machinery and production capacity, whereas the section on proprietary relationships recorded all ownership changes—at firm and registered company level—that a plant had undergone during its life or, at least, in its last 40 years. It included dates of acquisition and sale as well as corporate characteristics of the acquiring entity. The dates of plant construction and closure were obtained from history and industrial archaeology books and information about expansion projects and plant capacity from the trade's surveys, companies' reports and specialised magazines. Dates of foundation and closure of registered companies were obtained from the Italian Business Register, while information on ownership linkages was gathered from magazines and official documents from the Italian anti-trust authority as well as local councils. In instances of ambiguities or missing information, I conducted telephone interviews with the companies concerned or former employees. This second stage was very time-consuming as most sources were fragmented, accessible only in paper form and held in various libraries and repositories.

With the plant profiles completed, the construction of the database entered a third stage, which consisted of transforming the information assembled into quantitative variables. The result is a master excel database, from which three longitudinal datasets were derived: PLANT.xls, recording data at plant level, ENTERPRISE.xls at firm level and COMPANY.xls at company level. Table 2.1 reproduces a section of PLANT.xls. This structure also applies to the other excel files.

year	PLANT code	PLANT name	ENTERPRISE name	COMPANY name	PLANT event	PLANT state	OTHER variables
1971	*54*	rivagarda	bertelsmann	gardaA	**acquisition**	ongoing	
1971	58	sassoferrato	frezzotti	sentinofad	checkpoint	ongoing	
1971	*16*	chiampo	marchi	valchiampo	checkpoint	ongoing	
1971	57	sarego	marchi	sarego	**construction**	**entry**	
1971	*24*	duino	ferraro	timavo	checkpoint	ongoing	
1971	6	arbatax	ferraro	arbatax	checkpoint	ongoing	
1971	*54*	rivagarda	legrenzi	gardaA	**sale**	ongoing	

Table 2.1 Excerpt from PLANT.xls

Having identified all the proprietary linkages among plants, companies and enterprises, this third stage was laborious but rather straightforward. It mainly consisted of coding systematically the information contained in the plant profiles and, then, constructing variables at company and enterprise level from those at plant level. Table 2.2 lists the basic variables of the data files[33] for the thesis' units of analysis.

	PLANT.xls	**ENTERPRISE.xls**
Identifier	• Identification code • Name • Current year	• Identification code • Name • Current year
Location	• Town • Province • Region	• Town • Province • Region
Key dates and events	• Date of construction • Start-date of producing graphic paper • End-date of producing graphic paper • Date of shut-down • Current state	• Date of foundation • Start-date of producing graphic paper (i.e. date of entry) • End-date of producing graphic paper (i.e. date of exit) • Date of dissolution • Current state • Mode of entry/exit
Proprietary/administrative events	• Date of plant acquisition/ administrative transfer/sale • Name of the acquiring/divesting enterprise • Name of the acquiring/divesting company	• Date of expansion/reorganization/ contraction • Name of the acquired/divested plant • Name of the acquiring/divesting company
Background	• Founder's profession • Founder's sector of origin	• Founder's profession • Founder's sector of origin
Production	• Plant's current capacity • Owing enterprise's current capacity • Owing company's current capacity • Grade specialization • Inter-sector production	• Enterprise's current capacity • Grade specialization • Inter-sector production
Equipment	• Current total number of paper machines by width class • Current number of paper machines installed after WWII by width class	• Current total number of paper machines by width class • Current number of paper machines installed after WWII by width class • Single-multi-plant operation

Table 2.2 Basic variables in PLANT.xls and ENTERPRISE.xls

As to key events, whenever possible, four key dates were recorded: the founding/construction date, the year in which the plant and the enterprise began production of graphic paper, the year when they stopped producing for the graphic industry and the year of closure. However, when the start- or

[33] Definitions of the variables used in the thesis are provided in Appendix C.

end-date of activity was unknown, the date of foundation or dissolution was considered. Moreover, when only the year or the month was known, then, the date was approximated by the mid-point, that is, the 30th June in the former case and the 15th of the month in the latter.

Obtaining data on the number and type of paper machines in operation in a given year required some detective work. Through company histories and telephone conversations with plant managers and technicians, it was generally possible to fill the gaps or correct the information published in the trade's directories. However, it proved unachievable to obtain accurate and complete information about the machinery in operation in eight plants and on plant upgrading in fourteen plants. As a result, the equipment variables had to be simplified to numbers of paper machines installed pre- or post-WWII and wider or narrower than 3 meters.

The main difficulty in constructing quantitative data was, however, the estimation of production capacity. The trade's directories record yearly tonnage figures, but the accuracy proved to be modest. Not only were the times series, now and then, incomplete, but the reported values were, at times, inconsistent. Therefore, it was frequently necessary to make conjectures about yearly levels of capacity on the basis of the known reliable data values as well as information on type of machinery in operation and capital investment in plant upgrading. Although inevitably speculative, this practice led to an acceptable level of concordance with published aggregate figures. The time series of the industry's total capacity of graphic paper approximates the corresponding times series published by FAO within the range of $\pm$ 5 per cent.

In summary, the thesis' database is accurate in counting correctly plants and firms as well as recording their proprietary life trajectories over a relatively long period. However, it is limited in data on output exported and sales. This hampered the study of the effects of the business cycle on entry and exit at individual and industry levels. In addition, the incomplete information

concerning the exact dates when plants were upgraded has also prevented an analysis of the investment function.

Note on Terminology

In the thesis' database, enterprise indicates the empirical counterpart of the firm. Company is used to designate the registered legal entity that has the right to conduct business in its own name. Enterprises may consist of one or more companies.

The potential measurement bias that would have arisen from using company, rather than enterprise, to count firms is elaborated in the next chapter. In Chapters 5-8, the terms enterprise and firms are used interchangeably because of their substantial correspondence.

CHAPTER 4

ENTRY AND EXIT IN ITALIAN GRAPHIC PAPER INDUSTRY, 1964-2004

Preliminary to the following chapters that analyse exit and survival, this one presents the aggregate picture of turbulence in the graphic segment of the Italian papermaking industry from 1964 to 2004. After an initial overview of the structure of the industry, the remainder of the chapter focuses on the dynamics of entry and exit of plants and enterprises[1]. This chapter is complemented by Appendix B, which highlights development of the sector in terms of its aggregate capacity, production, consumption and trade.

4.1 Structure of the Graphic Paper Industry

Numbers

Figure 4.1 illustrates the total annual number of existing plants and enterprises[2] in the graphic papermaking industry during the period under consideration. The annual entry, exit, net entry and turbulence flows of plants and enterprises are presented in Tables D.4 and D.5 of Appendix D.

Despite significant growth in production and apparent consumption of graphic paper from 1964 to 2004 (Figure B.3, Appendix B), the industrial population has been constantly shrinking throughout the period: plants declining from a peak of 70 in 1965 and 1966 to 40 in 2004 and enterprises from 49 to 22, during the same period (Figure 4.1).

[1] As discussed in the previous chapters, the enterprise is the empirical proxy for the firm. Given their substantial concordance, the two terms can be used interchangeably. However, because of the statistical nature of this chapter, only the term “enterprise” will be used.

[2] Existing plants or enterprises are defined as those units that were still in operation as at the end of each year. It includes any entries and excludes any exits that occurred during the year. They differ from continuing units, as the latter are defined as those entities already in existence in the previous year and continued to be at least until the last day of the year under consideration.

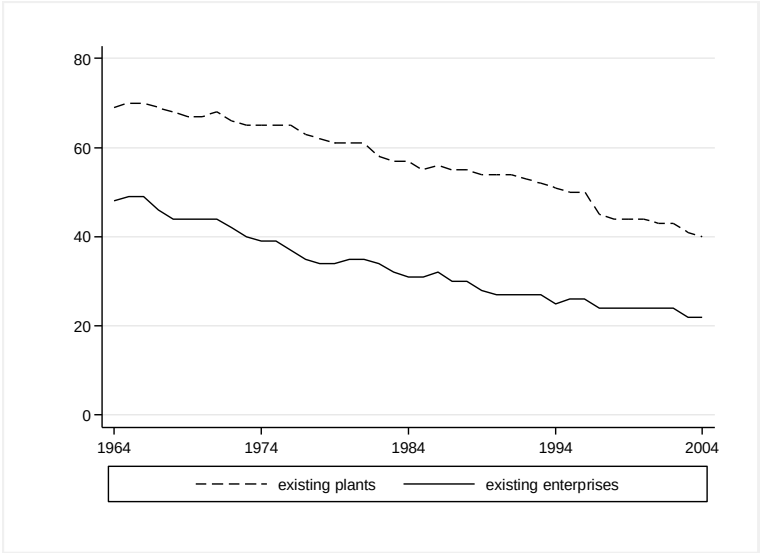

Figure 4.1: Number of existing plants and enterprises, 1964-2004

Distribution by size

This steady contraction of the population has been accompanied by a considerable shift towards plants and enterprises of larger size (Tables 4.1 and 4.2).

In 1964, nearly 60 per cent of plants had an annual capacity of no more than 10,000 tonnes and the dominant[3] class size[4] was up-to-5,000 tonnes annually. Two decades later, the weeding out of smaller operations was mostly completed. In 1984, the dominant class size was 25,000-50,000 and the percentage of plants producing no more than 10,000 tonnes annually had decreased to 35 per cent of the total. These results appear to be broadly consistent with the minimum efficient scale (MES) as estimated by industry experts[5] in the late 1970s.

[3] The dominant size class is defined as the class with the highest proportion of enterprises of that size class in the total number of existing enterprises in a given year.

[4] The breakdown by size class corresponds to that commonly reported in the trade's magazines and statistics. The inequality of size classes reflects the fact that an increase in the width of a paper machine generates more than a proportional increase in its output.

[5] Farinet (1989) reported the Ministry of Industry's MES estimations for main category of machines. In the late 1970s, MES for a plant manufacturing printing and writing grades was 70 tonnes daily, equivalent to some 21,000-23,000 tonnes annually, and the optimal width of the paper machine was 2.5 meters.

Size class (tonnes)	1964		1974		1984		1994		2004	
	median size	%	median size	%	median size	%	median size	%	median size	%
up to 1,000	500	10.1	150	7.7	575	7.0	1,000	5.9	560	5.0
1,001-5,000	3,000	30.4	3,600	20.0	4,000	15.8	3,350	11.8	3,600	10.0
5,001-10,000	7,500	17.4	8,500	15.4	8,500	12.3	9,000	11.8	8,000	2.5
10,001-25,000	17,000	15.9	15,750	21.5	17,000	15.8	12,500	9.8	13,500	12.5
25,001-50,000	40,000	15.9	36,500	12.3	32,250	17.5	40,000	25.5	35,000	27.5
50,001-100,000	75,000	8.7	75,000	18.5	70,000	17.5	70,000	17.6	70,000	12.5
100,001-250,000	120,000	1.4	140,000	4.6	130,000	14.0	180,000	15.7	130,000	17.5
above 250,000	0	0.0	0	0.0	0	0.0	380,000	2.0	330,000	12.5
Total	7,500	69*	15,000	65*	24,000	57*	36,000	51*	42,500	40*

Note: (*) indicates total number of plants in operation in the corresponding year

Table 4.1: Distribution of plants by size class, selected years

From the mid 1980s, the restructuring of the industry has progressed towards expanding operations. Although the dominant size class has remained the same, 25,001-50,000, the percentage of plants with a capacity more than 100,000 tonnes has nearly doubled. As a result, the overall median of plan size has grown from 24,000 tonnes in 1984 to 42,500 tonnes in 2004.

Similar upward trends are also found at enterprise level, although the speed of restructuring has been somewhat slower (Table 4.2).

Size class (tonnes)	1964		1974		1984		1994		2004	
	median size	%	median size	%	median size	%	median size	%	median size	%
up to 1,000	1,000	10.4	560	10.3	1,000	9.7	1,000	12.0	120	4.5
1,001-5,000	3,000	31.3	3,600	33.3	3,875	25.8	4,000	20.0	3,600	18.2
5,001-10,000	7,750	16.7	8,750	10.3	9,000	9.7	8,000	8.0	0	0.0
10,001-25,000	12,000	12.5	15,000	12.8	21,150	12.9	11,750	8.0	14,250	9.1
25,001-50,000	39,500	10.4	41,500	7.7	38,000	3.2	40,000	20.0	39,500	27.3
50,001-100,000	65,000	14.6	77,500	15.4	57,000	19.4	85,000	8.0	71,000	22.7
100,001-250,000	205,000	2.1	120,000	2.6	134,000	12.9	192,500	16.0	0	0.0
above 250,000	291,000	2.1	393,500	7.7	701,250	6.5	895,500	8.0	385,000	18.2
Total	7,750	48*	9,000	39*	19,300	31*	28,000	25*	40,250	22*

Note: (*) indicates total number of enterprises in operation in the corresponding year

Table 4.2: Distribution of enterprises by size class, selected years

In 1964, the percentage of small enterprises with an annual capacity of less than 10,000 tonnes was 58.4 per cent, with the dominant size class up to

5,000 tonnes. By 1994, the percentage of small enterprises nearly halved, the dominant size class increasing to 25,000-50,000. Although the dominant size class in today's industry is still 25,000-50,000, the largest enterprise[6] is some 40 times as large as the largest of the enterprises in this size class. This indicates a stratified market structure: a very large enterprise, three smaller but still large enterprises, many medium-sized operations and several small ones.

The increase in enterprise size is as much the result of increases in plants' size as of an increased agglomeration of plants under common ownership. As Figure 4.1 suggests, the average number of plants per enterprise[7] has also steadily increased from 1.42 in 1965 to 1.82 in 2004. This aspect and its impact on concentration levels is analysed in detail in Chapter 7.

Distribution by age

Papermaking enterprises and plants exhibit a remarkable longevity (Tables 4.3 and 4.4)[8]. Throughout the period under consideration, some two-thirds of the plants and some half of the enterprises were more than 50 years old. This implies that a considerable number of plants and enterprises survived at least a world war, if not two. Moreover, as the age class of plants and enterprises older than 100 years includes some mills spanning several centuries, this suggests the absence of specific upper bounds for age[9] for both plants and enterprises.

[6] The largest enterprise in 2004 was Cartiere Burgo spa with an annual capacity of some 1,905,000 tonnes.

[7] There are a few enterprises that, besides graphic plants, operate other mills producing different types of paper. Therefore, the average number of graphic plants per enterprise should not be intended as an overall measure of the size of enterprises but, rather, as an indication of the consolidation process that the graphic sector underwent.

[8] The inequality of age classes is motivated by the need to provide more detailed information on the younger firms, rather than the older ones.

[9] Had one analysed registered companies instead of enterprises, the conclusions would be opposite. The percentage of registered companies older than 50 years was consistently less than a third (17.5 in 1964, 23.5 in 1974, 31.7 in 1984, 30.3 in 1994 and 33.3 in 2004) and virtually none exceeded 100 years of age.

Age class (years since entry)	1964		1974		1984		1994		2004	
	median age	%	median age	%	median age	%	median age	%	median age	%
up to 5	1	11.6	3	1.5	0	0.0	1	2.0	0	0.0
5-10	6	7.2	10	7.7	7	1.8	0	0.0	0	0.0
11-25	14	7.2	16	21.5	21	17.5	20	3.9	11	2.5
26-50	39	5.8	36	4.6	31	14.0	33	27.5	41	30.0
51-100	68	29.0	74	20.0	80	24.6	88	23.5	85	25.0
above 100	162	39.1	167	44.6	194	42.1	198	43.1	214	42.5
Total	68	69*	78	65*	88	57*	90	51*	98	40*

Note: (*) indicates total number of plants in operation in the corresponding year

Table 4.3: Distribution of plants by age class, selected years

Age class (years since entry)	1964		1974		1984		1994		2004	
	median age	%	median age	%	median age	%	median age	%	median age	%
up to 5	4	14.6	2.5	5.1	4	14.3	1.5	8.0	1.5	9.1
5-10	7.0	10.4	7.5	5.1	6	7.1	5	4.0	7.5	9.1
11-25	14	10.4	18	25.6	21.5	14.3	17	12.0	21.5	9.1
26-50	40.5	16.7	45	10.3	30	21.4	39	20.0	44.5	18.2
51-100	62	29.2	65	33.3	71	35.7	81	36.0	89	40.9
above 100	166	18.8	128	20.5	151	7.1	124	20.0	134	13.6
Total	48	48*	57	39*	42	28*	69	25*	67	22*

Note: (*) indicates total number of enterprises in operation in the corresponding year

Table 4.4: Distribution of enterprises by age class, selected years

Yet, the age structures of the groups of plants and enterprises younger than 50 years differ considerably. While the population of plants becomes older as time elapses, that of enterprises seems to be able to rejuvenate itself. Table 4.3 shows that the dominant age class for plants progressively increased from 0-5 in 1964, to 11-25 in 1974 and 1984, and to 26-50 in 1994 and 2004. By contrast, the dominant age class of enterprises has always been 26-50, with an exception in 1974. This is the result of different turbulence dynamics at plant and enterprise level.

4.2 Patterns of Plant Entry and Exit

In 1964, there were 69 existing plants, of which two were new. Since then, nine additional plants have entered the sector, of which five between 1965

and 1974 and four between 1977 and 1993. No plant had been built or converted to production of graphic paper after 1993. By contrast, exit occurred throughout the period almost incessantly. Figure 4.2 and Table D.4 in Appendix D depict these dynamics.

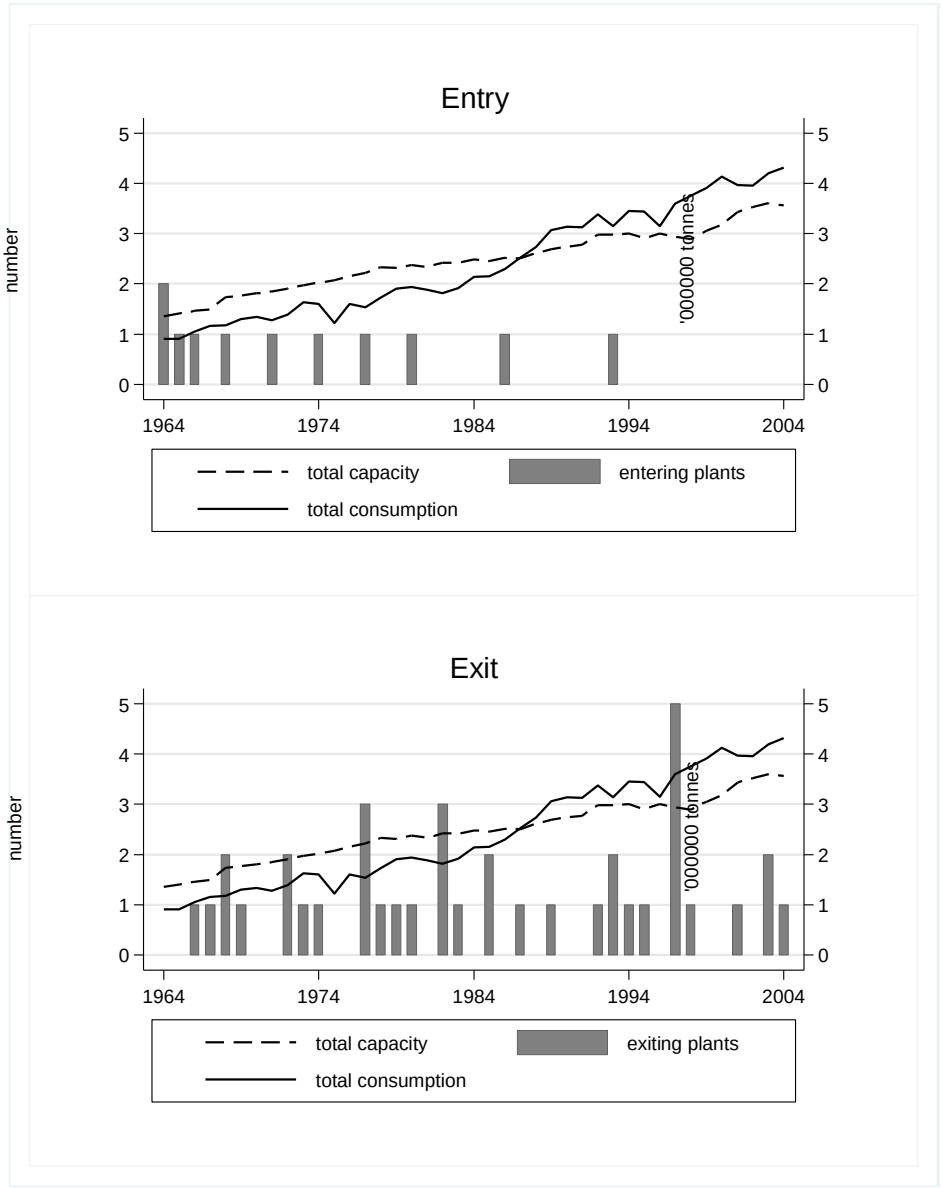

Figure 4.2: Number of plant entries and exits, 1964–2004

The nature of these demographic patterns is revealed more clearly when looked at in light of the evolution of market demand and supply. As shown in the first chart of Figure 4.2, plant entry occurred almost exclusively in the years when the industry's overall capacity (dashed line on the secondary y-axis) grew at a pace similar to domestic consumption (solid line on the

secondary y-axis). Conversely, when consumption began to be increasingly satisfied by import, no new plant was erected.

The higher frequency with which new plants were constructed until the late 1960s is not surprising. As explained in Appendix A, a paper mill is a specific-purpose facility that, if proven unprofitable, cannot be easily converted to another production. Moreover, construction of a new, efficient plant causes an abrupt considerable increase in the overall industry's capacity, which is likely to drive prices and profits down if it is not justified by a buoyant demand. Therefore, greenfield investment generally occurs when long-term demand prospects are looking up. As discussed in Appendix B, such circumstances characterised the 1950s and 1960s, when demand was growing at buoyant rates and domestic producers were shielded from foreign competition[10]. Most greenfield investment occurred during those decades. By 1974, however, demand growth had exhausted most of its drive and began fluctuating. With overcapacity in the industry (Figure B.3, Appendix B), installation of new plants was hardly an option.

Instead, lack of a positive association between plant entry and expanding capacity and consumption, which characterised the second half of the reference period, can be explained by the Government's liberalization policies introduced in the mid-1980s. To compete in an increasingly liberalized market, where Scandinavian producers enjoyed comparative advantages in production of commodity grades[11], Italian producers had to change their strategies from production of newspaper and magazine grades to value-added ones[12], which are generally produced in smaller quantities

[10] Due to technical characteristics of the software used for this figure, the growth dynamics of apparent consumption and capacity are not simple to recognize. Figure B.3 in Appendix B provides a clearer illustration of the evolution of apparent consumption, capacity and production.

[11] According to FAO figures, in 1984 the Italian production of newsprint, which is *par excellence* the commodity grade, was less than 5 per cent (207 thousand tonnes) of that of Finland, Norway and Sweden together (4,225 thousand tonnes). By contrast, in the same year, the Italian production of printing and writing grades corresponded to some 43 per cent (2,005 thousand tonnes) of the total of the three Scandinavian countries (4,602 thousand tonnes). This situation has remained substantially unchanged until today.

[12] An overview of the restructuring of the Italian industry in the 1980s can be found in PPI (1987) and Ferrari (1999).

and represent less attractive niches for larger foreign competitors. Such strategy was carried out by upgrading existing plants, rather than construction of new ones. That is why no new plants, except for one, were built in the last two decades.

Turning to exit, the second chart of Figure 4.2 above shows that shutting down operations occurred throughout the period, irrespective of the long-term trends of capacity and consumption. In principle, this pattern may reflect the natural weeding out of obsolete plants. If so, one would expect plants to be generally dismantled during downturns when profits are eroded due to depressed demand and high inventory stocks. However, data do not support a strong association of this kind.

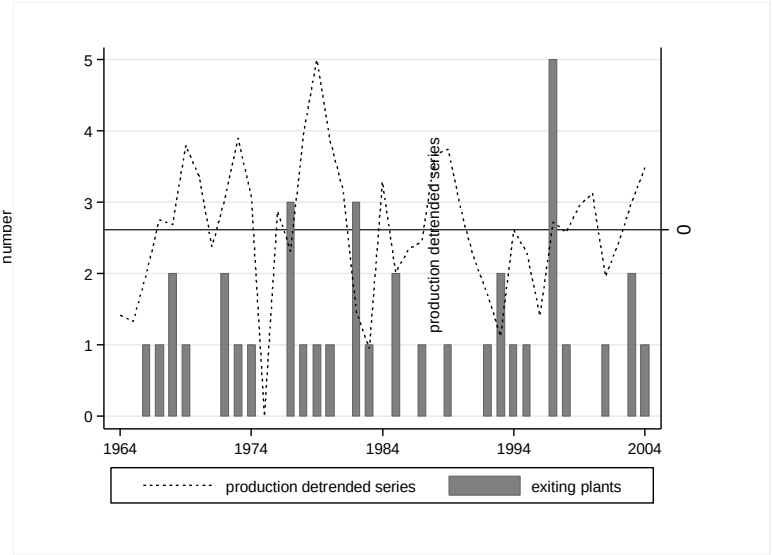

Figure 4.3: Plant exit and de-trended production, 1964-2004

Figure 4.3 shows the number of plant exits against the de-trended time series[13] of production of graphic paper. In principle, this figure is difficult to interpret because of the two-way causation between exit and downturns in production. Nevertheless, the general notion that plants are more likely to be shutdown during downturns is not confirmed. Exit occurred in significant numbers also during upturns when the market was a supplier market and papermakers used their machines even beyond the optimal operating rate to

[13] The de-trended series has been obtained by, first, regressing production on time *t* and, then, calculating the deviations of the observations from the trend.

satisfy orders. The data suggest that plant closure underlies a more complex decision where profitability considerations are likely to operate with time lags.

Finally, inter-sector mobility has been only a marginal phenomenon in the graphic papermaking industry. Of the 11 plants that entered the industry, only four were converted, partially or entirely, to graphic paper. Of the 38 plants that exited, only three converted production to non-graphic grades. With technological advances, paper machines have become increasingly more grade-specific equipment, making conversion to grades different from the original ones unprofitable.

4.3 Patterns of Enterprise Entry and Exit

Unlike plants, enterprises continued to enter and exit the industry throughout the entire period. From 1964 to 2004, 26 new enterprises entered and 52 exited. Again, the data do not indicate any significant evidence that entry of enterprises increased during upturns and exit during downturns. Moreover, entry and exit appear to be evenly spread across upturns and downturns of business cycles. Figure 4.4 illustrates entry and exit of enterprises against the de-trended times series of production and consumption.

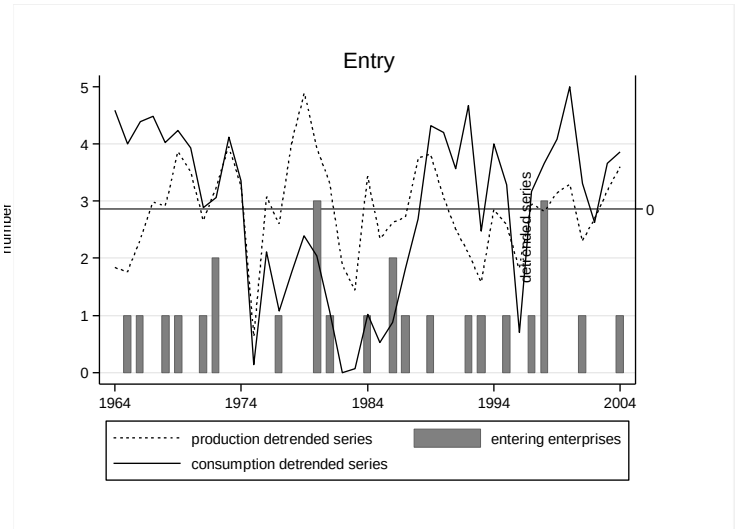

Figure 4.4: Enterprise entry and exit, 1964-2004

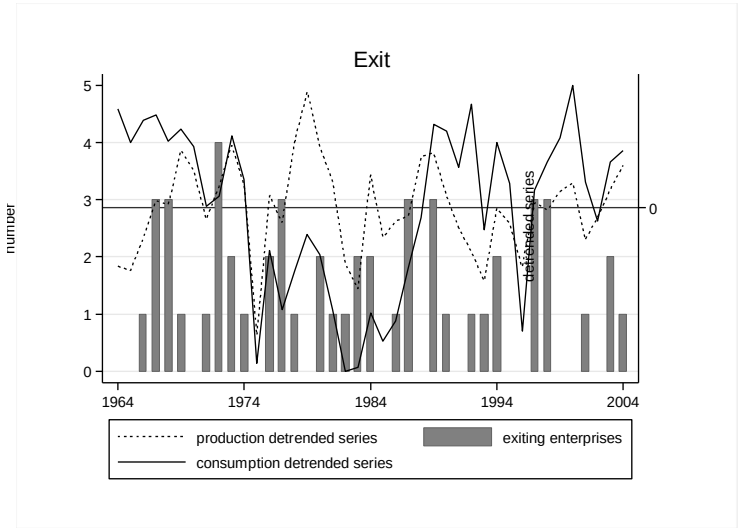

Figure 4.4: *Cont.*

However, interesting temporal patterns emerge when entry and exit flows are analysed in terms of the mode through which enterprises have appeared and disappeared from the market. Figure 4.5 shows the annual number of enterprises that have entered by plant construction (greenfield) and by plant acquisition as well as the annual number of enterprises that have exited by plant shutdown and plant sale.

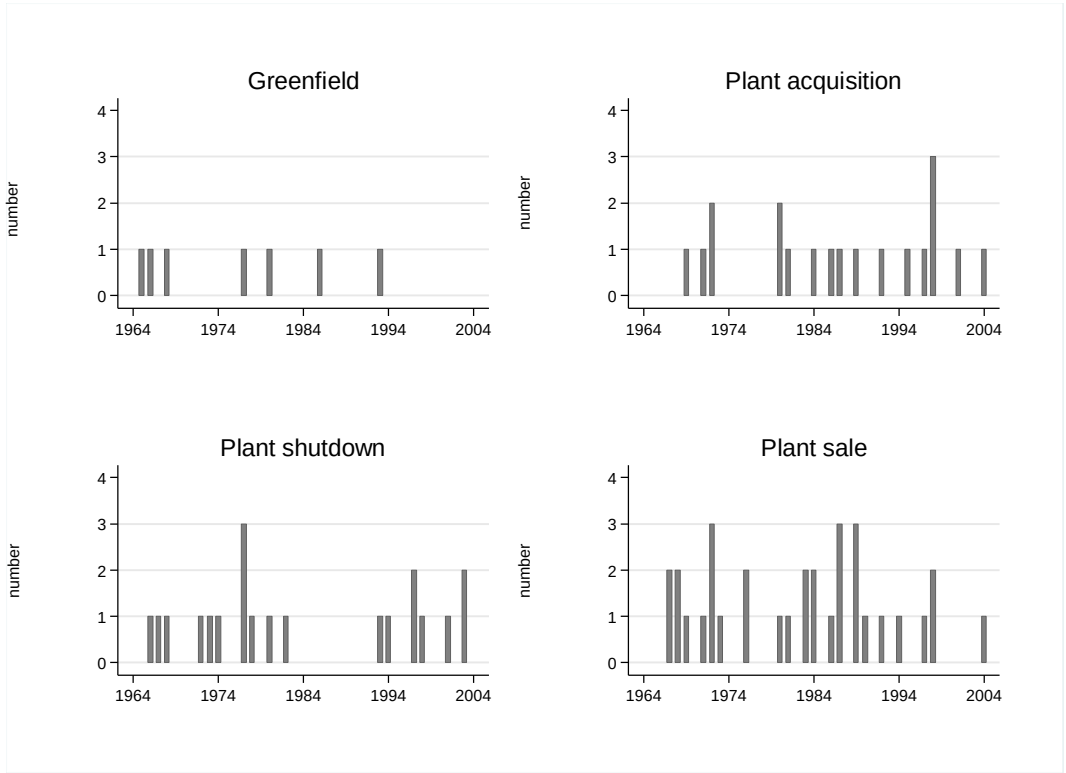

Figure 4.5: Enterprise entry and exit by mode, 1964-2004

Of 26 entries, seven were by plant construction and the remaining 19 plant acquisition. Of 52 exits, 20 were by plant shutdown and 32 plant sale.

Although relevant, greenfield entry and exit by plant shutdown do not account for the bulk of turbulence. Greenfield entry has been almost exclusively confined to the first phase of the development of the industry after the post-war recovery era. These dynamics appear to be consistent with the standard view of market evolution in the presence of economies of scale. In a situation of substantial balance between demand and overall capacity, would-be entrepreneurs are likely to refrain from entering competition by adding new capacity that, if the market cannot absorb it, would inevitably lead to overcapacity and, in turn, drive prices down.

The bulk of turbulence has been confined to the second half of the period under consideration, when entry by acquisition and exit by sale dominated market dynamics. With virtually no enterprise constituted through construction of new plants, 19 ones that wished to enter the industry had no alternative than to acquire existing plants. In the context of an industry, such as papermaking, where capacity is a strategic variable, these empirical regularities appear understandable. If the industry's capacity is comparable to long-term demand, the most appropriate strategy for an enterprise to expand is through acquisition of existing plants.

To summarise, the industry witnessed a progressive decline in the number of papermaking plants and enterprises. While the contraction in the population of plants resulted from halting construction of new establishments and shutting down existing ones, that of enterprises from continuously churning the population and changing the proprietary distribution of the industry's capacity. This leads to investigate determinants of closure at plant level (Chapter 5) and of survival at firm level (Chapter 6).

CHAPTER 3

WHAT MEASURE FOR THE FIRM?

3.1 Introduction

Analysis of market competition rests on the firm, as the economic entity that clusters all plants under common ownership. Although straightforward to define conceptually, its empirical counterpart is rarely available. Administrative and survey data generally collect data at the level of companies, that is, the smallest unit to which law attributes a legal personality. As a firm may consists of more than one legal unit, counting firms in terms of companies may lead to overestimation of demographic turbulence. As Baldwin and Gorecki (1989) stressed, "users of administrative and survey data have to proceed cautiously when they employ these sources for purposes that were not originally envisaged. This is especially the case when the appearance and disappearance of identification codes in these data bases are used to defined births and deaths. Identification codes can appear and disappear for …reasons none of which may satisfy the particular definition of entry and exit that the researcher has in mind" (p. 257).

Whether measurement discrepancies are an insidious feature is, ultimately, an empirical matter. In sectors dominated by micro- or small-scale operations, where enterprises are more likely to consist of only a legal unit, measurement discrepancies may not be an issue. However, in capital-intensive industries such as papermaking, intricate patterns of corporate ownership are likely to be the rule, suggesting that measurement biases may be relevant.

By and large, scholars have always been aware of the problems associated with the peculiarities of individual databases, and they have made corrections so as to exclude those entries and exits that they recognized as fictitious. But, detection of these cases has seldom been a documented routine

procedure. In fact, little[1] is known about the magnitude of these measurement biases. Although they are likely to differ across industries, countries and times, evidence of their existence and size would help to clarify the extent to which industrial turbulence is such an empirical regularity.

Drawing on the thesis' database that allows a clear distinction between enterprise and company, this chapter attempts to assess the magnitude of measurement biases in the Italian papermaking industry. The next section compares the time series for entry, exit, net entry and turbulence between the two proxies, Section 3 delves into companies' modes of demographic turnover and spurious turbulence[2] and Section 4 presents concluding remarks.

3.2 Enterprises vs. Companies

To assess measurement divergences in the Italian graphic paper industry, three aspects of entry and exit patterns have been considered: magnitude of entry and exit flows, correlation between entry and exit, and entrants' market penetration. These aspects are those on which the literature on firm turbulence has focused its main attention[3].

3.2.1 Magnitude and Correlations

Figures 3.1, 3.2, 3.3 and 3.4 illustrate entry, exit, net entry and turbulence flows of enterprises in comparison with those of companies. Tables D.5 and D.6 in Appendix D present the data in terms of numbers and rates. Net entry

[1] With a few exceptions, studies on firm entry and exit are rather vague about the statistical unit used. They refer to the generic term "firm". Therefore, it is difficult to gauge the relevance of measurement biases in their empirical findings. There are, however, few studies focusing on measurement biases. Johnson and Conway (1997) is a rare example of an analysis of the problems associated with the use of VAT registration data for the study of firm births. Another is a working paper by Jarmin *et al.* (2003) based on the US Census Bureau's Longitudinal Business Database.

[2] Spurious turbulence refers to that portion of turbulence that is regarded as irrelevant for the analysis of competition. Essentially, it encompasses the establishment and/or dissolution of companies for administrative/financial purposes, without ownership being changed.

[3] See Section 1.1.

is defined as the difference between entry and exit, whereas turbulence as the sum of entry and exit[4].

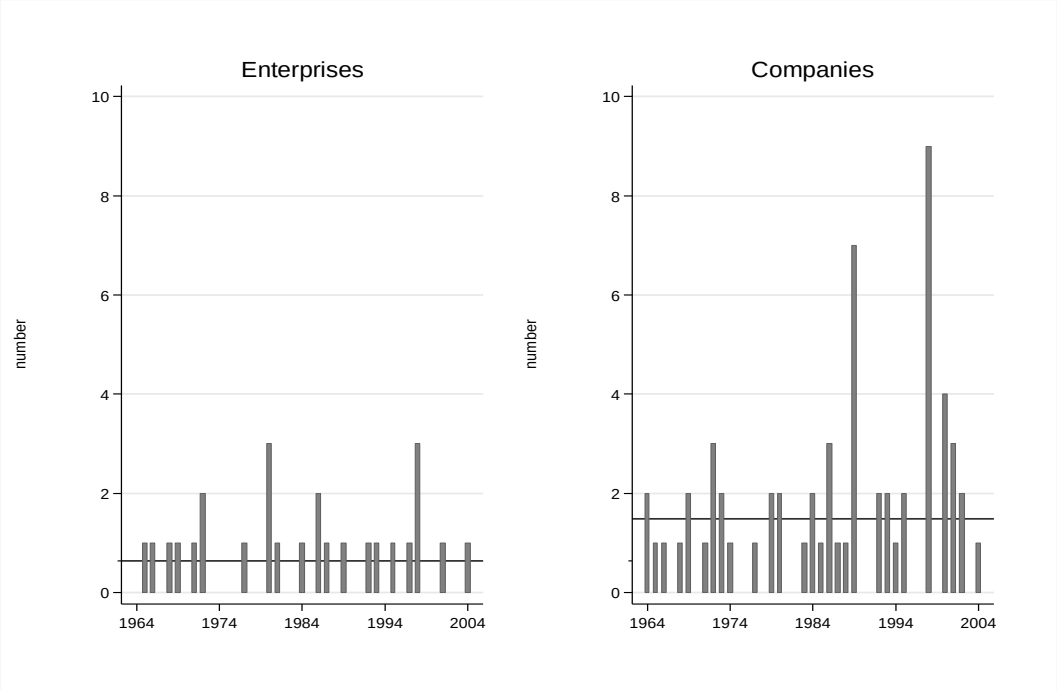

Figure 3.1: Entry in the Italian graphic paper industry, 1964-2004

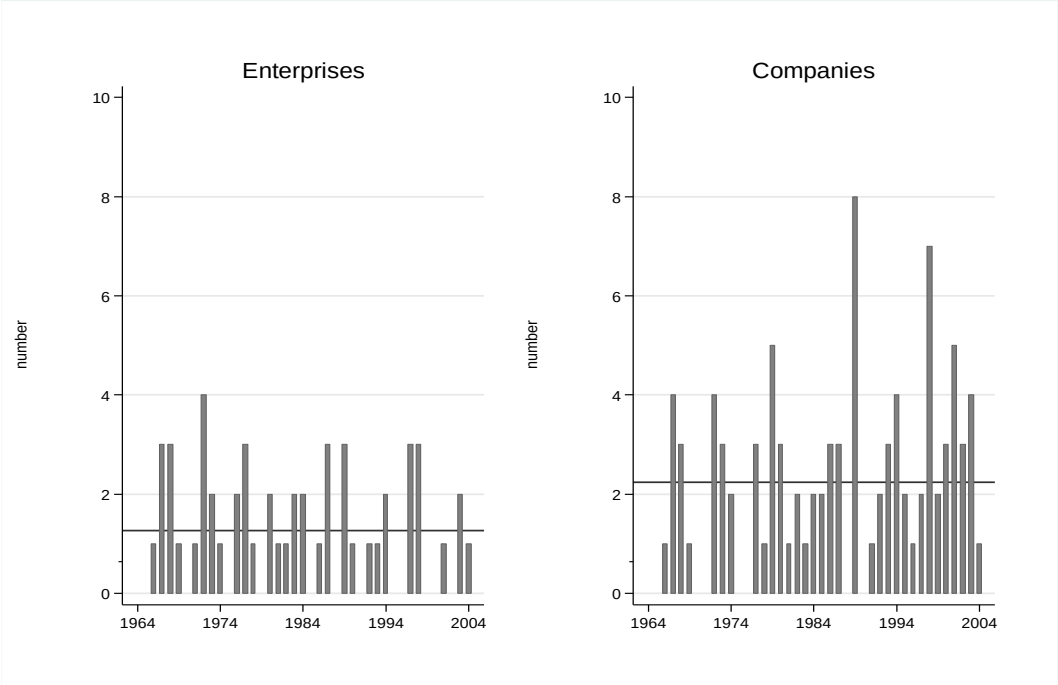

Figure 3.2: Exit in the Italian graphic paper industry, 1964-2004

[4] Sutton (1997) defines turbulence as the sum of gross entry and gross exit rates. Beesly and Hamilton (1984) proposed a similar measurement. They defined turbulence as the ratio of the sum of gross entry and exit to the initial stock of establishments in the industry.

The above figures show considerable differences in magnitude, though not in patterns[5]. Between 1964 and 2004, 61 new companies entered and 92 exited the industry. During the same period, only 26 new enterprises entered and 52 exited. The average annual number of entries and exits were 0.63 and 1.30 for enterprises and 1.49 and 2.24 for companies. The mean differences are statistically significant[6].

Consequently, industrial turbulence at company level was nearly twice that at enterprise level (Figure 3.3). Moreover, there were only four years when turbulence was zero, compared to 11 years of no turbulence at enterprise level. On average, the annual turbulence was 1.9 for enterprises and 3.7 for companies, the mean difference being statistically significant[7].

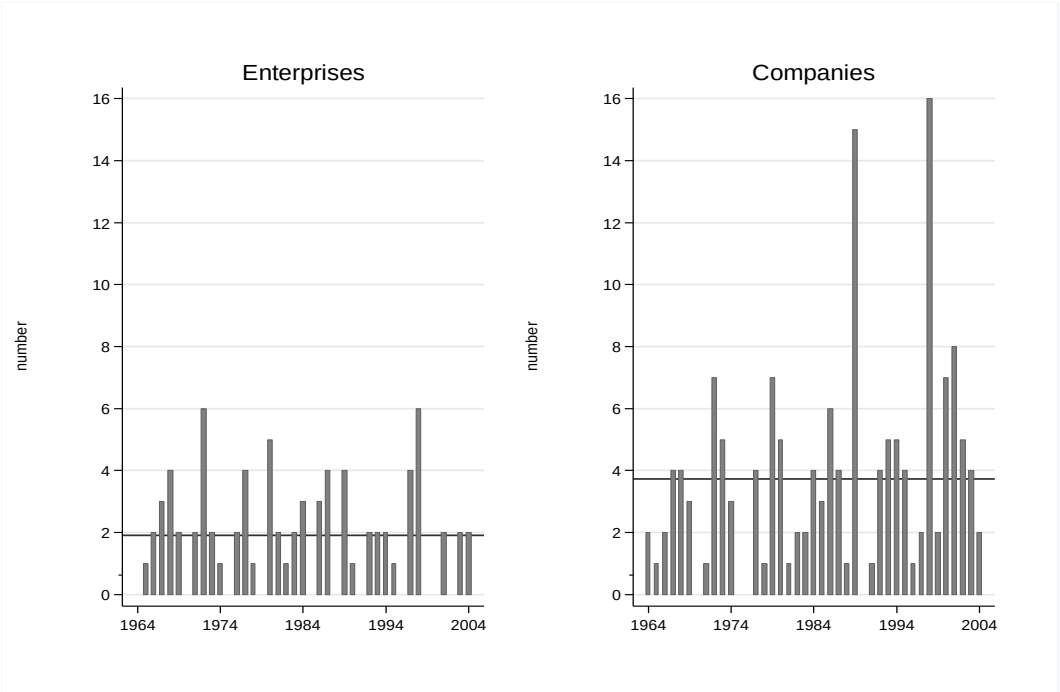

Figure 3.3: Turbulence in the Italian graphic paper industry, 1964-2004

By contrast, levels of net entry are remarkably similar for enterprises and companies. During the period, net entry mainly fluctuated between 1 and –2 both at enterprise and company levels (Figure 3.4). Over the period under

[5] The exceptions were 1989 and 1996 when companies' exit and turbulence peaked due to the demise of two major multi-company enterprises.
[6] The two-side mean comparison test for companies' and enterprises' mean is t(80)=-2.7351 p=0.0038 for entry and t(80)=-2.8249, p=0.003 for exit.
[7] The two-side mean comparison test is t(80)==-3.0611, p=0.0015.

consideration, annual average net entry was –0.63 for enterprises and –0.76 for companies, the mean difference being not statistically significant. As a result, decline in the number of existing companies nearly paralleled that of enterprises.

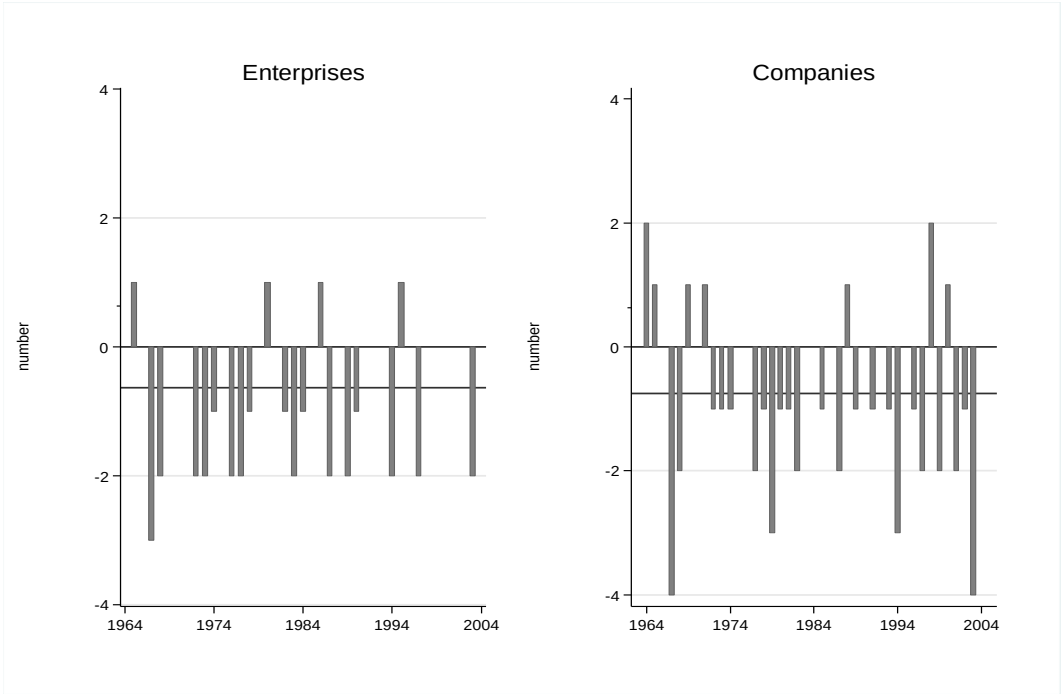

Figure 3.4: Net entry in the Italian graphic paper industry, 1964-2004

Similar results can be observed in terms of rates. As shown in Figures 3.5 and second chart of Figure 3.6 below, entry, exit and turbulence rates were nearly two thirds of the times higher at company than enterprise level. Over the entire period, the annual average rates of entry, exit and turbulence were 2.0 per cent, 3.8 and 5.9 for enterprises and 3.9 per cent, 5.8 and 9.8 for companies (Tables D.5 and D.6 in Appendix D). The test for mean differences rejects the null hypothesis of no difference between companies and enterprises.

In sharp contrast to these patterns is net entry. The substantial similarity between companies' and enterprises' net entry rates is reconfirmed (first chart of Figure 3.6). Between 1964 and 2004, the average annual rate was -2.0 per cent for enterprises and -2.1 for companies.

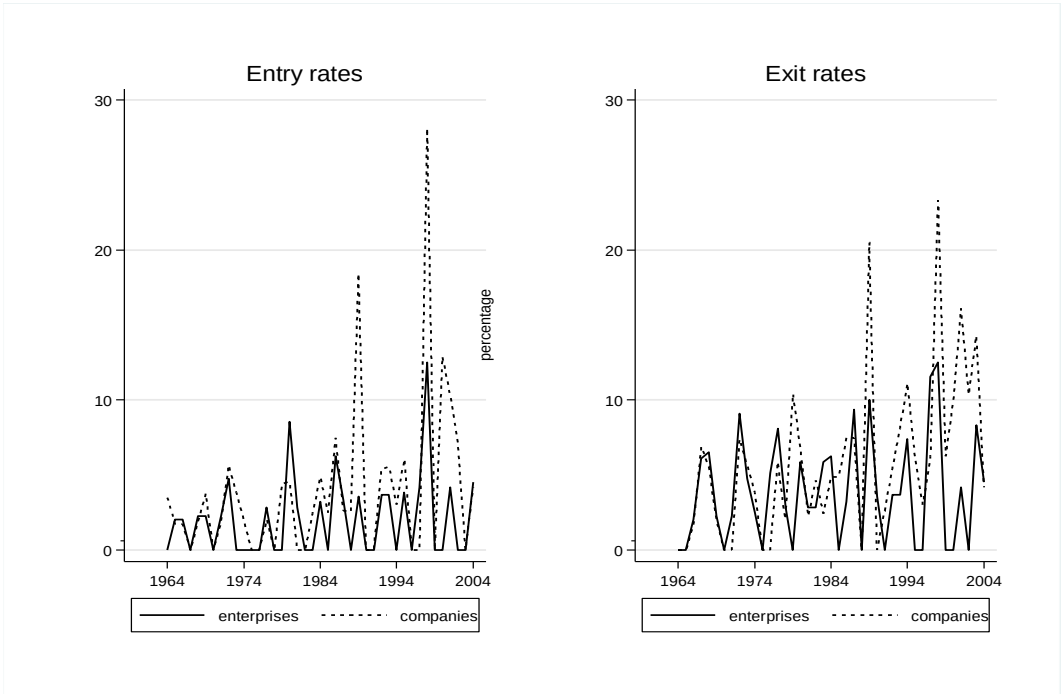

Figure 3.5: Entry and exit rates in the Italian graphic paper industry, 1964-2004

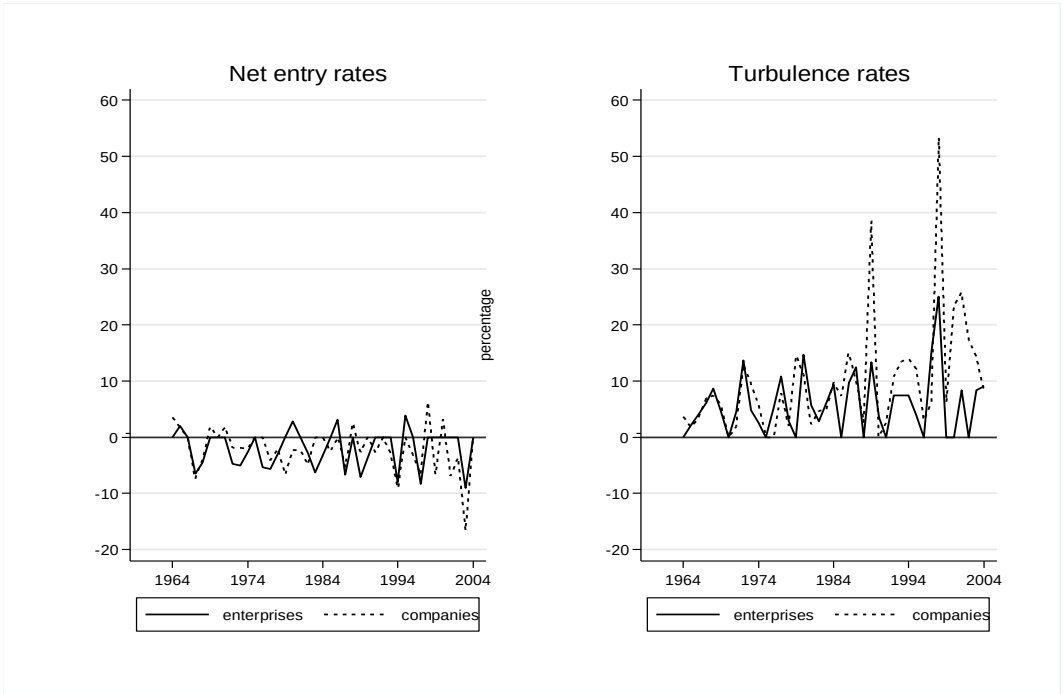

Figure 3.6: Net entry and turbulence rates in the Italian graphic paper industry, 1964-2004

As to the empirical evidence that entry and exit rates are generally correlated, the data confirm this and indicate, once again, that correlation is higher at company than enterprise level. The correlation coefficient between

entry and exit rates is 0.545 for enterprises and 0.783 for companies. Cross-correlation between entry and exit time series does not reveal any remarkable patterns.

Overall, these results appear to be in line with general findings, though turbulence in the Italian graphic paper industry appears to have been less pronounced. This is to be expected, since calculations at more aggregate ISIC levels include sectors more populated and less capital-intensive than papermaking and, therefore, more likely to have higher entry and exit flows. For the American paper industry[8], Dunne *et al*. (1988) report entry rates ranging from 7.0 to 52.0 per cent (31.4 per cent average) and exit rates from 14 and 43 per cent (29.9 per cent average) for the period 1963-1982. From the OECD study (2003) on firm demographics it can be inferred[9] that, between 1987 and 1993, annual average turbulence rate for sub-section DE (manufacture of pulp, paper and paper products, and publishing and printing) was some 14 per cent. This compares with 6.4 at enterprise level and 11.2 at company level for the Italian graphic paper industry during the same period.

3.2.2 Market Penetration

A common feature in industrial demographic patterns is that firms begin small. Consequently, the rate of entry penetration[10] is usually modest. Geroski (1995) reported rates between 1.45 per cent and 6.36 in the United Kingdom over the period 1974-79. Dunne *et al*. (1988) found that, between 1963 and 1982, overall market share of entrants into individual American four-digit industries ranged from 2.1 per cent (tobacco) to 26.4 (lumber). During the same period, American firms entering the paper industry

[8] As inferred from the study, the industry includes manufacture of pulp, paper and paper goods. As the capital investment for manufacture of paper goods (converting) is substantially lower than for papermaking, greater turbulence is to be expected for this segment. Consequently, entry and exit rates should be higher.

[9] The OECD study discusses major demographic developments, rather than trends specific to individual sectors at country level. However, in 2003 the study's database could be downloaded from www.oecd.org/eco/FirmLevelDataProject. The figures herewith reported have been calculated using the downloaded data file for Italy. At present, the study's database is no more available. OECD indicates that major statistical adjustments are ongoing.

[10] Entry penetration is defined as total capacity of entrant divided by total industry capacity.

accounted for some 10.7 per cent of the whole industry, whereas firms exiting accounted for 12.2 per cent.

Table 3.1 below records the average annual size—measured in terms of capacity—of existing enterprises and companies vis-à-vis the minimum and maximum size of entrants for each decades under consideration. In addition, it reports the minimum and maximum rates of entry penetration for each decade.

	ENTERPRISES				
	Existing	**Entering**			
	Average Size (tonnes)	**Individual size range** (tonnes)		**Market penetration rate** (%)	
		Minimum	Maximum	Minimum	Maximum
1964 - 1973	37,669	400	45,000	0.0274	3.1974
1974 - 1983	64,446	1,000	91,000	0.0676	3.8958
1984 - 1993	92,967	1,000	185,000	0.0335	6.8775
1994 - 2003	130,379	1,000	250,000	0.0340	8.9640
2004	162,015	40,000	40,000	1.1222	1.1222
	COMPANIES				
	Existing	**Entering**			
	Average Size (tonnes)	**Individual size range** (tonnes)		**Market penetration rate** (%)	
		Minimum	Maximum	Minimum	Maximum
1964 - 1973	30,988	400	85,000	0.0274	3.1974
1974 - 1983	49,403	120	18,000	0.1089	0.7999
1984 - 1993	69,903	1,000	185,000	0.0399	26.9153
1994 - 2003	106,004	120	1,835,000	1.6311	54.2623
2004	148,513	40,000	40,000	1.1222	1.1222

Table 3.1: Entry of enterprises and companies by size, 1964-2004

By and large, the Italian graphic paper industry exhibited low rates of market penetration, except for the decades 1984-1993 and 1994-2004 when penetration rates at company level were high as result two major waves of corporate restructuring within firms of considerable size. More importantly, rates were generally lower for enterprises than companies, confirming once

again that the use of companies, rather than enterprises, would have led to overestimation.

3.2.3 Temporal Dynamics

The previous sections have highlighted that use of the company as unit of analysis leads to overestimation of industrial turbulence. But how dissimilar are temporal behaviours of demographic turnover between enterprises and companies? Figure 3.7 illustrates the temporal dynamics of entry, exit and turbulence for enterprises and companies.

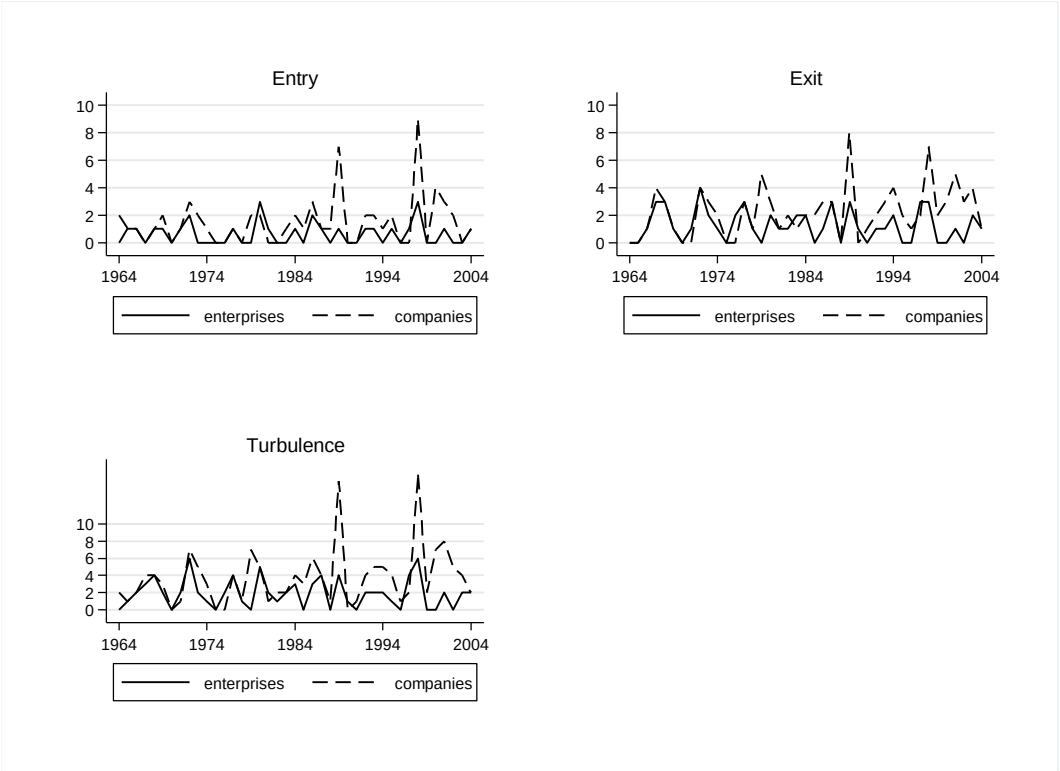

Figure 3.7: Entry, exit and turbulence time series, 1964-2004

At first glance, the times series of entry, exit and turbulence appear to follow similar temporal patterns, though with differences in levels. The augmented Dickley-Fuller test does not reject the null hypothesis that the variables exhibit a unit root at all common significance levels, confirming that all series, both at enterprise and company levels, are stationary. Furthermore, Barlett's

test statistics[11] does not reject the null hypothesis that entry, exit and turbulence time series are white noise processes. At enterprise level, Barlett's statistics has a p-value of 0.247 for entry, 0.284 for exit, 0.272 for net entry and 0.283 for turbulence. At company level, Barlett's statistic has a p-value of 0.632 for entry, 0.998 for exit, 0.875 for net entry and 0.987 for turbulence. So, it appears that, regardless of whether measured in terms of enterprise or companies, the temporal behaviour of firm entry, exit and turbulence appear to share similar stochastic processes.

3.3 Companies' Entry and Exit Modes

In short, data suggest that using the company as a proxy for the firm significantly overestimates the scale of industrial turbulence, though not its temporal behaviour. Why is turbulence more pronounced at company level? The answer lies in the modes through which companies are founded and dissolved.

3.3.1 Basic Modes of Entry and Exit

Conceptually, a firm enters an industry by constructing a new plant (greenfield entry) or acquiring an existing one from an incumbent or exiting competitor (entry by acquisition). As a mirror image, a firm exits by shutting down its plant (exit by shutdown) or selling it to an entering competitor or incumbent (exit by sale)[12].

These four modes apply at enterprise and company levels. But, companies may also appear or disappear due to mere administrative or financial

[11] Bartlett's periodogram-based test is a test of the null hypothesis that the data come from a white-noise process of uncorrelated random variables having a constant mean and a constant variance. In STATA 11, it is performed through the command *wntestb*.

[12] In principle, firms may enter and exit by a mixture of the two modes. However, this strategy is generally rare. On one hand, firms tend to enter as single-plant, and when they do not do so, they generally acquire a number of plants, avoiding being simultaneously involved in the construction of new establishments. On the other hand, exiting firms are likely, first, to divest their profitable plants and, then, to close down their unprofitable operations. Because of this temporal sequence, dissolution of firms rarely occurs by a mixture of plant sales and shutdowns.

reasons. As businesses grow in size and complexity, it is customary for a business to restructure, administratively, its organisation by rearranging the configuration of its legal units. Consequently, new companies might be set up and/or others dissolved. Furthermore, as property is handed from generation to generation within a family, old companies are closed and new opened to reflect the transfer of property titles within the family group.

The more intricate the patterns of corporate ownership are, the greater the potential for spurious turbulence[13] is. As Scherer (1990) noted, surprisingly low aggregate industrial concentration levels are often linked to patterns of corporate engineering where intricate inter-corporate ties are disguised through a myriad of ostensibly separate companies. In those contexts, foundation or dissolution of companies for legal or administrative purposes is likely to be more frequent.

To account for spurious turbulence, the thesis adds two new modes at company level: entry and exit by reorganization. Entry by reorganisation is defined as foundation of a new company while the set of plants under common ownership and the owner remain the same. Similarly, an exit by reorganization is dissolution of a company while concerned assets, which continue to belong to the same owner, are transferred to another company, either new or existing.

3.3.2 Spurious Turbulence

Tables D.8 and D.9 in Appendix D report entry and exit flows of enterprises and companies by mode. Figure 3.8 below illustrates the evolution of overall entry and exit of companies (grey bars) against total market entry by reorganization (black circles). The distance between the height of the bar and the circles represents the amount of real[14] entry or exit.

[13] For a definition of spurious turbulence, see footnote 2 of this chapter.

[14] Real entry(exit) is defined at the sum of entry by construction and acquisition(exit by shutdown and sale). Spurious entry(exit) coincides with entry(exit) by reorganization. Total entry(exit) is the sum of real and spurious entry(exit).

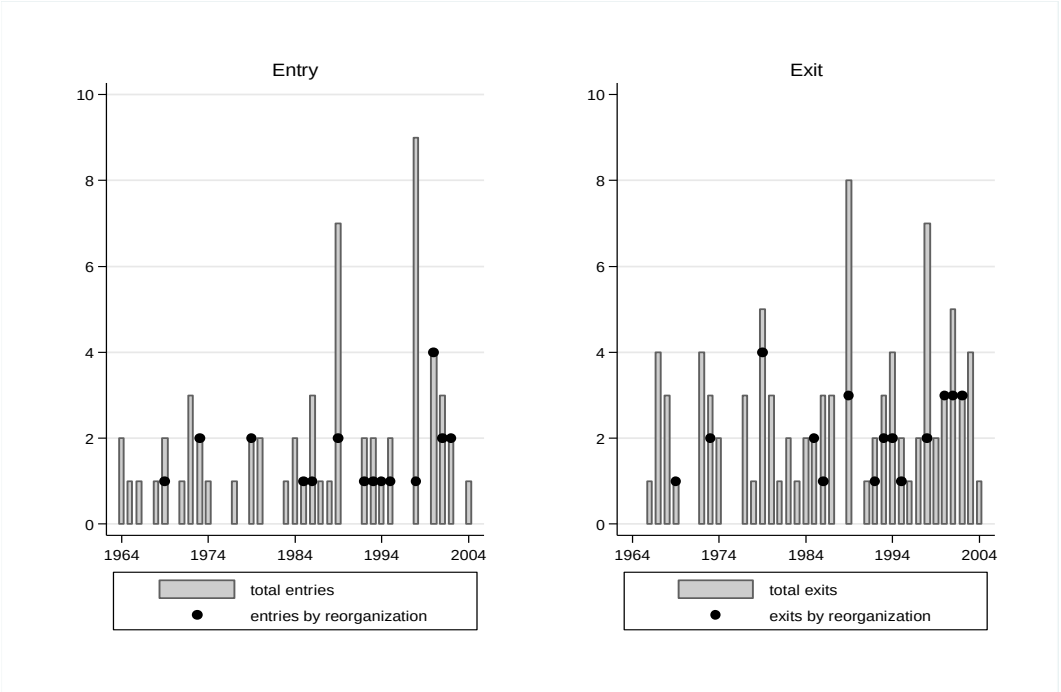

Figure 3.8: Entry and exit of companies by mode

Between 1964 and 2004, 61 new companies were founded, ten by opening new plants, 29 by acquiring existing ones and 22 by reorganisation of their legal or administrative structure. During the same period, 92 companies were dissolved, 23 by shutting down plants, 29 by divestiture of existing capacity and 40 by reorganisation[15] (Table D.9 in Appendix D). Total and real entry coincided 26 times during the period, whereas 19 times for total and real exit. The overall correlation coefficient between companies' gross entry and exit is 0.71, which reflects virtually zero correlation between greenfield entry and exit by plant shutdown, high correlation between entry by acquisition and exit by sale (0.782) and between entry and exit by reorganisation (0.803).

The data show that spurious entries and exits contributed some 40 per cent to overall turbulence at company level in the period considered. Moreover, spurious entries and exits explain the relatively modest correlation of total entry and exit flows between companies and enterprises (0.569 and 0.518,

[15] During the same period, 26 new enterprises entered the industry, of which 7 by plant construction and 19 by acquisition. Meanwhile, 52 firms exited, of which 20 by plant shutdown and 32 by plant sale.

respectively)[16]. While companies' real entry and exit flows have mostly mirrored that of enterprises[17], entry and exit by reorganization followed their own patterns, altering the correspondence between companies' and enterprises' time series.

3.3.3 Should Spurious Entry and Exit Be Dismissed?

Which modes to include or exclude from measurement of entry and exit is arbitrary, since it depends on the objectives of the specific research. As noted in Chapter 2, Bain (1956) limits his analysis to greenfield entry and exit by plant shutdown, since these two events affect both the industry's population as well as its size. Other scholars include entry by plant acquisition and exit by plant sale, which has an impact on the industry's population. By contrast, there is substantial agreement among scholars that entry and exit by reorganisation should be disregarded, as they are considered no more than administrative contrivances. They affect neither the industry's population nor its size. In this respect, the *Eurostat-OECD Manual on Business Demography Statistics* states that re-structure within the firm, "does not involve a significant change in the total production factors within the economy, and does not, therefore, result in any births or deaths. It may [however] involve the creation and/or deletion of one or more [company] references on the (life) business register" (2007, p.29).

In the literature, the answer to the question whether entry and exit by reorganisation should be excluded is positive. Nevertheless, the question that remains is how data on companies' demographics can be adjusted to omit spurious entries and exits. A suggestion could be to exclude entry and exit by reorganisation from the total[18]. Unfortunately, this practice is problematic

[16] In principle, correlations coefficients are not calculated for time series because of observations are potentially time dependent. However, the tests for stationarity described in section 3.2.3 do not reject the null hypothesis of a white nose process.

[17] The correlation coefficients between companies' and enterprises' flows are 0.710 for greenfield entry, 0.753 for plant acquisition, 0.935 for plant shutdown and 0.795 for plant sale.

[18] This procedure is comparable to the recommended practice of excluding all entries and exits that are recognized as the result of legal and administrative contrivances from the original data (Scherer, 2001).

because spurious turbulence also affects the number of existing legal entities at any point in time, hampering calculation of demographic rates. An example clarifies the point. Suppose that at time *t* a family group owns three separate independent legal units and, subsequently, at time *t+1*, the same family group decides to dissolve them and transfer the physical assets to a new company. Under these circumstances, the business register would record three exits and one entry by reorganisation. If entries and exits by reorganisation were to be omitted, then, the decrease by two units in the total number of existing legal entities between times *t* and *t+1* could not be accounted for. The problem of measuring firm turbulence by using administrative records, which cannot be systematically adjusted to omit spurious entries and exits, becomes relevant.

But, should turbulence by reorganisation be dismissed altogether, as irrelevant in economic terms? One can object that this empirical evidence may be confined to the specific sector under consideration and/or to Italy. Even so, this evidence should not be underestimated. Firms often undertake corporate reorganisations in order to take advantage of administrative, financial or tax incentives. Therefore, high levels of spurious entries and exits may indicate that institutional factors or firm-specific strategies are at work. Government policies, legislation and fiscal regulations affect the convenience of firms to opt for one or another corporate structure. Similarly, the entrepreneurial culture of a country or a firm determines whether it operates as a consolidated entity or a myriad of purportedly separate companies. Although corporate engineering does not change the population of firms and the industry's capacity, it should not be neglected because it reflects a firm's strategy for survival. This reflection is further developed in the analysis of plant closure (Chapter 5).

Scholars generally exclude from the original data all exits that are recognized as the result of legal and administrative contrivances.

3.4 Implications

There seems little doubt that the use of companies as the basic observation unit in administrative sources is inappropriate. In this chapter, I have demonstrated that the choice of the observation unit for measuring demographic turnover at firm level is not neutral. It has significant impact on several key statistics. In the context of the graphic paper industry between 1964 and 2004, use of company as a statistical unit leads to substantial overestimation of demographic turnover. The amount of entry, exit and turbulence is doubled, if not greater. Rates of market penetration are also higher, overestimating the contribution of entry and exit in churning the population. Spurious turbulence accounts for some 40 per cent of total turbulence among companies and contributes considerably to maintaining a high correlation between entry and exit rates. Yet, the stochastic processes underlining demographic turnover are similar for companies and firms.

For future research, these findings imply that special care needs to be used for treatment of administrative data and more detailed explanations on methodology used to correct such data needs to be included in exposition of research findings. Moreover, they suggest that administrative databases should be organized in such a way to provide data at enterprise and enterprise group level. Eurostat and OECD are moving in this direction, but compilation of such databases increases data requirements and calls for substantial changes in national systems of data collection. Although these methodological improvements are likely to be achieved in the future, statistical data for past decades are likely to remain affected by these weaknesses.

CHAPTER 5

PLANT EXIT

5.1 Introduction

The previous chapter described how the market structure of the Italian graphic paper industry rationalised by steadily closing plants, with few new ones constructed. This scenario begs the question of what determines plant exit.

In capital-intensive industries—where additions to capacity occur primarily in large lumps, are costly and require time to be installed—productivity and, in turn, profitability of a plant is determined by efficiency and suitability of its equipment. Although plant technological characteristics are crucial in affecting exit, they may be other factors. Inter-firm rivalry, differences in efficiency of closing and relocating assets from one industry into another may accelerate or retard exit. These considerations have induced scholars to include plants' and firms' characteristics in regressions of plant exit.

But, another aspect which might be relevant is proprietary changes. This has attracted less attention, though it is a widespread phenomenon. Before being shutdown, plants often have a considerable history of being acquired and sold to new or incumbent firms. Lichtenberg and Siegel (1987) mentioned that, of some 18,000 plants throughout the United States manufacturing sector, some 21 per cent underwent changes of ownership at least once between 1972 and 1981. In the case of the Italian graphic papermaking, plant acquisition became the most preferred growth strategy for papermaking firms from the mid-1980s. Nearly 31 per cent of the plants changed ownership at least once during their last ten years of operations, and more than 42 per cent in the last 25 years.

Most scholars are of the opinion that organisational changes are irrelevant for the study of turbulence because they do not change industry's total capacity or the competitive scene. But, an opposing view is slowly emerging (Caves,

1998). It is based on empirical evidence[1] about the positive impact of ownership changes on plants' productivity. This evidence suggests that, if an acquisition proves to be a mutually beneficial match between an acquired plant and the acquiring firm, a plant's chances of survival increase. If acquisition is intended to reduce overall capacity in the industry, then, chances worsen.

This chapter estimates the probability of plant exit as a function of three sets of factors: plant characteristics, firm attributes and plant organisational history. The next section reviews theoretical foundations and empirical evidence. Section 3 details data and variables and Section 4 presents descriptive statistics. Section 5 describes the results of multivariate logistical regressions. Implications and concluding remarks constitute Section 6.

5.2 Modelling Exit

In the existing economic literature of entry and exit, there are no models of plant survival as such. Instead, there are models of firm exit from which theoretical predictions of plant exit are derived. It is the firm that decides whether to maintain and, possibly, upgrade a plant or shut it down. Hence, empirical work on turnover of plants and firms inevitably shares similar theoretical foundations.

The decision to exit is essentially a choice between the profitability of exiting now and exiting at some future date. At any point in time, an incumbent firm compares the expected present discounted value from operations to the opportunity cost of remaining in the industry. If the latter is larger, the firm exits, foregoing current net profits and potential future earnings in the industry. If not, it continues, collects current net profits and retains the option of further activity in the industry. Within this conceptual frame, several models have

[1] Noteworthy studies on productivity and change in ownership include Lichtenberg and Siegel (1987), Jensen *et al.* (2001), McGuckin and Nguyen (1995a) and Ravenscraft and Scherer (1987).

been developed, depending on assumptions about costs, information available to firms, industry structure and demand.

5.2.1 Competitive Models of Industry Selection

In a perfectly competitive industry with complete information, traditional theory on investment decisions predicts that the least efficient plants will close first. With efficiency commonly approximated by size, this prediction implies that larger plants are more likely to survive.

This Darwinian selection of the fittest can also be expected to prevail in less restrictive settings. By assuming that firms discover their true efficiency after entry (models of Bayesian passive learning) or improve their performance while producing (models of active exploration or active learning)[2], these models predict that efficient firms grow and survive, while inefficient ones decline and, eventually, leave. Regardless of the learning process, these competitive models of industry selection with incomplete information provide theoretical support to entry, growth and exit behaviours that are broadly consistent with the empirical evidence that the probability of survival increase with size and age. However, the nature of these assumptions about the process by which firms learn about their true costs is not neutral. It has important implications for the set of state variables used in regressions of probability of exit. Pakes and Ericson demonstrated that "the active learning model implie[s] that the stochastic process generating the sales of surviving firms [is] ergodic[3]…, while [the] passive learning model implie[s] that the conditional distribution of future sales would be positively related to initial sales, no matter the time that elapsed in the interim" (1998, p.37). That is, current size would depend only on current attributes in the active learning

[2] The models of passive learning include Jovanovic (1982), Lippman and Rumelt (1982) and Hopenhayn (1992), whereas those of active exploration Ericson and Pakes (1995) and Pakes and Ericson (1998). The latter study provides a comparison between the two classes of models.

[3] As explained by Ericson and Pakes (1995) and Pakes and Ericson (1998), exhibiting ergodic characteristics mean that the effect of being in a given state in a particular period erodes away as time lapses from that period.

models and on current and initial characteristics in the passive learning models.

To provide some empirical evidence, Pakes and Ericson (1998) tested these predictions on a panel of Wisconsin firms for the period 1978-1986. The authors found that the expected current size of manufacturing firms was weakly increasing in initial size, but strictly increasing only in retail trade. These results suggest a selection process of active exploration for the former sector and of passive learning for the latter. In addition, Baldwin and Rafiquzzaman (1995) found that both processes were at work in the Canadian manufacturing sector during the period 1971-1989. However, passive learning appeared a more important contributor to the overall growth of a cohort. Audretsch (1995), Dunne *et al*. (2005), Klepper (2002), Mata *et al*. (1995) and Thompson (2005) provide further empirical evidence of the effects of firm's initial size or founder's experience prior to entry on the current size and survival. As these two learning processes are not mutually exclusive (Caves, 1998), they may occur contemporaneously or one may be more prominent than the other in certain industries or stage of the industry life cycle.

5.2.2 Oligopolistic Models of Industry Selection

The prediction of a positive relationship between size and survival could be reversed under specific oligopolistic conditions. The argument is that strategic interaction among competitors may affect the profitability of waiting for rivals to exit, leading, therefore, to situations where higher-cost plants survive lower-cost ones. Assuming size heterogeneity among producers, identical unit costs, inflexible scale of operations and monotonically declining demand, Ghemawat and Nalebuff (1985) proved the existence of a unique perfect equilibrium in which the largest firm is the first to leave as soon as its profits turn negative due to shrinking demand. The intuition behind this is that, because of the impossibility to reduce capacity incrementally, a larger firm can operate as a profitable monopolist for shorter periods than a small firm can do. Recognising this advantage, a larger firm exits first. Extended to allow incremental

divestment, the model predicts that large firms are the first to reduce capacity and would do so until their size becomes comparable to that of smaller rivals[4].

However, it seems that there is no natural generalisation of these basic predictions. By using an extension of Ghemawat and Nalebuff's model, Whinston (1988) analysed the equilibrium in a declining industry where firms have multi-plant operations. In this setting, the author demonstrates that there is no simple prediction based on plant size. Patterns of divestment and exit depend upon a multitude of aspects of industry structure and market decline. For example, Whinston's model reveals that, under some circumstances, "making one of its plants larger than that of its single-plant rival may improve the multi-plant firm's strategic position compared with having two plants that are each smaller than its rival's plant" (p. 570).

Moreover, the simple rule of the largest exiting first is also not confirmed by models of war of attrition. An example of this strand of the literature is the duopoly model by Fudenberg and Tirole (1986), in which neither firm knows the fixed cost of its rival but has prior beliefs regarding it. Under the assumption of an arbitrarily small probability that both firms may be profitable as duopolists, the authors demonstrate that high-cost firms leave earlier than low-cost ones. As suggested by the authors, fixed costs should be interpreted as the operating cost that a firm must incur to be in the industry plus the opportunity cost of profits forgone in alternative ventures.

It is sufficient to assume differences in the way firms evaluate their opportunity costs (Baden-Fuller, 1989) for contemplating the eventuality that a firm with better access to financial resources or more opportunities for diversification may leave first. Empirical work on declining industries[5], as well as recent

[4] The basic conclusion that larger firms exit first holds true also in situations of demand expansion and possible re-entry. For some parameter configurations, Londregan (1990) proves that, in the presence of substantial start-up costs, a higher-cost firm can exploit its commitment and pre-empt its lower-cost rival.

[5] The literature includes the case studies by Anderson *et al*. (1998), Baden-Fuller (1989), Deily (1991), Gullstrand (2005), Lieberman (1990), Klepper and Simons (2000), and Olley and Pakes (1996). Both Caves (1998) and Sutton (1997) provide overviews of empirical findings on plant and firm exit in declining industries.

longitudinal studies for the manufacturing sector[6], generally confirms a mild influence of firms' attributes. Being owned by a large, multi-unit, multinational or diversified firm seems to increase the chances of exit, though these effects are weaker and less systematic than plant characteristics such as size, age, product specialisation and labour productivity.

Turning to the papermaking industry, it is expected that technological factors will play a crucial role in determining plant closure. Maintaining inefficient plants in operation is costly. It is more convenient to shut them down. But, the possibility that parent firms' structural features alter the timing of closure of their plant(s) cannot be ruled out.

5.2.3 Organisational Changes

By and large, models of industry selection assume that a firm's decision to close a plant is between two alternatives: either to continue operations and, possibly, upgrade equipment or to exit by shutting down. Selling off assets during firm's lifetime or at exit is not considered. But, these sell-offs are responsible for much of firm turbulence and, as it appears, productivity improvements. The recent literature on ownership changes and productivity[7] has highlighted a positive relationship between the two. In particular, McGuckin and Nguyen (1995) found that ownership changes could improve the performance of large, but less productive, plants or boost smaller operations with above-average levels of productivity. Using an unbalanced panel of more than 28,000 American manufacturing plants from 1977 to 1987, the authors found that, "First,… plants with high productivity were the most likely to experience ownership change. Second, plants that experienced ownership change improved their productivity 5-9 years after being acquired. Finally, for large plants, those having 250 workers or more, firms tend to

[6] Examples of studies of plant exit from the manufacturing sector as a whole or subsets are in Bernard and Jensen (2007), Colombo and Delmastro (2000), Disney *et al.* (2003), Dunne *et al.* (2005), Harris and Hassaszadeh (2002), Persson (2004) and Tveterås and Eide (2000).

[7] Caves (1998) provides an overview of the literature on entry and exit through control changes, which includes the studies by Ravenscraft and Scherer (1987), Lichtenberg and Siegel (1987), Baldwin (1995) and McGuckin and Nguyen (1995).

acquire plants with low productivity rather than those with high productivity" (p. 272-73). The second finding is consistent with the results of Lichtenberg and Siegel (1987) and Baldwin (1991), who found that, generally, transferred plants experienced significant increases in productivity.

This empirical evidence suggests that ownership changes may alter the chances of survival of a plant in ways different from those expected, had the plant not been transferred. The explanation lies in the logic of match-making where the overall performance of the match is conditional on the quality of integration among its once separate assets. To clarify the point, assume that a plant has not changed hands for some time. This could be either because profitability of the plant is so low and beyond rescue that no other firm is interested in buying it, or the parent firm is managing the plant effectively. In either case, the plant's survival prospects remain the same because no change has occurred in the parent firm's asset configuration. Therefore, the probability of exit continues to depend on the plant's characteristics and parent firm's attributes.

However, if a plant was transferred to another firm, this implies that the acquiring firm had placed a higher value on the acquired plant than the selling firm, presumably because the acquiring firm is in a better position to exploit opportunities of economies of scale or scope[8]. If the match proves to be mutually beneficial[9], the acquired plant is likely to improve its productivity because managed by a more able owner and/or integrated into a different asset configuration that offers greater synergies. Consequently, the plant's chances of survival are now better than they would have been, had it remained within the selling firm. If the match proves to be unsatisfactory at a point in the future, the acquiring firm will soon try to relinquish control. As long

[8] McGuckin and Nguyen (1995) pointed out that the reason for divergence in values is not necessarily due to poorly performing sellers. The authors noted, "there are many motives for acquisition that are compatible with obtaining good performing plants: monopoly power, synergies, and tax incentives are all reasons that do not require purchase of low productivity plants". (p. 260)

[9] The fact that matches might undergo further ownership changes does not affect the conclusions. As long as a plant maintains a certain strategic value for at least some competitors, it will continue to be transferred until a suitable match is found.

as the transferred plant continues to be regarded by competitors as a desirable asset, it will be reshuffled among competitors postponing closure.

In the case of a particularly worthless acquisition, prospects of survival will be likewise altered. Closure may be postponed because some time will elapse before the acquiring firm becomes aware of the actual efficiency of the acquired plant[10]. But, an opposite effect could also be possible. To destroy capacity, an acquiring firm may wind down the acquired plant's operations faster than the selling firm would have ever done, had it not been able to sell the plant. Consequently, the plant's survival prospects would plummet to levels much lower than they would have been, had the plant not changed hands.

As Bernard and Jensen (2007) noted, the motivations behind an acquisition range from exploitation of synergies to destruction of production capacity. Therefore, as long as profitability of a plant is influenced, *inter alia*, by its integration with other assets under the same ownership, a change in control is likely to alter the plant's subsequent prospects of survival, at least in levels, if not in dynamics.

A similar line of reasoning could also be applied to a firm's decision to transfer plants from one to another of its registered companies (registration changes[11]). Firms frequently modify their organisational structures by dissolving and founding new registered companies as well as reshuffling plants among their registered companies. This practice is usually considered irrelevant for the study of entry and exit because it does not affect the

[10] Unless the result of an evaluation mistake or in the presence of specific government subsidies for industrial restructuring or taxation incentives, it is irrational to acquire unproductive operations, even if the aim is to destroy capacity. In fact, there is no advantage in purchasing an inefficient plant in order to shut it down soon after. In addition, evaluation mistakes are very unlikely in papermaking since the efficiency of plants, especially paper machines, are, to a large extent, common knowledge.

[11] Ownership change occurs when a plant has changed parent firm, regardless of whether its parent registered company has changed or not. By contrast, a registration change means that a plant has been transferred to a different parent registered company. This event may or may not be concomitant with an ownership change. Throughout the chapter, ownership and registration changes are broadly referred to as organisational changes.

configuration of the industrial population. However, firms decide to modify their organisational structure in order to take advantage of administrative, financial or tax incentives. If successful, such restructuring enables firms to grow, improving the survival prospects of their plants. Like in the case of ownership changes, inclusion of registration histories may contribute to explain plant exit.

Empirically, little is known. The scarce empirical findings seem to indicate a negative relationship between ownership change and survival. Bernard and Jensen (2007) included an indicator variable recording the occurrence of ownership changes in their estimation of determinants of plant deaths. The authors found evidence that, unconditionally, plants that had experienced changes in ownership in the previous five-year census period were more likely to have survived to the next one. When controlling for plant attributes, however, they found the reverse, with takeover targets more likely to fail than plants with unchanged ownership. Gullstrand (2005) obtained similar results, finding that changes in ownership increased probability of exit of plants in the Swedish textile and wearing apparel sector. However, since ownership changes are identified through changes in administrative file numbers of the owner, the results might be biased because of data inaccuracy.

5.3 Econometric Specification, Data and Variables

5.3.1 Econometric Specification and Data

Generally, theoretical models of entry and exit do not have a tractable structure for empirical analysis. Thus, scholars use a simpler framework, in which the dependent binary variable—entry or exit—is regressed on a set of explanatory variables chosen on the basis of the theoretical model of reference and data availability. Most studies include size, age and some sort of productivity measures. More recently, founder's experience (Dunne *et al.* 2005; Thompson, 2005) and ownership changes (Bernard and Jensen, 2007, Girma *et al*., 2007) have been added.

To study the determinants of plant closure, the probability of observing plant *i*'s exit is modelled as:

$$\text{prob}(EXIT_i=1|X_i) = \Lambda\ (X_i)$$

where Λ(*) is the cumulative distribution function for the error term (cdf) evaluated at given values of the covariates and X_i a set of covariates. For estimation purposes, I use the logistic function to represent CDF.

Although the thesis' master database is a longitudinal set, the econometric analysis is performed using a cross-section structure. The information loss is deemed to be minimal since plants' and firms' characteristics refer to structural features, which are fairly stable over time. Like in the active learning models, time-dependent variables are measured at the time of exit, if the plant was closed before 31 December 2004, or in 2004, if the plant was still in operation as of 31 December 2004[12].

5.3.2 Data

The sample consists of 78 plants, of which 67 had been established before 1964, two in 1964 and nine between 1965 and 1994. Although limited in size, the cross-section data do not present particular statistical problems for the logistical regression.

In regression models of categorical and limited depended variables, a rule of a minimum of ten observations per variable is generally recommended. However, Long (1997) cautions that the minimum requirements for the sample size depend on the characteristics of the model and the data. If the number of parameters to be estimated is considerable, covariates present a high degree of collinearity or the distribution of the dependent variable is skewed (e.g., nearly all of the outcomes are either 1 or 0), then, larger samples than the rule prescribes should be used.

[12] As most plants were built long before 1964 and their paper machines have been altered by significant investments since their construction, initial conditions were deemed unimportant.

Fortunately, the thesis' cross-section database is not problematic. The dependent variable exhibits significant variation, with 38 of the 78 outcomes having a value 1. Thus, the aggregate proportion of exits is 0.487. The independent variables present, at times, some modest degree of association (Section 5.4 in this Chapter). Consequently, the number of covariates that can be simultaneously included in the regressions of plant's exit should not exceed eight.

5.3.3 Variables

The dependent variable, EXIT, takes the value 1 if the plant exited at any time during 1964-2004 and 0 if it was still operating at the end of 2004. The sample includes plants that were already in operations in 1964 as well as the eleven ones that entered from 1964 onwards[13].

The probability of plant exit is estimated as a function of four broad classes of variables: plant characteristics, plant location, firm characteristics and plant history. The list of variables with their definitions is provided in Section C.3 of Appendix C.

Plant-level variables

Besides size and age, plant-level variables that control for profit heterogeneity are equipment specifications, product line diversification[14] and grade specialisation[15]. With capacity highly constrained by technical specifications of paper machines in use (Appendix A), the state and characteristics of a plant's equipment are likely to be key variables.

Plant size (PSIZEMRK) is measured as percentage in industry's total

[13] Estimation of the logistical regression (herein not reported) with a reduced sample omitting the plants that entered after 1964 yielded no substantial differences.
[14] Product-line diversification refers to the range of product lines operating at a single plant.
[15] Grade specialisation refers to the degree of expertise required to produce value-added grades within a specific class of paper.

capacity[16] at the time of exit, if the plant was closed before 31 December 2004, or in 2004, if the plant was still operating at the end of the year. The reason for use of percentages, rather than absolute numbers, is to control for distortions that would have arisen due to the relatively long period under consideration. During the 40-year coverage of the thesis' database, the minimum efficient scale (MES) has risen considerably, especially for commodity grades. Therefore, a plant that was above MES in the 1960s was likely to be below average in 2004. It is expected that plant size exerts positive effects on plant survival.

Plants' relative importance within parent firms is captured by PSIZEG. It is plant's share in parent firm's total annual capacity at the time of exit, if the plant was closed before 31 December 2004, or in 2004, if the plant was still operating at the end of the year. The effect on the probability of exit is deemed to be positive. A multi-plant firm is more likely to close its smaller operations, rather than the larger ones, because they are comparatively less efficient.

The essence of technological efficiency is captured by vintage and width of plant's paper machines. As explained in Appendix A, technological innovation in papermaking has progressed towards larger and faster paper machines, which last, on average, 40 years, during which their width remains fixed. Therefore, age and width of its equipment reflect the technological limits of a plant, which overhauls cannot change. Specifically, VINTAGE45, VINTAGE64 and VINTAGE04 are dummy variables indicating whether the newest paper machine in operation at exit or in 2004 was installed before 1945, between 1945 and 1963 or between 1964 and 2004, respectively. It is expected that VINTAGE45 increases the probability of plant exit. Given the length of the period considered, paper machines installed before 1945 (i.e., before the

[16] Plant–level data on values do not exist. The use of quantities, rather than values, might have serious implications for the regression because it may disguise the statistical significance of demand conditions as a key factor affecting the probability of plant exit. Since the 1980s, the paper industry worldwide has been characterised by larger price fluctuations while volume demand has continued to grow. As a result, demand expressed in values has exhibited larger fluctuations than volume demand. Because of its greater variability, sales are a more accurate proxy for size.

Second World War) are considered obsolete, regardless of the year of exit of the plant. The impact of VINTAGE64 is less clear because the degree of obsolescence of machines installed between 1945 and 1963 depends on the year of the closure of the plant. By contrast, VINTAGE04 is expected to reduce the probability of exit, as paper machines installed from 1964 to 2004 are generally efficient.

The indicator variable PMMAX indicates whether the largest paper machine at exit or in 2004 less than 3 meter wide[17]. After controlling for paper grades, it is expected that the impact of PMMAX on the probability of exit is negative. Two additional variables have been included to control for equipment efficiency. VINTAGE measures the percentage of paper machines installed after 1945 in total number. EFFICIENT indicates the percentage of paper machines wider than 3 meters in total number. Both variables can be expected to reduce the probability of plant exit.

Following Jensen *et al*. (2001), plant age is included to control for managerial competency, which is commonly believed to drive productivity growth. LPAGE is measured as the logarithm[18] of the number of years of being in operation. Technological vintage and managerial competency are differently related to age. If best-practice technology is embodied in new capital, then the most productive plants should be the younger ones. However, as plants age, managers accumulate experience and undertake investments to achieve economies of scale, which, in turn, improve plant-level productivity. Therefore, the net effect on the probability of exit is, *a priori*, uncertain.

Finally, two additional variables have been introduced to control for product diversity. PSPEC is an indicator variable that distinguishes plants by grade[19]

[17] The efficient width of paper machines producing printing and writing paper in the later 1970s was 2.5 to 3 meters. Currently, most fine paper is produced on paper machines 3 to 3.5 meters. The mid-value (3 meters) has been chosen as cut-off width.
[18] The logarithmic transformation was introduced because the existence of some plants spans several centuries.
[19] A paper grade is a type or class of paper identified as having the same physical and mechanical characteristics. Each class of graphic papers encompasses several different grades. For more details, see Appendix A.

specialisation: commodity paper (sold in large volumes) and specialty paper (customer-tailored and produced in small quantities). PSPEC takes the value 1 if the plant was always manufacturing specialty grades in the reference period and 0 otherwise. In principle, small-scale plants of this kind do not imply a sub-optimal operation. Thus, PSPEC can be regarded as a cofounder for size. Moreover, with the liberalization of the industry in the mid-1980s, specialization in the production of specialty papers has been a successful strategy. Therefore, its impact is expected to be positive.

PDIVER distinguishes plants by product lines. It equals to 1 if the plant was manufacturing only graphic papers during the period under consideration and 0 if it produced a mixture of papers. Given that technological advances have moved towards increasingly specialised paper machines[20], efficient plants have tended to specialise in one product-line. Thus, the coefficient of PDIVER is expected to be negative.

Firm-level Variables

Having controlled for divestment incentives related to plant scale and technological efficiency, I allow for the possibility that parent firms' characteristics affect the decision of plant exit. As stressed in many studies, the larger and the older firms are, the greater the chances of survival. But, inter-firm rivalry as well as differences in efficiency of closing and relocating assets from one industry to another may alter the order of exit to the extent that larger plants would be the first ones to exit.

To test for firm efficiency, two variables have been considered: size and age. GSIZEMRK is calculated as the share of a firm's capacity in industry's total. LGAGE[21] is the logarithm of parent firms' age. It is expected that firm size and age positively affect plant survival.

[20] Unlike in the past, today's paper machines are tailored to manufacture a limited number of grades.

[21] As in the case of plants, the logarithmic transformation has been used to adjust for the long life span of several firms.

Differences in the opportunity costs of closing are captured by three variables. GTYPE is an indicator variable that equals to 1 if the firm was a multi-plant enterprise at the time of plant exit or in 2004 and 0 otherwise (single-plant firm). It is deemed that single-plant firms are more likely to be reluctant to close plants, when this would lead to their dissolution.

GDIVER takes the value 1 if parent firm produced different kinds of papers at the time of plant closure or in 2004 and 0 if the firm limited its production to graphic paper only. Like in the case of GTYPE, parent firms producing only graphic paper are more likely to defer closure of their plant(s) as it would imply their dissolution or lead to substantial reduction of their market presence.

The effect of product-line diversification might be mitigated by firms' own origins. Even when enterprises venture into industries far from their original segment of the market, they often maintain a token interest in their original sector. Therefore, firms may be more reluctant to exit from their original industry compared to exit from recently entered markets. To account for this potential influence, an indicator variable GCORE has been included. It takes the value 1 if the original sector of the founder of the firm was different from graphic papermaking and 0 otherwise.

History-level Variables

Dunne *et al*. (2005) have found empirical evidence that a founder's experience enhances prospects of plants' survival. The more experienced founders are, the greater the changes are that their ventures will survive the first years of existence due to their greater managerial acumen and/or technical skills compared to new comers. GPAST1 is a dummy variable that equals 1 if the founder has no prior experience in manufacturing; GPAST2 if the founder has been previously involved in manufacturing and GPAST3 if the founder has been involved in any segment(s) of the paper-value chain (pulping, papermaking, converting or distribution). It is expected that GAPST1

increases probability of plant exit due to the relative inexperience of the founder, whereas GPAST2 and GPAST3 decrease it.

To test the impact of ownership changes on plant survival, a set of variables were constructed. OWN25 is an indicator variable that takes the value 1 if the plant underwent an ownership change—with or without a registration change—at least once in the previous 25[22] years of the plant's existence and COM25 if the plant underwent a registration change—with or without an ownership change. To test for intensity effects on the probability of exit, variables measuring the number of administrative changes were also introduced. OWN25TOT and COM25TOT record, respectively, the total number of ownership and registration changes that a plant underwent during its last 25 years. Because ownership and registration changes do not necessarily occur simultaneously, they were disaggregated into their constituent parts. OWNCOM25TOT records the total number of simultaneous ownership and registration changes that a plant underwent in its last 25 years, OWNONLY25TOT the total number of mere ownership transfers (i.e., without transfer to a different company) and COMONLY25TOT the total number of mere registration changes (i.e., without change in ownership change). It is expected that coefficients are significantly different from zero. No *a priori* assumption is made on the sign of the coefficients.

Region- and Market-level Variables

In papermaking, external economies have always played an important role. Access to water, for power and as a raw material in manufacture, pulp and skilled labour has influenced location of paper mills for centuries. From the twentieth century, these factors have become less relevant, but proximity to main arteries of communication, larger markets and economically growing areas have continued to exert a certain influence. To control for regional

[22] Several time lags (5, 10, 25 and 40) have been considered. With the amount of investment necessary to acquire a papermaking facility, plants tend to remain under the same ownership for a number of years. 25 years was a reasonable period during which a plant could have, in principle, experienced one or more organisational changes.

agglomeration, three dummy variables were used: AREAREST, which takes the value 1 if a plant is located in central and southern Italy, AREANW if in north-western Italy, and AREANE if in north-eastern Italy. With the industrial expansion of the North, it is expected that location in these two areas would be associated with lower probabilities of plant exit.

Because this research focuses on the graphic papermaking industry in Italy, most market factors are essentially given. The stage of development of the papermaking industry can be regarded as mature throughout the reference period and technological advances towards wider and faster machines have equally affected all competitors and every product segment. Yet, there would be sound justifications for inclusion of market conditions in an analysis of plant exit. Being a basic materials industry, the pulp and paper industry constantly alternates periods of high profits, in which equipment is utilised above optimal operating rates, with those of marked losses, in which equipment is operating at below full capacity, if not temporarily stopped. Therefore, it would have been reasonable to assume that adverse market conditions could have accelerated closure of inefficient plants while buoyant demand postponed it. Owing to its cross-section structure, this hypothesis could not be tested in the present logistical analysis. But, the loss is deemed to be minimal[23]. Previous comparison between de-trended production time series and plant exit (Figure 4.3, Chapter 4) did not reveal any specific association.

5.4 Descriptive Statistics

Table D.10 in Appendix D reports pair-wise correlation coefficients among quantitative variables, whereas Tables D.11-14 reproduce cross-tabulations between categorical variables of plants' and firm's characteristics, regional agglomeration and organisational histories. Table D.15 reports the means of plant size, grouped by categorical plant and firm characteristics and Table

[23] Comparison between de-trended production time series and plant exit reveals that market conditions do not appear to influence plant survival (figure 4.3, Chapter 4).

D.16 reports the means of each variable, grouped into survivors and exitors. These statistics reveal a number of significant associations of economic interest.

- Surviving plants are nearly four times larger than exiting ones (Table D.16) confirming that size is a reasonable predictor of survival. As expected on the basis of technological advancements in papermaking, plant size is positively associated with the width of paper machines (PMMAX) as well as grade specialisation (PSPEC) and negatively with product-line diversification (PDIVER) (Table D.15). Larger plants are, on average, three times more likely to be owned by graphic papermaking firms (GDIVER) and four times by multi-plant firms (GTYPE) (Table D.16). These statistically significant associations with plant characteristics and firm attributes indicate that plant size—as a predictor of survival—captures both technological and managerial factors.

- As expected, plants with more modern machines are nearly three times more likely to survive than those with older equipment (Table D.16). The association of vintage and width of paper machines is significant[24]. Of 50 plants with paper machines narrower than 3 meters, 17 had them installed before 1945, 23 between 1945 and 1963 and 10 from 1964 onwards. By contrast, of 28 plants with paper machines wider than 3 meters, none had machines installed before 1945. However, VINTAGE does not reveal any significant association with firm attributes (not shown). This suggests that as a measure for plant efficiency, VINTAGE may be an alternative to size as predictor of plant survival.

- With more than a third of firms being single-plant, firm size is strongly correlated with plant size (Table D.10). More interestingly, surviving plants owned by firms specialized in the manufacture of graphic paper (GDIVER) and/or with a tradition in graphic papermaking (GCORE) are nearly twice as many as those that produce a mixture of grades (Table D.16).

[24] Statistics are available with the author.

- Firms of surviving plants were, on average, younger than firms of closing operations. The mean age difference is significant at 5 per cent level of confidence (Table D.16). The opposite applies to plants. Exiting plants were, on average, older than surviving ones, though the mean age difference is not statistically significant. This suggests that younger firms were more likely to own younger plants, which had better survival prospects.

- Plants located in North-East Italy appear to have a higher probability of survival than those in other parts of the country. About 42 per cent of surviving plants are sited in this area, against only 10 per cent of exiting ones (Table D.16). Since localisation in this area is associated with comparatively newer equipment, multi-plant firms (Table D.12) and higher propensity to administrative reorganisation (Table D.13), this feature may reflect the more extensive degree of modernisation of plants in the North-East.

- The richer the administrative history of plants (COM25, COM25TOT and COMONLY25TOT), the more likely it is to survive (Table D.16). This may reflect the fact that such plants were also weakly associated with more modern equipment (PMMAX and PMVINTAGE) (Tables D.14 and D.16). Ownership changes appear to be more frequent among survivors than exitors, though their impact is not statistically significant (Table D.16). This statistical evidence gives an inkling of a world in which organisational restructuring within the firm may contribute to maintaining plants at the cutting edge of technology.

5.5 Estimation Results for Multivariate Logits

Estimation[25] of multivariate logits is based on the following equation:

[25] A methodological remark on the size of the thesis' dataset is warranted. Scholars caution about using ML estimation techniques with samples less than 100 observations because the

$$\Pr(Exit = 1 | X) = \frac{\exp(\alpha + \beta X)}{1 + \exp(\alpha + \beta X)}$$

where X is a set of explanatory variables, α a constant and β a vector of coefficients for the covariates. Instead of reporting the logit coefficients, odds ratios are reported. They indicate the change in the odds for an infinitesimal change in the value of the continuous variable or a unit change in the value of a dummy variable. When interpreting the odds ratios, coefficients greater than one indicate positive effects whereas coefficients between zero and one indicate negative effects.

Table 5.1 presents the results of five logit regressions. To assess how firms' features and plant's organizational histories affect probability of exit, columns 1 and 2 report the odds ratios when only regional- and plant-level variables are included, whereas Columns 3, 4 and 5 reports the results when various firm-level characteristics and history-level variables are added.

Technological Efficiency and Location

The econometric results confirm the significance of both location and plant characteristics in predicting exit. The signs of the coefficients are as expected. As expected in a capital-intensive industry such as papermaking, size or, alternatively, technological vintage seem to capture, most of the effects of plant characteristics on the probability of exit suggesting that a sort of Darwinian selection of the fittest is at work. For Example, an additional 0.1 per cent increase in the relative size of a plant (PSIZEMRK) reduces the odds of exiting by some 8 per cent[26].

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behaviour of ML estimators under those circumstances is largely unknown. However, the dataset used for this analysis consists of the entire population. In this particular case, McCloskey and Ziliak (1996) argue that significance tests are somewhat irrelevant. In fact, the p-value denotes the probability of a non-zero value if the true value of the coefficient were zero. But the coefficient is already the true value[25]. In discussing the results, I follow Long's suggestion, "given that the degree to which ML estimates are normally distributed in small samples is unknown, it is more reasonable to require smaller *p*-values in small samples" (1997, p. 54).

[26] For a change of 0.1per cent, the odds ratio is 0.919839, that is, $\exp(-0.83556 \times 0.1)$. Therefore, the percentage decrease in the odds of exiting is $\approx (1 - 0.919839) \times 100)$.

	(1)	(2)	(3)	(4)	(5)
Regional-level variables					
AREAREST	11.526 **	5.700 **	5.528 **	5.849 **	5.065
	[1.62, 81.78]	[1.34, 24.29]	[1.06, 28.78]	[0.84, 40.56]	[0.67, 38.33]
AREANW	10.451 ***	6.867 ***	5.847 **	7.475 **	7.761 **
	[1.88, 57.89]	[1.83, 25.76]	[1.20, 28.44]	[1.15, 48.78]	[1.18, 51.27]
Plant-level variables					
PSIZEMRK	0.442 ***				
	[0.28, 0.68]				
PSIZEG	0.243				
	[0.04, 1.56]				
PDIVER	1.093				
	[0.29, 4.12]				
PSPEC	0.508				
	[0.14, 1.87]				
LPAGE	0.772				
	[0.43, 1.37]				
VINTAGE45		11.658 ***	19.088 ***	21.178 ***	23.321 ***
		[1.94, 70.30]	[3.06, 118.93]	2.69, 166.48]	[2.50, 225.69]
VINTAGE64		3.812 **	5.858 **	7.002 **	8.124 **
		[1.18, 12.30]	[1.45, 23.61]	[1.43, 34.22]	[1.50, 44.09]
Firm-level variables					
GDIVER			4.686 **	9.852 ***	8.749 ***
			[1.37, 16.03]	[1.98, 49.05]	[1.95, 39.29
LGAGE			0.559 *	0.416 **	0.580
			[0.30, 1.02]	[0.20, 0.86]	[0.30, 1.13]
History-level variables					
GPAST1				0.311	
				[0.06, 1.57]	
GPAST2				1.018	
				[0.16, 6.56]	
COM25				0.117 ***	
				[0.03, 0.56]	
COM25TOT					0.398 ***
					[0.21, 0.77]
OWNONLY25TOT					4.324
					[0.70, 26.83]
Number of observations	78	78	78	78	78
Convergence after	5 iterations	4 iterations	4 iterations	6 iterations	5 iterations
Log likelihood	-39.348	-42.743	-36.850	-32.384	-31.816
Pearson chi2	70.03, p=0.476	6.34, p=0.175	79.25, p=0.058	78.51, p=0.121	90.35, p=0.036
Hosmer-Lemeshow chi2	0.77, p=0.679	1.03, p=0.598	0.80, p=0.670	1.46, p=0.482	0.65, p=0.724
Pseudo R2	0.272	0.209	0.318	0.401	0.411
BIC	-226.274	-232.554	-235.626	-231.488	-236.980
Correctly classified (%)	71.79	74.36	79.49	79.49	84.62

Note: Confidence intervals in parentheses. (***) indicates 1% level of confidence, (**) 5% and (*) 10%.

Table 5.1: Results of multivariate logits

When technological vintage, rather than size, is considered, the effects are even stronger. For plants with equipment installed before 1945 (VINTAGE45), the odds of exiting are some 11 to 24 times greater than for the plants with equipment dating back to the Second World War. Similarly, the odds of exiting for plants with paper machines installed during the period 1945-1963 (VINTAGE64) are three to eight times greater than for the rest.

Other plant-level characteristics such as product line diversification (PDIVER), grade specialization (PSPEC) and plant age (LPAGE) do not provide additional explanatory support to the model. The signs of their coefficients are as predicted but statistically insignificant. This may be due to the considerable degree of correlation that exists between them and size or technological vintage. Omission of these variables from the regression does not seem to bias the results[27].

Turning to regional-level variables, being located in North-East Italy decreases remarkably the probability of exit. The empirical results show that if a plant is located in South and Centre Italy (AREAREST), the odds are at least 5 times greater than been located in any other part of the country. Similar effects hold for plants located in North-West Italy (AREANW). Since location is associated with plant size and technological vintage, the robust significance of its coefficients across specifications[28] is noteworthy. It suggests that location seems to capture some negative externalities of regional agglomeration such as competition from other industries, overwrought arteries of communication and other infrastructure or, simply, outdated entrepreneurial models.

Firms' Attributes

Unlike for plants, the relative size of the firm owning the plant (GSIZEMARK)

[27] The likelihood-ratio (LR) tests (not here reported) indicate that the null hypothesis of simultaneous no effects of PSIZEG, PDIVER, PSPEC and LPAGE cannot be rejected.

[28] The exception is specification (5). The statistically insignificance of the coefficient for AREAREST is probably caused by the lower than average proportion of plants in Centre and South Italy that have undergone an organisational change in the last decades of their existence.

appears to exert an inverse effect on probability of exit[29], though the effect is not statistically significant. Being correlated with plant size, it is plausible that its effect is entirely captured by equipment vintage.

By contrast, firm age and product-line diversification have a distinct impact on plant survival. The odds of exiting for a plant belonging to a firm that produces a wide range of papers (GDIVER) are at least 4.6 times greater than for plants belonging to firms specialised only in graphic papermaking[30]. In addition, being owned by a ten years-older firm (LGAGE) also reduces the odds of exiting by at least 20 per cent[31] (Column 3).

Other firm-level characteristics such as firm's core specialization (GCORE) or typology (GTYPE)[32] seem to be insignificant. The likelihood-ratio tests confirmed that the null hypothesis of a zero coefficient for GTYPE and GCORE are not rejected at 1 per cent level.

Ownership vs. Registration Changes

Columns 4 and 5 of Table 5.1 report the estimation results when plants' histories are added. Contrary to previous research, the background of the plant's founder appears to be inconsequential, though having a background outside manufacturing (GPAST1) seems to decrease, rather than increase, the probability of plant exit.

What matters are organisational changes, especially registration changes. Both ownership[33] and registration changes decrease the probability of plant exit though only the impact of the latter is statistically significant. The odds of

[29] Results not here reported.
[30] Similar results are obtained for plants belonging to firms whose original core of business was graphic papers. Because GCORE and GDIVER are highly correlated, only one variable has been considered.
[31] The regression results refer to the logarithm of firm's age. Thus, an increase of ten years is equivalent to an increase of 2.302585 in LGAGE. For example, as per Column 3, the odds decreases by a factor of 0.231685 ($\approx$ exp(-0.635102*2.302582)).
[32] Results not here reported.
[33] Not reported in Table 5.1.

exiting are about eight times as high as for plants with no registration change as for plants that underwent such change, holding all other variables constant (Column 4).

The more dominant role played by registration, rather than ownership changes, is further confirmed when measures of intensity of registration changes are considered. If organizational changes are disaggregated into their constituent parts (Column 5), for each additional registration change (COM25TOT), the odds of exiting decrease by a factor of 0.39, holding all other variables constant. By contrast, mere ownership transfers (OWNONLY25TOT) appear to increase, rather than decrease, the probability of exiting. However, their impact is not statistically significant.

Compared to specifications of the logit model with only regional-, plant- and firm-level variables (Columns 1-3), adding plant organisational histories to the set of explanatory variables improves the predictive power of the model (Columns 4 and 5). The Pseudo R2 are the highest, the percentage of correctly classified observations among the greatest and the BIC among the least. If the intensity of organisational changes is considered, the percentage of correctly classified observations is nearly 85 per cent.

These results seem to be broadly consistent with the theoretical considerations explained earlier in this chapter. To reduce the probability of exit, ownership changes need to be accompanied by registration changes. The reason might lie in the fact that integration of an acquired plant into an acquiring firm requires a new administrative setting in order to exploit potential synergies. The same argument applies to mere registration changes. To take advantage of administrative or financial incentives, which, in turn, are likely to expand a firm's resources, a new organisational structure is needed. By contrast, a ownership change that is not accompanied by a registration one—that is, the acquired plant continues to operate under its pre-acquisition registered company—may reflect an intention of the acquiring firm not to integrate administratively the new plant into its own assets. In this case, the

acquiring firm may be more prone to shut down the acquired operation if it proves unprofitable. This would be in line with the empirical findings of Bernard and Jensen (2007) and Gullstrand (2005).

5.6 Concluding Remarks

Once again, the study of exit in the Italian papermaking industry confirms that survival of plants depends critically on their size. Although capacity is a good proxy for productivity and, in turn, profitability of a plant, technological vintage appears to be even more influential.

Moreover, the study confirms that firm attributes and regional agglomeration add to the predictive power of the model. Firm attributes do not necessarily coincide with those found in other case studies. This is understandable because a successful attribute in a sector may be irrelevant, if not counterproductive, in another. In the case of papermaking, the successful strategy has been product line specialization, rather than diversification. It is to be noted that this business strategy has, however, a technological connotation, since innovation has progressed towards customised paper machines manufacturing a limited range of paper grades. Whether it is firms' business strategies that have pushed technological advances in this direction, or vice versa, is not clear.

The unexpected finding concerns the role of organisational changes. Whether or not linked to ownership changes, they appear to enhance the probability of survival of plants. These results suggest a relationship between the fate of a plant and the way the parent firm integrates, administratively, such plant in its physical assets. These results suggest that successful integrations are likely to require administrative restructuring.

Despite the relatively long period considered for this study of plant exit, these findings appear to hold even for shorter intervals. As shown in Chapter 4, the

mid-1980s represented a turning point in the evolution of the Italian graphic paper industry, which was brought about by changes in the economic and regulatory climate. However, estimation of the logit models[34] by introducing a dummy variable for the sub-periods (1964 to mid-1980s, and mid-1980s to 2004) did not underline any substantial divergence in the role that the plant-, firm-, regional- and historical-level variables played in the probability of plant exit over the entire period.

Although revealing, the study of organisational changes and their eventual effects on the probability of exit is still at its infant stage. Proxies used are unsophisticated measures and conceptual foundations need refinements. Empirical evidence may also reflect country or sector specificities that prevent generalisation. Therefore, the results should not be considered as definitive. However, the fact that this study, as well as the work of Bernard and Jensen (2007) and Gullstrand (2005), found organisational changes statistically significant should encourage further investigation in this direction.

[34] The results have not been incorporated in the text.

CHAPTER 6

SURVIVAL OF FIRMS

6.1 Introduction

How long do firms survive in an industry? How does the duration of survival vary across individual firms? Answers to questions such as these are helpful for understanding competition over time. At the individual level, survival has often been regarded as an indicative, though hazy, measure of performance of firms. The longer a firm is able to survive in a given industry compared to its competitors, the more capable it appears to be. At the industry level, the distribution of individual survival spells sheds light on the speed at which different age classes of firms transit through an industry and, therefore, on how incumbents are, most likely, deterring new comers.

The empirical literature on the determinants of firm survival is considerable[1]. It views survival as determined by a mixture of firm-specific attributes, industry characteristics and environmental conditions, measured at the date of entry and/or at current one. The theoretical literature discussed in Section 5.2, Chapter 5, underpins this strand of empirical research. The preferred methodology used is the event-history analysis[2].

This chapter examines the comparative relevance of technological attributes and strategic orientation on the survival process of Italian firms in the graphic papermaking industry from 1964 to 2004. The next section discusses data structure, econometric specification and variables. Section 3 presents the non-parametric estimates of the survivor function by main time-independent characteristics. Section 4 examines the role of technological and strategic factors in survival among firms. Section 5 presents the conclusions.

[1] Santarelli and Vivarelli (2007) and Manjón-Antolín and Arauzo-Carod (2008) review the recent literature on firm survival. The latter authors also present a critical examination of how survival analysis has been applied in this area.
[2] Survival, duration, and event history analysis are synonymous.

6.2 Specification of the Econometric Model

6.2.1 Data Structure

The analysis draws on the thesis' database of all firms that produced graphic paper in Italy between 1964 and 2004. It consists of 74 firms, of which 48 were already in operation in 1964 and the remaining 26 entered at any time from 1964 to 2004. By the end of 2004, only 22 firms were still producing graphic paper. This implies that the survival data used in this analysis contain both right-censored and left-truncated event histories.

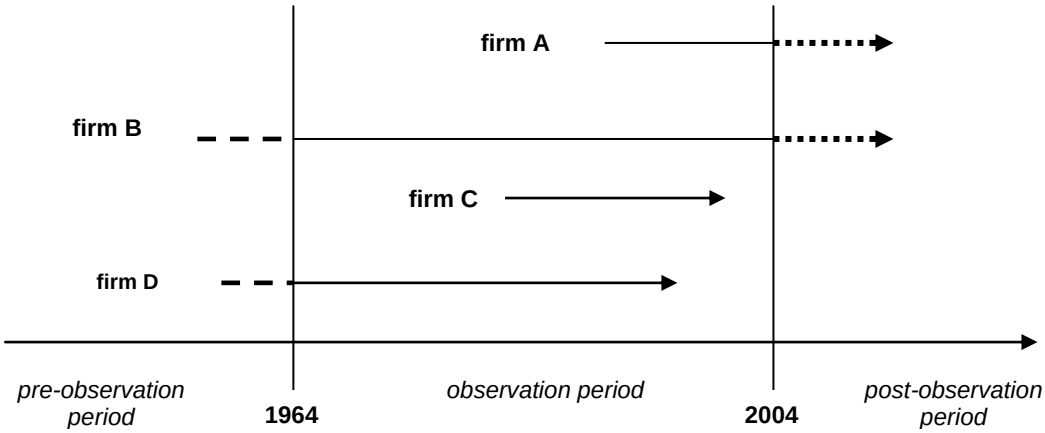

Figure 6.1: Illustration of types of event histories

Figure 6.1 illustrates the various types of event histories in terms of calendar time. The vertical lines at 1964 and 2004 represent the beginning and end of the observation period, whereas the horizontal lines the event-histories of typical firms from the onset of becoming at risk of exiting (i.e., from the date of entry) to the occurrence of the event (i.e., exit). The event-history of firm C is ideal because its entire life trajectory is known. It entered and exited within the observation period. For all other firms, information about their life trajectories is deficient. The event-histories are either right-censored (firm A)

or left-truncated (firm D) or both (firm B)[3]. Specifically, firm A and firm B are right-censored because exit was not observed before the end of the observation period. Firm D and B are left-truncated because the onset of becoming at risk of exiting occurred before observation began in 1964.

The database contains 17 complete event histories (firm C type), 9 right-censored (firm A type), 35 left-truncated (firm D type) and 13 left-truncated and right-censored (firm B type). Unlike censoring, left-truncation causes the sample to be biased because it excludes those firms that have not survived long enough to be observed in 1964. That is, the left-truncated cases observed at the beginning of the observation period tend to contain a disproportionate number of long-lived firms (Kennedy, 2005). But, the problem could be overcome because the date of entry was known for each firm in the database (Guo, 1993). With the necessary adjustments[4], it is possible to utilize the left-truncated event-histories in the survival analysis.

As the dates of entry and exit are recorded in terms of day/month/year, the duration data[5] could be reasonably treated as continuous, allowing use of continuous-time survival models[6].

6.2.2 Econometric Specification

Survival analysis is a method for analysing the length of time (duration) spent from the onset of being at risk of experiencing a specific event[7] (original state) until it occurs (destination state) or until measurement is taken, if this

[3] This section only discusses the cases that pertain to the dataset under consideration. For a review of all possible cases, see Cleves *et al*. (2008) and Blossfeld *et al.* (2007).
[4] In practice, left-truncated subjects should enter the set of individuals at risk only from the time intervals during which such subjects are observed. In other words, their entry into the risk set is delayed until an intermediate events occurs (Hosmer *et al*.2008). Cleves *et al*. (2008) indicate that STATA version 9 has the capability to handle left-truncation data.
[5] They are also referred to as survival data, failure-time, time-to-event, or event-history (Rabe-Hesketh and Skrondal, 2008, p.331).
[6] In case of discrete-time duration data, survival models become models for dichotomous responses and logistical regression is applied. See Rabe-Hesketh and Skrondal (2008, Chapter 8) for discrete-time survival analysis using STATA.
[7] Because of its broad range of applications, the lexicon of survival analysis contains various synonyms for the basic concepts. The term event is often named death, failure or termination. The term hazard rate, which will be discussed later in this section, is also called transition rate/intensity, failure rate/intensity, risk function or mortality rate.

precedes the event (right-censoring)[8]. Let T denote the survival times and be a continuous random variable, with probability density function (pdf) $f(t)$ and a cumulative distribution function (cdf) $F(t) = \Pr\{T \leq t\}$. The survivor function $S(t)$ reports the probability of surviving beyond time t. Statistically, it is defined as:

$$S(t) = \Pr\{T > t\} = 1 - F(t) = \int_{t}^{\infty} f(x)dx$$

The hazard function $h(t)$, or instantaneous rate of occurrence of the event, is defined as:

$$h(t) = \lim_{\Delta t \to 0} \frac{\Pr(t \leq T \leq t + \Delta t \mid T \geq t)}{\Delta t} = \frac{f(t)}{S(t)}$$

This expression is the ratio between the conditional probability that the event will occur in an infinitesimally small interval (Δt)—given that it has not occurred before—and the length of the interval. Therefore, $h(t)$ can be interpreted as the instantaneous rate of occurrence of the event. As the density function $f(t) = -dF(t)/dt$, the hazard rate can also be written as the ratio between the density of events at t and the probability of surviving beyond t.

Inherent to the logic of survival analysis, it is the notion that there is a time-ordering between causes and effects, meaning that a change in some variables x_t at time t may cause a change in the speed to which a subject moves to its destination state[9]. This, in turn, implies that transition rates can only depend on conditions that occurred in the past (before t), but not at current time t or in the future (Blossfeld *et al*. 2007, p. 27-28); hence, the importance of hazard rates in survival analysis. This feature of survival

[8] The theoretical and applied literature on failure time methods is extensive and ranges from advanced to self-learning texts for biomedical, social sciences and engineering disciplines. The present exposition of the basic concepts in survival analysis is based on Box-Steffensmeier and Jones (2004) and Bossfeld *et al*. (2007).

[9] Blossfeld *et al*. (2007, p. 27-37) provide a detailed, not formal, discussion of time order and causal effects in event history analysis.

analysis lends itself to model the hazard rate as dependent on time and a set of covariates *X*, that is,

$$h(t) = \lim_{\Delta t \to 0} \frac{\Pr(t \leq T \leq t + \Delta t \mid T \geq t, X)}{\Delta t}$$

Several models have been proposed, depending on the assumptions made about the form of the survivor function and the way covariates exert their influence. In general, survival models are classified as non-parametric, when there are no restrictions on the form of the hazard function, semi-parametric, when the baseline hazard function does not need to be specified, and parametric models, when the hazard function is specified. Although parametric models yield more efficient estimates of the time dependency as well as of the covariate parameters, this property does not hold, for any sample size, if the hazard function is incorrectly parameterised (Box-Steffensmeier and Jones, 2004). Therefore, in case of little or no *a priori* knowledge on the form of the survivor function, it is best to use non- or semi-parametric models, though they yield less efficient estimates.

Neither the literature in industrial economics, nor that in organizational ecology has yet developed theoretical models that can be used to obtain clear indications for the precise specification of survivor function for firms (Kiefer, 1988; Manjón-Antolín and Arauzo-Carod, 2008). In the absence of a theory-based specification of the hazard function, I use the most common approach: the semi-parametric Cox Proportional Hazard model.

6.2.3 Variables

The events that define the transition to failure are: (i) entry into the Italian graphic paper industry (original state) and (ii) exit from the same industry (destination state). Consequently, the dependent variable (SURVIVAL) is defined as the length of time (measured in days and shown in year-scale) from the date of entry to the date of exit or censoring (date of failure), if the firm had not yet exited the industry by the end of 2004.

In the present study, the hazard rate $h(t)$ is assumed to depend on a set of firm technical characteristics, strategic orientation and history. Demographic variables and size are also included. Section C.4 in Appendix C provides detailed variable definitions and statistics.

Demographic variables There are numerous distinctions that can be made about types of entrants. Two, however, have been repeatedly considered in the literature: the mode by which firms enter (greenfield or acquisition) and the extent to which firms are new (*de novo* or diversifying)[10]. To capture their influence, two indicator variables were introduced: ENMODE and ENSTATE.

ENMODE equates to 1 if the firm entered by acquisition and 0 if entered by plant construction or conversion. Compared to greenfield entry, it is not clear *a priori* whether entry by acquisition improves or not the entrant's chances of survival. Acquiring an established efficient plant is likely to decrease the odds of failure. Nevertheless, the success of a business also depends on the capability of the entrant to manage effectively the acquired plant, which can only be proven in the market. Therefore, no specific expectation about the sign of the coefficient of ENMODE is advanced.

ENSTATE equates to 1 if the firm was a *de novo* entrant and 0 if it was a diversifying firm with activities elsewhere. From previous studies (Geroski, 1991), it is expected that diversifying entrants have better survival prospects than *de novo* ones since they can rely on larger financial resources, proven managerial capabilities and lower sunk costs.

Size variables The effect of size on firm survival has been repeatedly observed across countries and sectors. Three alternatives have been considered[11]. LSIZE is defined as the logarithm of the firm's capacity (in

[10] See section 2.1.

[11] As firm's size is regarded as an instantaneous variable in survival analysis (Cleves, 2008, pp.41-43), the values that are considered in the computation of hazard rates are those recorded at the date of failure, that is, at exit or 2004.

tonnes), SIZEMRK is the firm's share in industry's capacity and SIZECLASS is a categorical variable grouping plants in three basic categories: annual production capacity up to 25,000 tonnes (SIZECLASS1), between 25,000 and 100,000 tonnes (SIZECLASS2), and above 100,000 (SIZECLASS3). The cut-off values for this variable have been chosen on the basis of the evolution of the dominant (*i.e.* most frequent) firm size. As shown in Table 4.2 (Chapter 4), SIZECLASS1 was the dominant size for the first two decades and SIZECLASS2 for the subsequent decades. Although SIZECLASS3 has never accounted for a large proportion of firms, its relevance has been constantly increasing. As repeatedly observed[12], size is expected to affect positively survival.

Technical-level variables To investigate the influence of technological efficiency, a series of variables were constructed on the basis of vintage and width of the paper machines in use at the time of firm's failure date (exit or censoring). PMAGE indicates the firm's total number of machines installed after 1945 and PMEFFICIENT total number of machines installed after 1945 and wider than 3 meters. PMAGE% and PMEFFICENT% measure the percentage of PMAGE and PMEFFICENT in the firm's total number of machines. All four variables are expected to lower the risk of exit.

Binary variables, which measured whether the largest and newest paper machine was at least 3 meter wide and/or installed after 1945 (such as those included in the logistical analysis of plant exit in Chapter 5), were considered not appropriate because they did not show much variability. Some 35 percent of all firms were multi-plant operations and, therefore, the occurrence of having at least a modern machine was higher than at plant level.

Firm strategic and location variables Production diversification within the paper industry, pursuit of external growth strategies (i.e., acquisitions or divestments) and localization of additional plants are strategic

[12] See OECD (2003) for an international comparison.

considerations for any firm. They affect performance and sustainability. To capture their potential influence, the following variables were constructed.

DIVER is an indicator variable that takes the value 1 if the firm always produced a mix of graphic and other papers (i.e., packaging, sanitary, industrial, etc.) and 0 if the firm manufactured only graphic paper. As explained in the previous chapter, it is expected that production-line diversification would increase the risk of exit.

EXPAND and SHRUNK indicate, respectively, the number of acquisitions that a firm underwent during its existence (excluding the initial acquisition by which the firm was established) and divestments (excluding the sale of plants by which the firm was dissolved). EXPAND is expected to exert a positive effect on survival, while SHRUNK a negative one. An additional variable REORG records the number of organizational restructurings that a firm underwent during its life. No *a priori* prediction on the sign of the coefficient of REORG is advanced (see Chapter 5).

Given the positive correlation between plant survival and location in North-East Italy, an indicator variable AREANE was compiled. It is 1 if all plants belonging to a firm at the failure date were located in this area and 0 otherwise.

Owner's background variables The indicator variable ORIGINCORE was compiled to explore the potential influence of firm background. It is 1 if the entrant was a foreign firm or its original core activities were large businesses in sectors other than papermaking. ORIGINCORE is expected to be positively related to the risk of exit. Having substantial businesses outside papermaking or being a foreign corporation (generally a papermaker) would make the owner less reluctant to exit, should

its papermaking activities be less profitable than expected. This variable is highly correlated with the demographic variable ENSTATE[13].

Temporal variables It is reasonable to suppose that the period in which a firm is established can affect its future prospects since distinct institutional settings and/or macroeconomic conditions affect firms' technological, managerial and organization make-up. Given the considerable longevity of the Italian papermakers, the sample was divided into three groups: COHORT1, including firms established prior to 1950, COHORT2, including firms that entered between 1950 and 1963, and COHORT3, including entrants from 1964 onwards.

Cofounders In addition, a series of alternative categorical variables were included as potential cofounders. These were grade specialization (SPEC), multi- or single-plant operation (TYPE), firm's background (PAST) and firm original sector (CORE). Their definitions are included in section C.4 of Appendix C.

6.3 Survival Patterns

Preliminary to the multivariate analysis, this section investigates the overall survival patterns without introducing any *a priori* assumptions about the functional form of the hazard rate[14]. Figure 6.2 illustrates the Kaplan-Meier survival curves for the whole set of firms (ALL FIRMS) and for the set consisting only of firms established after 1964 (POST-1964 FIRMS). Figures 6.3, 6.4 and 6.5 present the Kaplan-Meier survival curves stratified by firms' typology. Time on the x axis is reported in analysis time, which is made to correspond roughly to historical years.

[13] The difference between ENSTATE and ORIGIN lies in the definition of core business. The former classifies firms into manufactures of graphic vs. manufactures of graphic and other papers. The latter categorises firms into Italian papermakers vs. foreign and/or other than papermakers. The compilation of the variable ORIGIN required a certain degree of judgemental considerations.

[14] This is carried out by looking at the Kaplan-Meier survival functions that measure the fraction of subjects at risk of exiting during the intervals between observed failure times.

Consistently with previous empirical findings (Geroski, 1995), Figure 6.2 below illustrates that about half of the firms exited within the first decade and an additional quarter in the following 15 years. That is, just about quarter of firms survives beyond 25 years. Similar patterns can be seen among the post-1964 firms. Though survival rates are generally lower, the difference is minor[15], especially in light of the fact that the whole set of firms is biased towards long survivors[16].

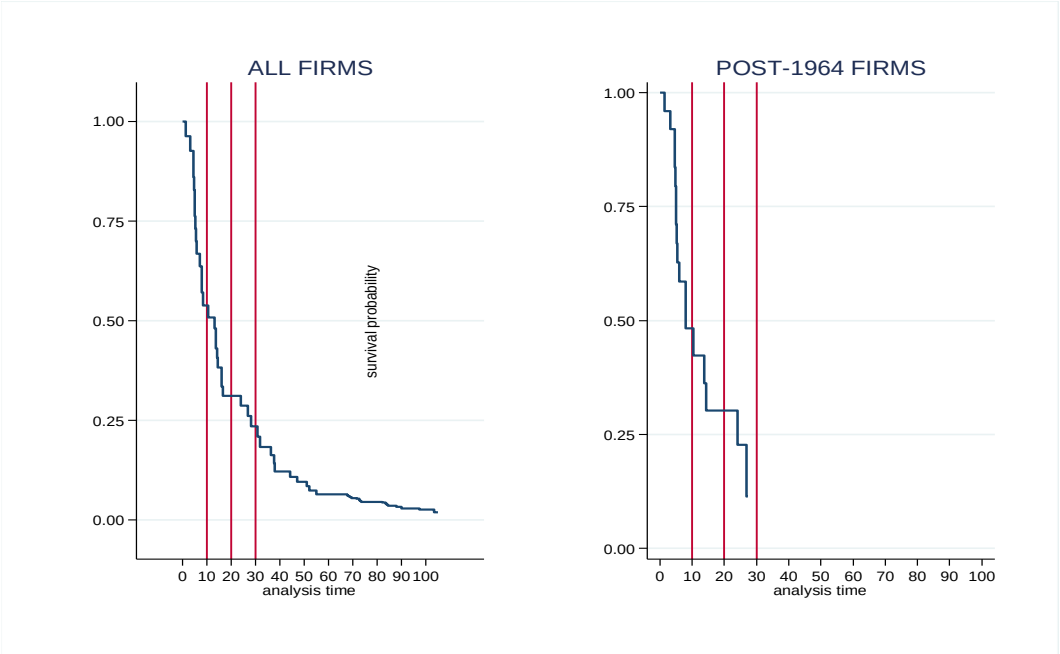

Figure 6.2: Kaplan-Meier survival curves

Mode of entry, product line diversification and the original core business at entry do alter firms' survival prospects.

Figure 6.3 below show that, throughout the reference period, the estimated survival function for entry by acquisition lies below the one for greenfield entry. The difference is more manifest for post-1964 firms, probably because of preponderance of entries by acquisition among these enterprises (73 per cent). In this case, the null hypothesis of common survival curves is rejected

[15] The survival rates at analysis times 10 and 20 are 0.5373 and 0.3106 for all firms and 0.4830 and 0.3019 for post-1964, respectively.

[16] As explained in section 6.2, the whole set of firms include a large portion of left-truncated data. However, the survival estimates are not biased because the truncated subjects are included in the risk sets only for the interval of their duration that occurred during the observation period 1964-2004.

at 5% level of confidence[17]. However, if the whole set of firms is considered, the null hypothesis is rejected at 10% level only on the basis of Wilcoxon test[18], which provides more weights on the initial first years of survival. Therefore, the route by which firms enter the market might not be a strong predictor of their survival.

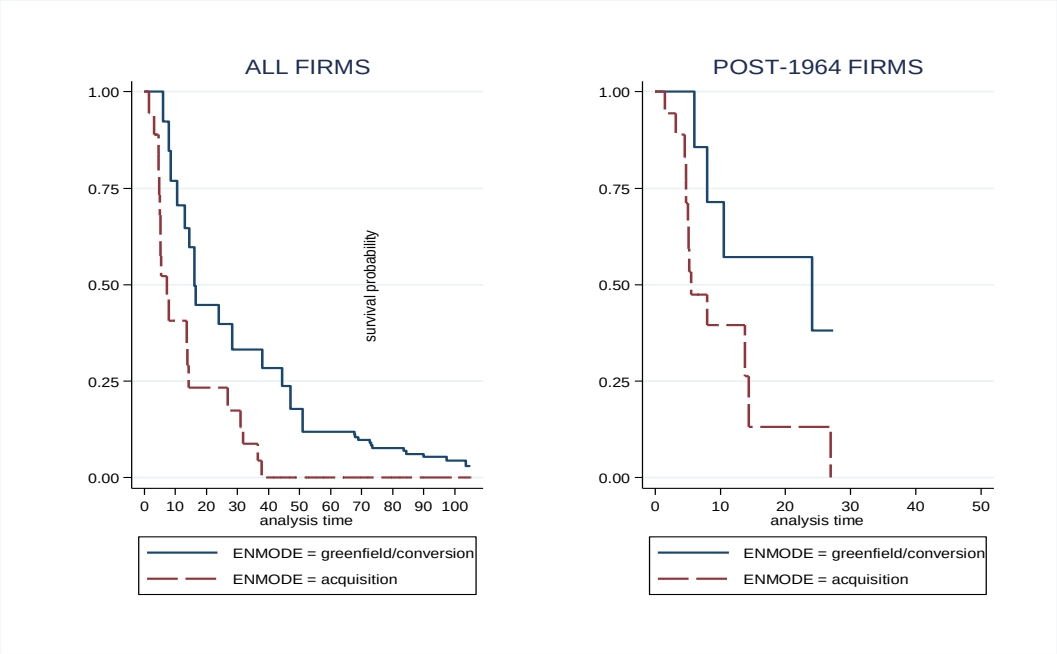

Figure 6.3: Kaplan-Meier survival curves by entry mode

Instead, production-line diversification appears to be more relevant. Figure 6.4 below compares the survival curves of firms that pursued a product-line diversification with those of firms that did not do so. In the first 20-30 years of existence, survival prospects are clearly greater if firms have concentrated their production in the manufacture of graphic paper, compared to rivals that have maintained a diversified production. This result reflects the trends of technological advances in papermaking. With post-war advances towards paper machines specializing in fewer paper grades, firms found more convenient to narrow their production-lines towards a specific type of paper,

[17] The statistic of the log-rank test is chi2(1)=3.81, p>chi2=0.0510 and for the Wilcoxon is chi2(1)=3.89, p>chi2=0.0486.
[18] The statistic of the log-rank test is chi2(1)=2.43, p>chi2=0.1189 and for the Wilcoxon is chi2(1)=2.84, p>chi2=0.0920.

rather than producing a full range of it. Moreover, the increasingly specialisation of distribution channels by paper grade may also have discouraged firms to pursue diversification strategies because of the amount of resources needed to maintain all channels open.

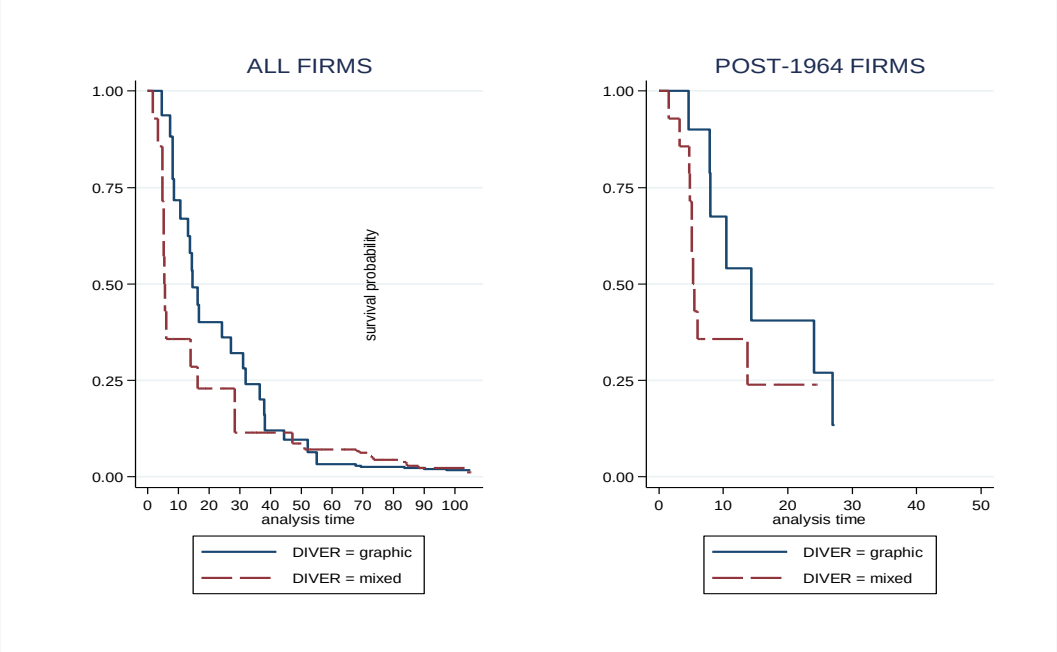

Figure 6.4: Kaplan-Meier survival curves by product line diversification

With time, however, diversification seems to lose relevance. From the fourth decade onwards, the two survival curves mirror each other. The significance of this temporal difference is confirmed statistically. The Wilcoxon statistics[19], which provides more weight for the first decades, indicate that the null-hypothesis of similar curves is rejected, at least, at 5 per cent level of confidence for both sets of firms.

On the contrary, the log-rank statistics[20] do not reject the null hypothesis. This finding may not be in contradiction with the previous one. In fact, it may have originated by the fact that the complete sample (i.e. ALL FIRMS) contained a large percentage of firms that had been established before World War II when diversification was a successful strategy pursued by most firms.

[19] The statistics of the Wilcoxon test are chi2(1)=4.82, p>chi2=0.0282 for the whole set and chi2(1)=3.81, p>chi2=0.0509 for the post-1964 set.
[20] The statistics of the log-rank test are chi2(1)=2.26, p>chi2=0.1329 for the whole set and chi2(1)=2.18, p>chi2=0.1395 for the post-1964 set.

As to the firm's background, the results are less definitive (Figure 6.5). Contrary to other studies (Thompson, 2005 and Dunne *et al*., 2005), being a papermaker seems not to have assured greater survival prospects[21] to entrants. Specifically, having already a large, established core business in a sector outside papermaking at the time of entry or being a foreign papermaker (ORIGINCORE) appears to lower survival probabilities either after the first years or after two decades of permanence in the industry[22].

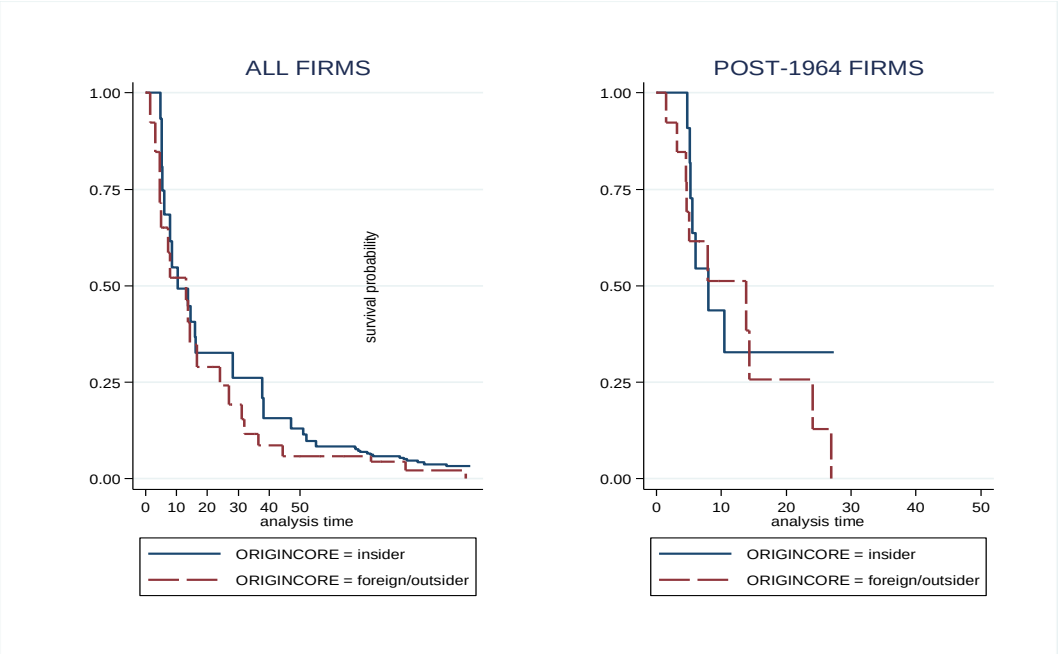

Figure 6.5: Kaplan-Meier survival curves by core business

This pattern is not unreasonable. Being a foreigner or having an established core business outside papermaking indicates a certain degree of strategic flexibility. Should firms not find profitable to stay in a particular industry, they are likely to be less reluctant to leave. Figure 6.5 suggests that such firms do so either within the first years or after a time span of about two to three decades. Papermaking is an industry where structural conditions change slowly and two to three decades may be a reasonable period for the relative

[21] Several non-parametric estimates (not shown) stratified by type of profession of the owner at entry have yielded non significant results.

[22] If the whole period and the ALL FIRMS set are considered, the null hypothesis cannot be rejected at any level of significance. But, if the first 6 years of survival are considered, the null hypothesis is rejected at 5 per cent level (logrank test are chi2(1)=6.17, p>chi2=0.0130) Likewise, it is rejected at 10 per cent in case of the period between 20 and 40 years of survival (logrank tests are chi2(1)=3.31, p>chi2=0.0689).

profitability between papermaking and the sector of origin to have changed. The moderately higher hazard rates exhibited by outsiders in the first years are less easy to interpret. Although no definitive hypotheses can be advanced because of limited information, the histories of those firms that quickly left the industry suggest pursuit of hit-and-run strategies stimulated by the possibility of obtaining subsidies for rehabilitation of acquired plants.

6.4 Multivariate Analysis

The multivariate specification of Cox Proportional Hazard function is:

$$h(t, x_i, \beta, \lambda) = g(t)\exp(x_i, \beta)$$

where $g(t)$ is a baseline hazard of unspecified form**,** x_i is the vector of covariates of firm *i* and β is a vector of parameters. Hazard ratios less than 1 indicate that increases in the corresponding covariates reduce the risk of exit; the reverse if hazard ratios are greater than 1. Hazard ratios of 1 indicate that covariates have no effect.

The results are reported in two subsections. The first discusses the size and age effects on survival without imposing any condition on demographic, technological or other firm's characteristics. The second subsection explores the effects of firms' features other than size on survival.

6.4.1 Size

The size-age dependence has been amply documented[23]. Evans (1987), Dunne *et al*. (1988), Mata and Portugal (1994) and Strotmann (2007), to cite a few, have found that larger and older firms have better chances of survival. In the context of specific industries, Thompson (2005) found a strong and significant effect for size—regardless whether measured as market share, gross tonnage or number of vessels produced—in the American shipbuilding

[23] See Cabral (2007) for a brief and critical overview on the subject.

industry between 1825 and 1914. Similar evidence was obtained by Van Kranenburg *et al*. (2002) for the Dutch daily newspapers industry from 1950 and 1996. The papermaking industry seems to follow suit. Based on data on pulp and paper mills operating in the United States during the period 1900-1940, Ohanian (1993) found, "the probability of failure and mill growth generally were negatively associated with mill size and age" (p. 160).

Yet, evidence on firm survival in the Italian manufacturing industry challenges this empirical regularity. Audretsch *et al*. (1999) examined the post-entry performance of 1,570 manufacturing firms established in 1987 for seven years and found no evidence that start-up size was positively related to survival. The authors' ascribed this result to a number of potential causes such as the underdeveloped and highly imperfect Italian capital market, which might have acted as a *de facto* pre-entry selection process, features of social security files, which might have recorded entry dates with delay, and the success of industrial districts, which might have lowered the barriers to survival for firms operating within their boundaries. However, these explanations might not be the only ones.

Against this background, the size-age dependence in the Italian graphic paper industry was tested by using the Cox Proportional Hazard model where the only covariate is the firm's size. Table 6.1 reports the hazard ratios of this basic specification.

Although survival in the Italian graphic paper industry seems to be positively related to size, the relationship is not statistically significant[24]. As shown in columns 1 and 2 of Table 6.1, an increase in the relative size of a firm reduces minimally the hazard rate and the effect is not statistically significant. The size dependence seems to emerge weakly only[25] in case of small firms. When controlled for paper grade specialization and all firms are taken into consideration, being small (SIZECLASS1) is estimated to face some 1.8 of

[24] Different measurements of size, such as multi/single plant and logarithm of current capacity, stratified by firm characteristics produce insignificant results (not shown).
[25] Similar inconclusive results, not herein reported, have been obtained using different specification of the basic model.

the hazard of being larger (capacity higher than 25,000 tonnes). The rate is significant at 10 per cent level.

	All Firms	Post-1964 Firms	All Firms	Post-1964 Firms
	(1)	(2)	(3)	(4)
SIZEMRK	0.952 (0.039)	0.968 (0.067)		
SIZECLASS1			1.763* (0.541)	1.140 (0.751)
SIZECLASS2				
SPEC			0.773 (0.256)	1.216 (0.809)
Number of observations	74	47	74	47
Convergence achieved after	3 iterations	3 iterations	4 iterations	3 iterations
Log likelihood	-141.435	-42.228	-140.692	-42.180
stphtest (global)	chi2(1)=0.18 p= 0.671	chi2(1)=4.85 p= 0.028	chi2(2)=0.91 p= 0.634	chi2(2)=2.60 p= 0.273

Note: Standard errors in parentheses. (***) indicates 1% level of confidence, (**) 5% and (*) 10%.

Table 6.1: Results of effects of size on hazard ratios

A possible explanation of this quandary might be found in that specialty grades are manufactured in smaller quantities than commodity ones. Being small is not necessarily a limitation that curbs prospects of survival. Another explanation is that many firms exited by plant sale, which implies that plants acquired by entrants were generally of a size comparable to that of incumbents. Table 6.2 below supports this argument.

	Total number	Average SIZEMRK (percentage)	SIZECLASS 1 (number)
Surviving firms	22	2.89	11
Exiting firms by sale	34	2.71	17
Exiting firms by shutdown	18	0.36	17

Table 6.2: Surviving and exiting firms by size and exit mode

Of 52 firms that exited the graphic paper industry, nearly two thirds (34 firms) were dissolved by selling their plants and their size was comparable to that of survivors. By contrast, the 18 firms that exited due to plant closure were all, but one, very small; hence, the reason for lack of a strong relationship between survival and size. Had exit by plant sale been omitted from the sample, small firms would have faced a hazard rate that is about 13 times higher than that of larger firms[26].

Curiously, manufacture of specialty grades affects differently, though not significantly, pre and post-1964 firms. If all firms are considered, being a producer of specialty grades decreases the risk of exit (column 3, Table 6.1). The reverse occurs with post 1964 firms (column 4). This might indicate a sort of first-comer advantage, where the most successful firms in specialty papers were those that established themselves earlier in the twentieth century.

6.4.2 Technical Attributes and Strategic Orientation

The analysis of plant exit in Chapter 5 highlights that plant survival depends on a mixture of plant characteristics, organizational history and firm attributes. The analysis of firm survival suggests that firm strategies and location might be more relevant than technological factors.

Table 6.3 reports the hazard ratios for the Cox regression where the covariates are firms' technical, strategic and location variables. There is no evidence that these specifications violate the proportional hazard assumption.

As expected, technological efficiency —measured as the number of modern, large paper machines—decreases significantly the risk of exit. An additional machine installed after 1945 and wider than 3m reduces the hazard rate by 74 to 78 per cent. But, if post-1964 firms are considered, then the hazard

[26] The hazard ratio is 13.23 and p>0.012.

ratio turns positive. This does not contradict the general prediction that technological efficiency is positively related to survival. First, the coefficient is close to 1 indicating that the effect is minimal. Most post-1964 firms own plants with machines established after the Second World War and, therefore, more modern. Secondly, it captures the unsuccessful history of a large plant at Arbatax, which was constructed in the early 1960s for the production of newsprint and equipped with two very large machines. Although technically efficient, profitability at that plant was often below average[27] and none of the two post-1964 firms that owned it had been able to restore its efficiency.

Being located in North-East Italy decreases the risk of exit by a factor of 0.3. As indicated in Appendix B, most of the pre-unification Italian states developed papermaking districts to meet their domestic demand for paper. Although the political unification of the country in the nineteenth century appears to have minimally disrupted the geographical distribution of paper mills, post-war industrialization has slowly produced today's agglomeration of the graphic paper industry in North Italy, especially in the North East.

Turning to production-line diversification, its importance is confirmed at 5 per cent level of confidence. Regardless of which set of firms[28] is considered, producing a mixture of graphic and other categories of paper more than double the risk of exit. First, older machines are generally used for manufacture of a wider range of paper grades. Secondly, compared to specialized firms, diversifying ones would need today to establish and maintain considerable networks with a multitude of buyers, which only very large producers can afford.

[27] One of the major problems, if not the major, affecting profitability at this plant was its location in Sardinia, where inputs and outputs had to be shipped.

[28] Because the Grambsch-Therneau test revealed that the proportional assumption was violated for the coefficient of NEAST, the regressions were performed by stratifying the data on the basis of NEAST.

	All Firms		Post-1964 Firms		All Firms		Post-1964 Firms[1]		All Firms		Post-1964 Firms[1]	
	(1)		(2)		(3)		(4)		(5)		(6)	
ENTRYMODE	1.411											
	(0.430)											
DIVER (mixed=1)	2.296	***	3.418	**	2.216	**	3.976	**	2.024	**	3.626	**
	(0.720)		(2.079)		(0.710)		(2.516)		(0.651)		(2.325)	
NEAST	0.387	**	0.094	**	0.336	**			0.320	**		
	(0.176)		(0.102)		(0.157)				(0.149)			
PMEFFICIENT	0.785	*	1.051		0.740	**	1.019					
	(0.112)		(0.354)		(0.113)		(0.341)					
EXPAND									0.568	*	0.449	
									(0.173)		(0.277)	
SHRINK									2.017	**	2.284	
									(0.641)		(1.431)	
REORG									0.625		0.982	
									(0.189)		(0.837)	
COHORT1 (before 1950)					0.119	**			0.073	**		
					(0.122)				(0.085)			
COHORT2 (1950-1963)					0.458				0.480			
					(0.236)				(0.244)			
Number of observations	169		47		169		47		169		47	
Convergence achived after	4 iterations		4 iterations		4 iterations		3 iterations		4 iterations		3 iterations	
Log likelihood	-133.936		-37.003		-132.031		-33.543		-140.686		-42.145	
Grambsch-Therneau(global)	chi2(4)=3.31		chi2(3)=5.26		chi2(5)=2.49		chi2(2)=0.03		chi2(7)=0.97		chi2(4)=4.58	
	p= 0.604		p= 0.154		p= 0.778		p= 0.987		p= 0.809		p= 0.333	

Note: Standard errors in parentheses. (***) indicates 1% level of confidence, (**) 5% and (*) 10%.

Table 6.3: Hazard ratios from Cox Proportional Hazard models

Besides production-line diversification and location, external growth strategies (Columns 3 and 5), measured as number of acquisitions (EXPAND) and divestments (SHRUNK), appear to affect the risk of exit. An additional acquisition decreases the hazard ratio by some 45-56 per cent[29], whereas an additional divesture more than doubles the risk of exit. Organizational changes (REORG) decrease the hazard but, their influence appears not statistically significant. Although size *per se* does not significantly influence firm survival, external growth strategies do. Unfortunately, due to lack of precise information on how many times paper machines were upgraded, it was not possible to test whether internal growth strategies (growth by upgrading existing capacity) would make a similar impact[30].

Like in the case of plant exit, adding growth strategy variables improves the goodness of fit of the Cox model. As shown in Figure 6.6

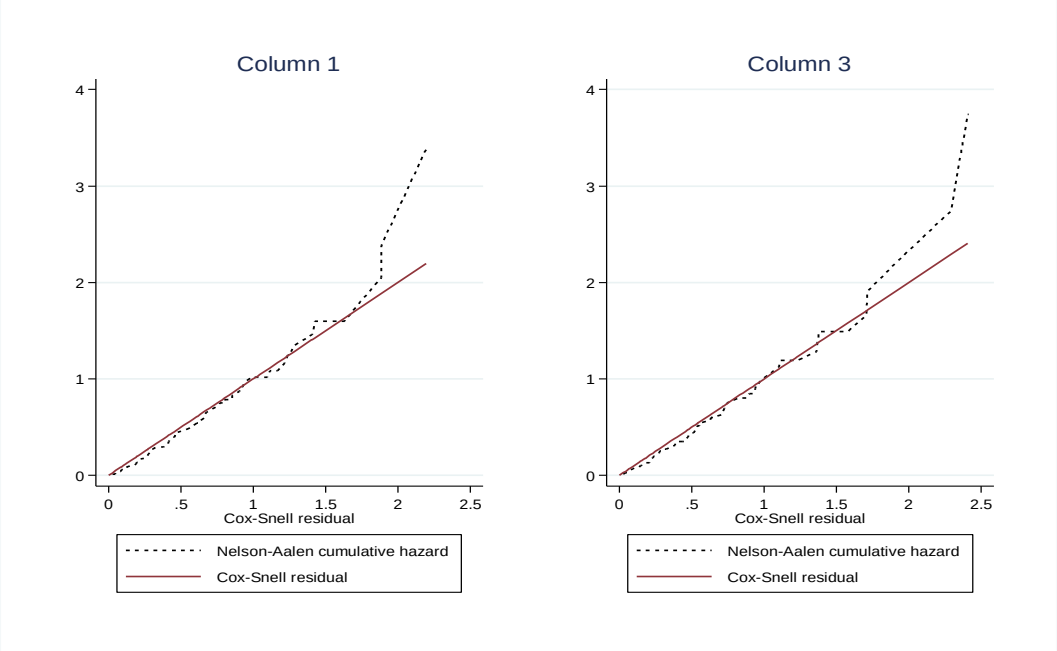

Figure 6.6: Cumulative hazards of Cox-Snell residuals

[29] In specification B3 of Table 6.2, the covariate for technological efficiency is omitted. The reason is that it is correlated with EXPAND. Understandably, firms tend to acquire plants that are equipped with relatively more modern machine; hence the correlation between PMEFFICIENT and EXPAND.

[30] An attempt was made by using the total amount of capacity increased through upgrading and/or plant construction during the lifetime of the firm. The results indicated a statistically significant negative relationship with the risk of exit. However, when measured as percentage of the industry's annual capacity, the coefficient was not significant.

Interestingly, being established before the Second World War reduces the risk of exit by 7 to 11 per cent and 45 to 48 per cent in case of firms established between 1950 and 1964. This suggests the presence of a sort first-comer advantage. However, some caution is warrant. Although the software package STATA has the capability to handle left truncated data, this result might reflect the fact that the set of pre-1964 firms is biased towards long-lived firms, whereas the post-1964 firms have not yet had the chance to survive more than 40 years. The median duration for the whole set is some 34 years and the mean duration is some 43 years.

6.5 Conclusions

The analysis of firm survival produced a mix of expected and unexpected results. As predicted, strategic variables such as production-line diversification, localization and external growth strategies seem to have clearly affected survival prospects. Lack of more detailed information on firms' growth strategies have hampered a deeper analysis of growth by acquisition compared to growth by plant upgrading. It is believed that further study on this area might bring useful insights in the process of survival

Contrary to common knowledge, current size has not emerged as a predictor of the risk of exit. An explanation of this peculiarity can be found in the preponderance of exit by sale that characterise the evolution of the Italian graphic papermaking industry in the last decades. This suggests that the route through which firms come to existence and disappear are not neutral to survival patterns as well as to the dynamics of individual market shares. Had the dataset being larger, it would have been interesting to estimate competing risk models that would account for the alternative modes by which firms exit. In the specific case of the Italian papermaking industry, it might have allowed to discriminate the impact of size on exit by plant closure from that on exit by plant divestment.

The comparatively greater relevance of strategic and location variables than of size may be coincidental, reflecting the peculiarity of this database. But, it could also point to a genuine difference in the way these factors affect firms vis-à-vis plants.

CHAPTER 8

CONCLUSIONS

This study has revealed that fairly significant levels of turbulence may emerge simply from pursuit of entry strategies by acquisition. Such strategies have been a sensible choice in the Italian graphic papermaking since the 1970s. To maintain supply and demand in fairly equal balance in face of moderate long-term demand prospects, would-be papermakers were left with little room for manoeuvre except for acquisition of existing plants. Had the study been confined exclusively to the appearance of *de-novo* firms established by greenfield investment and exit by plant shutdown, then turbulence in the Italian graphic paper industry would have mainly coincided with exit. By including entry by acquisition and exit by sale, then turbulence has emerged, instead, as a consistent feature of the industry. It has produced tangible effects. It allowed more modern plants to continue operating and firms to attempt to become leaders.

By and large, the dynamics of acquisitions and sales seem to portray the evolution of the graphic papermaker population in the last decades as a matchmaking process, by which new and incumbent firms change the portfolio of their respective physical assets in their attempts to survive and grow. If this is the case, then, understanding the distribution of plant attributes becomes crucial for understanding turbulence dynamics at firm level. In industries where production is carried out in large and complex plants, it may be more useful to regard the firm as the combination of two separate elements: the entity that provided the legal foundation to the firm and the production site. The two do not need to be tied together for the whole duration of the firm's life. This approach might also contribute to understand better the chain of causes-and-effects through which policy measures affect industries because such policies affect the firm's selection of clustering together plants.

In this concluding section, I now outline some points for further research. A first point concerns the extent to which public policies may distort the convenience to enter and the length of their survival. Generally, new firms enter when they judge their business idea viable and are confident that they will succeed. But, new firms may purposely decide to enter just to exploit opportunities that have a very limited duration. While in the first case turbulence will result from a market selection process, in the latter from a deliberate hit-and-run decision. As long as these two processes reflect the individual firm's assessment of the nature of business opportunities, turbulence rates depict the evolution of the industry. However, the convenience of limited forays into the market can be prompted by specific public policies, such as subsidies, financial incentives to distressed companies and the like. The Italian graphic paper industry witnessed a few negative examples of this kind[1], where firms were created, acquired plants and left soon after having received some public funds. The result was a rapid turnover in the space of few years. But, these anecdotes suggest that the new firms were clearly not interested in surviving. They enhance turbulence but do not reflect a willingness to compete. Therefore, similar turbulence statistics at aggregate level may disguise very diverse causes and underlying different welfare costs in terms of resource misallocation. More work should be done to analyse the relationship between turbulence and public policies and the potential distortions that certain measures may generate[2].

A second point concerns the dynamics of market shares and their stability or instability. This case study has shown that acquisitions were an important source of turnover among the leading companies and that a significant portion of these leading companies were relatively new. The life trajectories of Fabbri, Sottrici and, more recently, Marchi are cases in point. The first two were unsuccessful, while the last one appears more solid. Rapid external growth allowed Fabbri and Sottrici to become the first and the second largest

[1] Unfortunately, evidence on the occurrence of these cases is anecdotic and could not be used in the quantitative analysis.
[2] Cabral (2007) commented on the distortions on firm mobility that policy measures such as severance payments, legal and economic restrictions to layoffs and the like.

firms for a relatively short period of time. However, overburdened by debts, they, then, dissolved into bankruptcy. As the market cannot *a priori* pick the winners among entrants, so it cannot *a priori* single out the survivors among the leading firms. This case study indicates that at least some turbulence is linked to instability of market shares among the leading firms. In light of recent literature on market share dynamics and persistence of leadership (Geroski and Toker, 1996, and Sutton, 2007), it would be interesting to investigate whether different kinds of turbulence are linked to instability of market shares in excess of that predicted under a benchmark model[3]. Like in the case of duration of industry leadership, the central problem is that the observed amount of turbulence can be judged to be high or low only if measured against a benchmark model, for example, of Markovian kind. Exploring this issue could enhance understanding of the phenomenon of turbulence and its features.

A final point relates to the importance of using case studies to refine the strength of the empirical regularities on entry and exit. This case study has documented a persistence of turbulence in an industry where was not expected, given the incremental and predictable technological advancements that characterise it. It suggests a more complex picture that aggregation disguises. It would be interesting to learn whether similar patterns typify the papermaking sector in other countries and/or other mature, capital-intensive industries.

[3] The usefulness of using an appropriate benchmark against which to judge whether the duration of leadership is long or short has been recently revived by Sutton (2007). By developing a benchmark model of a Markovian kind, the author verified that at least some of the 45 Japan industries investigated exhibited a “Chandlerian” leadership persistence.

CHAPTER 7

CONCENTRATION AND TURNOVER

7.1 Introduction

The constant contraction of the industrial population of graphic papermakers suggests that the industry may have evolved into a concentrated structure. Yet, new firms have continued to enter and exit throughout the second half of the twentieth century, suggesting that entry barriers may not have been so high. Might high levels of concentration ratios conceal a continuous struggle to achieve and maintain market leadership[1] in the Italian graphic paper industry?

This issue has been approached in the literature on market concentration by investigating the relationship between concentration changes and market share stability[2]. Volatile market shares may be regarded as indicative of the vigour of competition. From a conceptual point of view, oligopoly theory indicates that, as seller concentration rises, collusive behaviours are more likely to occur, with the consequence that market shares among the leading firms are less subject to wide fluctuations. Empirically, Gort (1963) and Heggestad-Rhoades (1976) found evidence of a positive association between degree of concentration and stability of market shares. Although collusive behaviours are more likely in oligopolistic structure, the identity and size of firms change over time. By making collusive agreements less effective (Caves and Porter, 1978), exogenous disturbances caused by shifts of demand or costs, such as changes in consumer preferences, inflation costs, entry of new competitors, technological innovations and the like generate turnover in rankings and, in turn, increase market share instability.

[1] Curry and George (1983) and Scherer and Ross (1990, Chapter 3) provide comprehensive overviews of the conceptual issues and empirical findings on industrial concentration.
[2] Gort (1963), Caves and Porter (1978), Heggestad-Rhoades (1976), McGuckin (1972), Geroski and Toker (1996), Davies and Geroski (1997) and Sutton (2007).

Recent empirical studies on market instability include Baldwin and Gorecki, 1994, and Davies and Geroski, 1997. The former investigated the relationship between concentration and firm mobility and compiled empirical evidence that a wide range of mobility patterns are consistent with a similar value of the four-firm concentration ratios. Davies and Geroski, instead, developed an econometric model to derive joint predictions about the instability of market shares and change of concentration. By using a dataset of 200 UK leading firms from 1979 to 1986, the authors found that fairly stable concentration levels coexist with considerable volatility in market shares among the leading firms, the two are loosely connected and entry contributes little to changes in concentration.

The analysis of the Italian graphic paper sector confirms the concomitant presence of increasing concentration ratios and volatile individual market shares. The analysis also shows that these two seemingly unrelated dynamics originate from implementation of similar external growth strategies (entry and expansion by acquisition) by surviving firms. Section 2 presents the evolution of concentration in the period considered, Section 3 analyses turnover in the ranks of the four largest firms and Section 4 discusses the relationship between plant acquisition and dynamics of market shares. Concluding remarks comprise Section 5.

7.2 Changes in Concentration

The industry seems to have undergone a significant increase in seller concentration[3], moving from a moderately to a highly concentrated structure. Table D.17 in Appendix D reports the four- and eight-firm capacity concentration ratios (CR4 and CR8) and the Herfindahl-Hirschman index (HHI) from 1964 to 2004, whereas Tables D.18 and D.19 report the individual annual shares of the first eight largest firms. Figures 7.1, 7.2 and 7.3 illustrate the trends in the annual concentration indexes for selected groups of firms.

[3] Due to unavailability of sales data, market shares are calculated on the basis of production capacity (in tonnes).

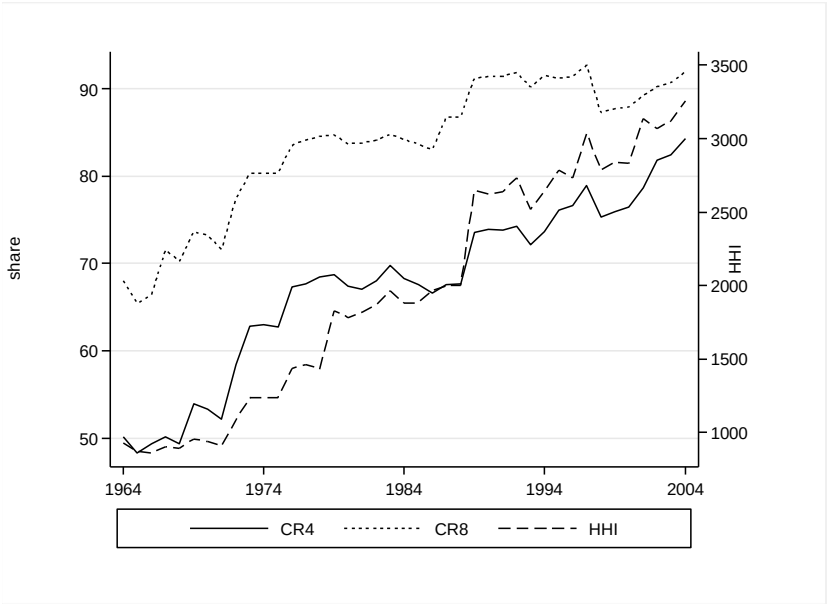

Figure 7.1 Concentration indexes, 1964-2004

As shown in Figure 7.1, concentration has risen in steps: periods of relative structural stability alternated with short periods, in which the largest incumbents rapidly increased their market shares by acquiring plants, mostly from enterprises in distress. In the years of such rapid increases (1972-1973, 1989 and 2001-2002), CR4 increased, on average, 9.8, 8.7 and 3.4 points, respectively. This compares to 0.6, 0.6 and 0.4 for the immediate antecedent periods. HHI and, to a minor degree, CR8 followed similar patterns[4]

Despite a steady movement towards a highly concentrated structure, two distinct dynamics seem to have been at work: one pre-1982, characterised by close rivalry among the three largest firms, and one post-1982, where the largest firm began to distance itself from the next two (Figure 7.2).

[4] The average annual change in CR8 and HHI were, respectively, 5.7 and –1.4 per cent in 1964-71; 5.9 and 16.6 per cent in 1972-73; 0.6 and 3.8 per cent in 1974-88; 5.2 and 32.3 per cent in 1989; -0.3 and 0.8 per cent in 1990-2000; and 1.3 and 4.3 per cent in 2001-03.

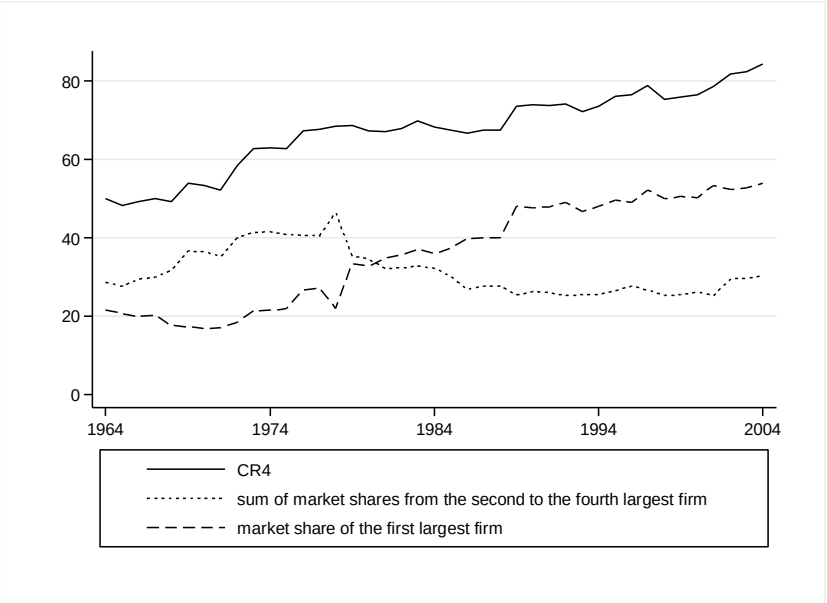

Figure 7.2 Concentration ratios for the first four firms, 1964-2004

Until the mid-1970s, the individual market shares of the three largest firms were almost comparable. Then, the largest embarked on a rapid, but unsuccessful, expansion strategy that led the firm to divest, in 1981, a significant part of its plants to its top rivals (the pointed dip in the market share of the largest firm and the corresponding pointed peak in the cumulative shares of the other three top firms). Nineteen eighty-two was the turning point. It was the first year in which the market share of the largest firm surpassed the cumulative market shares of the next three largest corporations (CR2-4), a situation unchanged to date.

By contrast, concentration amongst the lower ranking seems to have remained rather stable for most of the period (Figure 7.3). Until the mid-1990s, the combined market share of the fifth to eighth largest firms (CR5-8) has fluctuated minimally, between 21 and 15 per cent. But, from the second half of the 1990s until 2004, all these firms experienced a steady erosion of their market shares, though not necessarily of their ranks. CR5-8 decreased from some 15 to some 7 per cent.

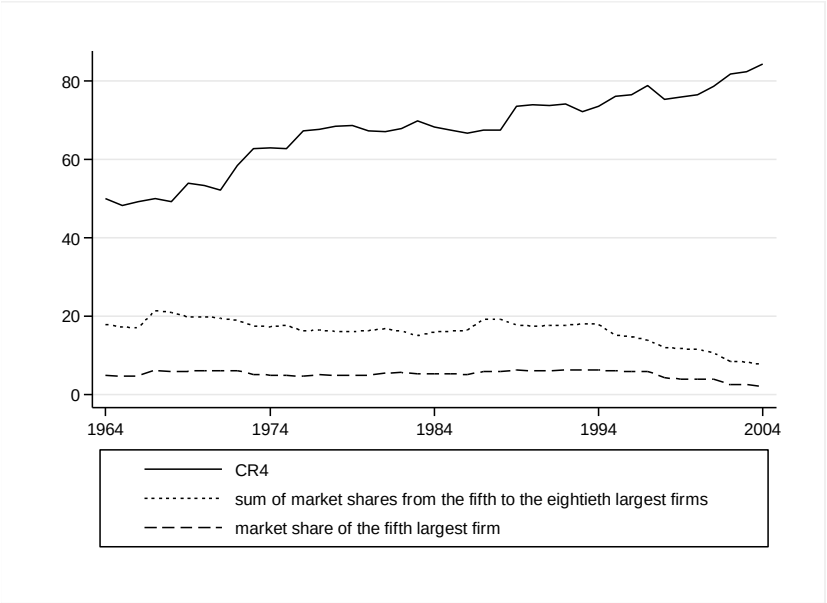

Figure 7.3 Concentration ratios for selected top ranked firms, 1964-2004

There is little doubt that the industry has moved towards an ever more tight oligopolistic structure. However, these various indexes may overestimate the actual degree of oligopoly, especially in the last decade, because of failing to take into account foreign competition. In fact, due to a combination of direct state interventions and tariff protection measures, the Italian market for graphic paper had been sheltered from foreign competition until the early 1980s, when the government finally embraced liberalization policies. Since then, foreign suppliers have gradually penetrated the Italian market for graphic paper, whereas Italian companies have ventured into European markets. Imports have increased from 35 per cent in 1988 to 83 per cent of total production, while exports from 25 per cent to 50 per cent. Therefore, measuring concentration at country level might be too restrictive, especially for the top four firms.

7.3 Changes in Market Shares

Turning to market shares, they reveal that membership in the ranks of the largest firms (commonly referred to as turnover[5]) was not necessarily long-

[5] Scherer and Ross, 1990, p. 68-70.

lasting. Between 1964 and 2004, 24 firms appeared in the list of the eight largest enterprises at one time or another, of which 12 appeared in the list of the top four (Table 7.1). Only one of the top eight in 1964 remained as such throughout the period (Burgo). Since its foundation in 1906, Burgo pursued careful expansion strategies that combined a forward-looking attitude to product market trends with sound financial plans developed jointly with major Italian banks (Banca Commerciale in the early period and, subsequently, Mediobanca)[6]

	1964		2004
1st	Burgo (entered in 1906)	1st	Burgo
2nd	Ferraro (entered in 1959, last appeared in 1972)	2nd	Marchi (entered in 1960, first ranked in 1989)
3rd	state (entered in 1928, last appeared in 2001)	3rd	Lecta (entered in 1998, first ranked in 1998)
4th	Donzelli (entered in 1925, last appeared in 1971)	4th	Fedrigoni (entered in 1888, first ranked in 1976)
5th	Rizzoli (entered in 1953, last appeared in 1988)	5th	Pigna (entered in 1870, first ranked in 1989)
6th	Sterzi (entered 1930, last appeared in 1980)	6th	Spinoglio (entered in 1985, first ranked in 2001)
7th	Avondo (entered in 1787, last appeared in 1968)	7th	Cariolaro (entered in 1986, first ranked in 1997)
8th	Mondadori (entered in 1957, last appeared in 1988)	8th	Favini (entered in 1906, first ranked in 2004)

Note: the years when the firm entered the industry as well as when first and last appeared in the top four ranking are reported in parenthesis.

Table 7.1: Eight top firms in 1964 and 2004

A first impression of the magnitude of the turnover can be gauged by comparing the lists of the top eight firms in 1964 and 2004. Of the top eight firms[7] in 1964, Avondo, Donzelli and Ferraro dropped from the list in the following decade. The two modern plants of Ferraro were acquired by the newly constituted Fabbri in 1973 and Avondo's plants and the majority of

[6] As detailed in appendix A, investment projects in papermaking require vast financial resources. Therefore, sound financial plans are essential to minimize the risk of liquidity crisis, at a later stage. Although no systematic financial information on the expansion strategies adopted by papermaking firms was available at the time of the thesis, circumstantial evidence suggests that the too rapid aggressive M&A strategies of Fabbri (the largest firm between 1973 and 1980) and Sottrici (the second largest group between 1989 and 1996), which were financed by borrowing, were at the root of their dissolution.

[7] As firms can comprise several companies under their ownership (see section 3.2), they are cited by the name of their owner, rather than the commercial name of their companies.

Donzelli's assets were acquired by the state in 1969 and 1972, respectively. In the 1980s, three other firms dropped in ranking: Sterzi and Rizzoli due to severe financial difficulties and Mondadori because of a change in the orientation of its core business[8]. Finally, the State dropped from the classification in 2001, following the sale of Cartiere Miliani to Fedrigoni.

In reverse, the list of the eight top firms in 2004 contains six enterprises that entered the eight-firm list in the previous 15 years. The entries of Marchi, Fedrigoni and Favini are the result of expansion strategies that combined internal and external growth, whereas the emergence of Cariolaro and Pigna was due to plant upgrading. The entry of Lecta in the top four coincided with its entry by acquisition of the plant at Riva del Garda, previously owned by Bertelsman, which occupied the eight-firm classification from 1973 to 1997.

Yet, it is changes in individual market shares, rather than in ranking, that better indicate the nature of competition among these top firms[9]. In principle, frequent changes in ranking may be caused by small changes in individual markets. Infrequent ones may conceal substantial displacement of the second-, third- and fourth-ranked firms (Gort, 1963). Table D.18 in Appendix D presents the individual market shares of the four largest firms in all years between 1964 and 2004. Figure 7.4 illustrates the competitive struggle among the largest firms during relevant intervals[10].

[8] Between the 1950s and early 1965, the three major Italian publishing and printing houses, namely Mondadori, Fabbri and Rizzoli ventured into papermaking in order to secure, at subsidized price, a constant supply of coated and uncoated grades for their vast printing operations. However, with the decision of the Italian government in the early 1980s to reduce subsidies, the economic rationale for vertical integration strategies disappeared.

[9] A critique of the superiority of market share, rather than ranking, in the analysis of the dynamics of concentration is provided by, among others, Hymer and Pashigian (1962). The authors devised an instability index defined as the sum of the absolute value of the change in shares of all firms and found that concentrated industries often exhibited above-average market share instability. Application of this index to the thesis' context is not appropriate. As market share is computed on the basis of capacity, rather than sales, the corresponding time-series of the annual instability index could fluctuate substantially from one year to another, just due to one large capital investment.

[10] Similar analysis (not shown) has been done for the next group of four largest firm (five to eight rank). Once again, it confirmed the presence of significant turnover throughout the period under consideration.

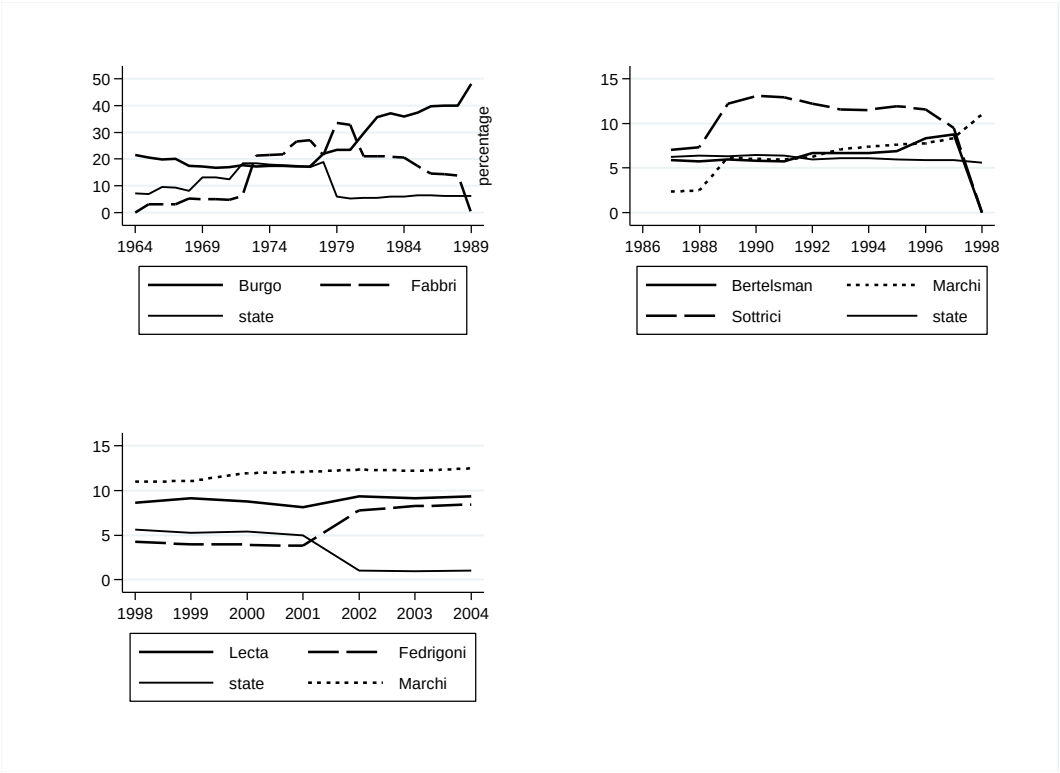

Figure 7.4: Market shares of selected top ranked firms

Inspection of the data indicates a substantial turnover throughout the period, despite increasing concentration. The first chart in Figure 7.4 depicts the dynamics of market shares of the three players that came to dominate the market in the 1970s, namely Burgo, Fabbri and the state. Through acquisitions of plants from traditional corporate groups facing severe financial crisis, the state and, especially, Fabbri rapidly increased their market shares to a level that made them comparable to the long-established Burgo. From occupying the eleventh position in 1965, Fabbri surpassed Burgo in 1973 and retained the top position until 1980. Such elbow-to-elbow rivalry, however, lasted until the late 1970s. In 1979, Fabbri entered Burgo's Board of Directors while Fabbri's modern plant at Sora was transferred to Burgo[11]. In 1982, in pursuit of a modernization strategy, the most modern plants of Fabbri were acquired by Burgo while Fabbri applied for receivership. Fabbri's enterprise group was finally dissolved in 1988.

[11] With this move, the two firms ceased *de facto* to be direct competitors, until 1982, when Fabbri entered into receivership. Fabbri's empire was finally dissolved in 1988.

The second chart in Figure 7.4 illustrates rivalry for the second, third and fourth positions, from the demise of Fabbri in the mid-1980s to that of Sottrici a decade later. In 1986, the state was the third top firm and Bertelsman the fourth, together accounting for some 12 per cent of the industry's capacity. Sottrici had just entered the ranks of the eight largest firms and Marchi was the ninth. Three years later, through a series of acquisitions, Sottrici had become the second largest firm and Marchi the fifth. Bertelsman and the state alternated their positions between the fourth and sixth. But the aggressive acquisition strategy pursued by Sottrici, which was mainly financed by borrowing, revealed its shortcomings by the mid-1990s. The high level of indebtedness coupled with a market downturn caused ownership to be transferred from the Sottrici family to their creditors (mainly banks), which, then, decided to dissolve the enterprise group.

The third chart shows the competitive scene among the top firms in the last years. Once more, acquisition strategies resulted in the ascendance of Marchi to the second position and Fedrigoni[12] to the fourth. Since the latter was caused by acquisition of Cartiere Miliani from the state, the dynamics of market shares of Fedrigoni mirrors that of the state. By contrast, Lecta[13] increased its market share by internal growth (upgrading its equipment).

In short, leaving aside the dynamics of the largest firm (Burgo), turnover among the leading firms has been a constant feature of the industry. It is the result of pursuance of growth strategies through acquisition by old, as well as relatively new, enterprises. The Italian case provides further evidence that mature, highly capital intensitive industries with a concentrated structure do not necessarily deter competition.

[12] Fedrigoni is an old firm, established in the nineteenth century and specialised in technical papers since the 1930s. Because speciality papers are produced in limited amounts, its entry into the four top leaders is remarkable.
[13] Lecta acquired the plant at Riva del Garda from Bertlesman in 1997.

7.4 Plant Acquisitions, Market Shares and Concentration

Inspection of individual market shares of the top firms also suggests that external growth strategies (that is, plant acquisitions) have played a fundamental role in determining the ascendance and demise of firms throughout the period[14]. In this case, the dominant role of acquisitions appears particularly remarkable. Between 1964 and 2004, industry's capacity nearly tripled, from 1,224,390 to 3,524,320 tonnes. To achieve this level, 3,250,200 of new capacity were installed and 950,270 scrapped. During the same period, the total volume of capacity that had been acquired (divested) was 3,323,200, marginally higher that the total volume of new capacity and 45 per cent higher than the total volume of net new capacity.

Using a technique devised by Weiss (1965) and applied, among others, by Desvousges and Piette (1979) and, more recently, by Davies and Geroski (1997), the contribution of mergers and acquisitions to changes in concentration ratios can be measured by decomposing the difference between the total capacity of the top largest firms (majors) at start and end period (reference interval) into its constituent parts: total capacity acquired by the end-of-period majors during the reference interval (external growth contribution), total new capacity built by the end-of-period majors during the reference interval (internal growth contribution) and total capacity of the start-of-period majors that had been displaced by end-of-period majors during the reference period[15]. Such decomposition yields the following results for the changes in the four-concentration ratio in the Italian context (Table 7.2).

[14] Curry and George (1983) provide a critical overview of the empirical literature on mergers and concentration, outlining the different methodological approaches and conflicting empirical findings. Yet, the authors conclude that, "When all the facts and arguments have been assembled it is difficult to escape the conclusion that mergers have been the dominant factor in increasing concentration" (1983, p. 247).

[15] Weiss (1965) decomposes the change in concentration between the start and end period into mergers, internal growth and displacement. The effect of mergers is defined as, "the percentage of initial industry capacity assignable to plants acquired by the four(eight) largest firms at the end of the period (hereafter time two majors)", the effect of internal growth by time two majors as, "the amount by which they were able over the period to increase the share of total industry capacity assignable to their plants and acquisitions" and the effect of displacement as, "the portion of the growth of the time two majors' share of total capacity which went into catching up with time one majors and therefore did not increase concentration" (p. 174).

Period	Acquisitions	Internal Growth	Displacement	Total Change
1965-1974	0.427	-0.120	-0.178	0.129
1975-1984	0.053	0.042	-0.021	0.010
1985-1994	0.256	0.019	-0.221	0.054
1995-2004	0.132	0.123	-0.148	0.107

Table 7.2: Decomposition of total change in CR4 by period

From Table 7.2, it appears that acquisitions had been chiefly responsible for the increase in concentration in all four periods. Without acquisitions, and with the other components unchanged, concentration would have either decreased or remained essentially stable over the four decades. Although undoubtedly significant, the contribution of acquisitions according to this decomposition is, however, likely to be exaggerated because it does not take into account its potential association with displacement (Weiss, 1965). Four of the seven displacements observed at four-firm level were caused by acquisitions of plants by majors ascending into the ranks of the top four. The correlation coefficient between acquisition and displacement is 0.728.

The importance of acquisitions in the dynamics of market shares and concentration ratios can be also assessed by comparing the largest plants in 1964 with those in operation in 2004. Table 7.3 below shows for each of the fifteen largest plants in 1964 and 2004 the owning firm at the time, its rank and the number of ownership changes that the plant had undergone during its existence.

In line with the results of the decomposition of concentration changes, the leading firms during the last 40 years centred their growth strategies around acquisition of large plants owned by other large firms. In 1964, 12 of the 15 largest plants were owned by firms among the eight leading firms. In 2004, all 15 largest plants were integrated into the assets of the six majors. Despite the turnover in the ranks of the major firms, nine of the biggest plants in 1964 had remained so, 40 years later. Of these nine plants, only two (Verzuolo and Manova) had not changed hands, that is, they remained property of the

leading firm throughout the 40 years. The bulk of them (seven plants) had experienced an average of two ownership transfers between 1964 and 2004. Similar conclusions can be deduced looking at the list of the largest plants in 2004. With the exception of Alzano, owned by Pigna since its foundation in 1870, all five other majors had at least one of their largest plants acquired at some point during the last 40 years.

	1964				2004		
	Plant name	Firm	Ownership transfers		Plant name	Firm	Ownership transfer
1st	Duino	Ferraro (2nd)	2	1st	Verzuolo	Burgo (1st)	0
2nd	Mantova	Burgo (1st)	0	2nd	Duino	Burgo (1st)	2
3rd	Verzuolo	Burgo (1st)	0	3rd	RivaGarda	Lecta (3rd)	2
4th	Arbatax (exit in 1997)	Ferraro (2nd)	2	4th	Sora (entry in 1965)	Burgo (1st)	1
5th	Marzabotto	Rizzoli (5th)	1	5th	Avezzano	Burgo (1st)	2
6th	Serravalle (exit in 1985)	Avondo (7th)	3	6th	Chieti	Burgo (1st)	2
7th	Verbania (exit in 1983)	Vulcanizzata(9th)	1	7th	Toscolano	Marchi (2nd)	3
8th	Tolmezzo	Pirelli (10th)	1	8th	Mantova	Burgo (1st)	0
9th	Ascoli	Mondadori (8th)	2	9th	Tolmezzo	Burgo (1st)	1
10th	Corsico (exit 1997)	Burgo (1st)	0	10th	Fabriano	Fedrigoni (4th)	1
11th	Toscolano	Donzelli (4th)	3	11th	Sarego (entry in 1971)	Marchi (2nd)	0
12th	Chieti	State (3rd)	2	12th	Villorba	Marchi (2nd)	3
13th	Riva Garda	Legrenzi (11th)	2	13th	Alzano	Pigna (5th)	0
14th	Avezzano	Torlonia (13th)	3	14th	Germagnano	Spinoglio (6th)	1
15th	Crevacuore	Donzelli (4th)	3	15th	Marzabotto	Burgo (1st)	1

Note: Firms' current rank is reported in parenthesis.

Table 7.3: Top plants in 1964 and 2004

That external growth has been a fundamental strategy throughout the four decades can be explained in terms of the increased importance of economies of scale over time. As described in Appendix A, technological advances have expanded enormously the capacity of paper machines, which, in turn, have increased the optimal size of plants. Consequently, the average size of plants and firms has steadily increased over the period (Chapter 4). If plant-scale economies stimulated firms to increase their size, demand conditions did not call for expansion of industry's capacity. From the late-1960s to the 1980s, the industry suffered from substantial overcapacity,

while trade liberalization measures in the mid-1980s forced Italian producers to concentrate their investments in improving product quality, rather than quantity[16]. In this context, pursuit of external growth strategies appears reasonable and likely to be the most successful one for firms intending to gain prominent positions in the market. The fact that concentration has increased is an inevitable consequence.

However, this case study reveals that the effects of such external growth strategies are not necessarily long-lasting, as the ascendance and demise of Fabbri and Sottrici indicate. In fact, a series of acquisitions may lead to a substantial leap in the position of the acquiring firm in the short-run, but such acquisitions may or may not be successful in the medium- or long-run. As the literature on plant ownership changes indicates (Chapter 5.2.3), the performance of an acquisition is conditional on the quality of integration of acquired plants in the asset portfolio of acquirying firms. If the integration is successful, then, acquiring firms will maintain their assets and market position; if unsuccessful, they will try, or be forced, to relinquish control over part or the whole of their assets, with the consequent loss of market shares. But, as soon as unsuccessful mergers are dissolved, new acquisitions are pursued. If plant-scale economies explain changes in concentration in the long-run, it is firms' growth strategies that are likely to explain how concentration evolves.

Postscript

This concluding note presents the most recent developments for the eight top firms in 2004. Burgo (the largest firm since the mid-1980s) and Marchi (the second) merged in 2006. Spinoglio (ranked sixth in 2004) went into bankruptcy in 2007 and dissolved. Its plant at Germagnano was, subsequently, acquired by the Grazzini family. Similarly, Favini (ranked

[16] Being a country with no forest resources, Italian producers are at disadvantage in production of commodity grades, which are produced in large quantities. The most advantageous product strategy for them is to manufacture highly value-added grades, whose world demand is limited.

eighth in 2004[17]) went into liquidation in 2008 and was acquired by Orlando, a private equity fund. Both firms are successfully operating the mills. Fedrigoni, with its acquisition of Cartiere Miliani in 2001, has strengthened its European position in the segment of technical paper and banknotes. Cariolaro and Pigna continue to maintain their position.

Not having access to recent information on the current capacity of each plant and firm in operation, it was not possible to calculate whether concentration has increased or stabilized. However, if all firms maintain the same 2004 shares, this would mean that the group Burgo-Marchi accounts for nearly 69 per cent of the entire Italian production[18]. The recent developments seem to confirm continuation of the incessant turnover of plants and firms that characterised concentration in the period 1964-2004.

[17] Besides the Italian mills at Rossano Veneto and Crusinallo, the Favini family acquired two other plants in the Netherlands in the late 1990s. Its position in the 2004 top firms refers only to its Italian operations.
[18] With this merger, Marchi entered into the world's top 100 largest firms.

APPENDIX A

TECHNICAL NOTES ON MODERN PAPERMAKING

This Appendix provides a brief account of papermaking and the paper industry. The aim is to provide an overview of the basic demand and supply conditions that have shaped the industry and, by doing so, explain some features of the thesis' data and quantitative analysis. Unless otherwise mentioned, this account refers to the industry as a whole, rather than solely to the graphic segment. Since the structural features of manufacturing paper are essentially the same for the various kinds of paper.

These technical notes are based on a number of articles and books, with only specific references quoted. The main books consulted for the technical aspects were: the *Handbook of Paper and Board* by Herbert Holik and *Paper and Paperboard: Manufacturing and Converting Fundamentals* by James E. Kline, and for the interplay between the industry's technological requirements and economic conduct *The Economics of the Pulp and Paper Industry* by Magnus Diesen. Specific references to these works are omitted in the text.

The Appendix is organized into four sections. It starts by describing the product, its varieties and classifications, followed by an overview of today's demand for paper and graphic papers. The third section presents a summary of the papermaking process, paper machines, technological advances and economies of scale. The Appendix finishes with a description of the main business strategies with respect to investment, vertical integration and pricing.

A.1 The Product

Paper is defined as a homogeneous sheet of felted cellulose fibres, bound together by interweaving and bonding agents[1]. It excludes any other material

[1] Retrieved from RISI: http://www.risiinfo.com/community/paperdictionary on 25 May 2009.

made from synthetic polymers, such as non-wovens[2] or material not formed by a random web of fibres, such as papyrus[3].

Although paper is a specific material, its versatility and availability have paved the way to creation of a multitude of different products and product markets over the centuries. Currently, there are some 3,000 kinds of paper and paperboard[4] (hereafter referred to as paper or papers), which are used for storage and communication of information, cultural and artistic purposes, shipment and protection of goods, personal hygiene, medical care and industrial purposes. There are papers that can decompose in water or withstand wetness and acid, burn or resist fire, be opaque, translucent or transparent. Paper may be impregnated, enamelled, metallized, creped, watermarked, waxed, glazed, sensitised, folded, twisted, crumpled, moulded and coated, to cite a few kinds of treatment.

Paper comes in hundreds of different grades[5], with specific structural, optical, strength and water-sensitivity properties[6]. There is no universally adopted classification for paper, as there is no one-to-one relationship between grades and end-uses. To date, significant differences exist between the trade's and industrial statistical classifications, as well as, between those

[2] Non-wovens are webs or mats made from synthetic polymers, such as high-strength polyethylene fibres. In recent years, non-wovens have become substitute for paper in large envelopes and tote bags.

[3] Unlike paper that is made from vegetable fibres obtained through maceration, papyrus is made from thin strips of the pith of the plant, laid together, soaked, pressed and dried. It was the most commonly used writing medium in ancient Egypt, Greece and the Roman Empire. Papyrus is also the etymon of *paper* in the English language.

[4] Specialized literature often refers to the industry as the paper and paperboard industry. The distinction between paper and paperboard is based on weight: the former up to 225g/m^2 and the latter more than 225g/m^2. Paperboard is used mainly to make items for packaging, such as cardboard boxes, shipping containers for produce and appliance containers. However, in recent times, some kinds of paperboard are lighter than certain papers, so there is no specific weight cut-off that separates universally the two categories. In this thesis, the term paper will be used to identify the broader group, including paper and paperboard products.

[5] Paper grade is a type or class of paper identified as having the same fibre, colour, additive, and chemical composition and manufactured to the same physical and mechanical characteristics.

[6] The structural properties include basis weight, calliper (i.e., thickness of the paper), bulk (i.e., volume per unit weight), density (i.e., ratio between basis weight and calliper), moisture content and stability, directionality (i.e., tendency to align the cellulose fibres in the machine direction) and felt/wire side. For graphic papers, optical and strength properties are crucial because they affect quality of print as well as performance of paper in printing presses, the so-called runnability.

used in North America and Europe. The differences between commercial and industrial classifications concern mainly the criteria by which the classes of products are disaggregated at the finest levels: content and basic properties in the case of commercial classifications and technology in the case of industrial classifications. The differences across regions mainly reflect differences in national systems of measurement. As a result, statistics from different sources are not immediately comparable. The remainder of this section describes the classification system used by paper associations and that by statistical institutions in Europe.

A.1.1 Commercial Classifications of Paper

Table A.1 presents the classification of papers according to the Confederation of European Paper Industries (CEPI)[7] and the Italian association of pulp and paper producers (ASSOCARTA). This classification is substantially similar to that adopted by *Pulp & Paper International*, the foremost international magazine on papermaking, and the Food and Agriculture Organization (FAO)[8].

At first level, the trade groups paper into four basic categories: graphic, packaging, sanitary and others. Graphic paper refers to a large range of different paper grades suitable for printing and writing and made from virgin or recycled fibres or mixtures of them. It may be coated on one or both sides or uncoated and have been subjected to a variety of processes to improve smoothness and printability such as sizing, calendaring, super-calendering, glazing or similar processes.

Packaging paper and board consists of a large group of papers and boards used for packaging. It includes case materials mainly used in the

[7] The Confederation is composed of the 18 representatives of national associations (16 European Union countries, Norway and Switzerland), of which the Associazione italiana fra gli industriali della carta, cartoni e pasta per la carta (ASSOCARTA) is the Italian member country. Through its member countries, CEPI represents some 800 pulp and paper producing companies across Europe.

[8] For concordance between the trade's and statistical classifications, see CEPI, *Harmonised List for Paper and Board Grades*; retrieved from http://www.cepi.org on 27 May 2009.

manufacture of corrugated board, such as kraftliner, testliner, semi-chemical fluting and waste-based fluting; carton board, which has good folding properties, stiffness and scoring ability and is mainly used in cartons for consumer products; wrapping papers, which may be subject to various finishing and/or marking processes; and other papers for packaging mostly produced from recovered fibres and subject to conversion.

1st level	2nd level	3rd level
graphic paper	newsprint	
	printing and writing	uncoated mechanical coated mechanical uncoated woodfree coated woodfree
packaging paper	case materials	krafliner testliner recycled liners flutings
	carton board	
	wrappings	sack kraft kraft wrapping food wrapping
	other paper for packaging	
sanitary and household paper		
other paper		

Source: CEPI, *Harmonized List of Paper and Board Grades*

Table A.1: Commercial classification of paper

Sanitary and household paper encompasses tissue and other hygienic papers for use in households, commercial and industrial premises. Examples are cellulose wadding (a highly absorbent product made from virgin fibres and used for sanitary towels, surgical artificial cotton, patients' sheets and packaging cotton), toilet paper, facial tissues, kitchen towels, hand towels and industrial wipes and the like. In industrial statistics, quantities and values refer to parent reels before conversion to finished products. Trade statistics, however, record figures in both parent reels and finished products.

Other paper is a residual category including paper and paperboard for industrial and special purposes, such as base papers for décor and wallpaper, priming and barrier foils, cigarette papers, papers for electrical and technical purposes, filter papers, photographic base paper, gypsum liners, presspan, building paper and other specific applications and treatments.

Each of the four categories is, then, segmented in a number of sub-categories. In the case of graphic paper, these subcategories reflect the basic paper properties, which are determined, in turn, by two fabrication parameters: fibre content (woodfree or groundwood)[9] and surface treatment (coating or uncoating)[10]. The former determines the durability of graphic paper while the latter its colour-printing quality. On these bases, the trade divides graphic paper into newsprint and printing and writing papers.

- **Newsprint** is mainly used for printing newspapers. It is made largely from mechanical pulp and/or recovered paper with or without a minimal amount of fillers (less than 10 per cent). Since the mid-1980s, the use of recovered paper has increased dramatically, to reach 100 per cent in certain cases. Weights usually range from 40 to 52 g/m^2 but can be as high as 65 g/m^2. Newsprint is sold almost entirely in reels. Its

[9] There are two basic types of fibres: groundwood, which is obtained by mechanical means; and woodfree, which is obtained from chemical pulping and is free from groundwood fibres. Mechanical pulp means that cellulose fibres have been separated by mechanical means. It is a low-grade material, often containing small pieces of timber still intact. By contrast, chemical pulp is obtained by separating cellulose fibres with chemical agents. Because of its structure, groundwood fibres have a greater tendency to yellow with age, so they are mainly used when the life of the printing material is likely to be relatively short. By contrast, woodfree fibres withstand age without loosing original colour, so they are used when printed material has to be retained for considerable time.

[10] All graphic paper undergoes some sort of surface modification to improve their smoothness, such as surface sizing, calendaring and supercalendaring. However, pigment coating is treated separately because this operation creates a surface that is smother than the uncoated one making these grades particularly suited for high quality halftone reproduction. Coated grades constitute a very large category of graphic papers, which can be further divided in a variety of ways depending on the market, manufacturer and what else might be considered. It is common to categorise coated grades by weight: light-weight (LWC), medium-weight (MWC) and heavy-weight (HWC). The lighter weights are most likely to contain groundwood fibres. As the weight increases, the probability that the grade contains groundwood decreases to almost mil, cost increases, as does quality and probability of being used in promotional material and up-market publications.

performance properties are mainly assessed in terms of smoothness and runnability.

- **Printing and Writing Paper** (pr/wr*)* comprises all paper for printing purposes other than for newspapers. It is distinguished from newsprint by such properties as brightness or smoothness. It includes office paper, data paper, manual and school writing paper, copy paper, stationary and the like. This class is sub-divided into four groups according to fibre content and surface treatment:

  - Uncoated mechanical is generally used for printed material whose life expectancy is limited and price low, as in the case of magazines, catalogues, directories and advertising materials such as inserts, flyers, coupons, as well as mass market paperback books. It contains mainly wood fibre from mechanical pulping and 15-30 per cent fillers. It is mostly sold in reels. Weights usually range between 50 and 60 g/m^2. Stable quality, smooth surface for four-colour printing and good runnability are the most important performance properties.

  - Coated mechanical paper, occasionally referred to as coated groundwood paper, is made from mechanical pulp and undergoes super-calendering or other manufacturing processes to make it glossy. It is used mainly for magazines and catalogues. In Europe, coated mechanical paper is classified according to basis weight (medium- and light-weight) whereas, in North America, according to brightness. Europe is the world's largest producer of lightweight grades (LWC), which accounts for some 80 per cent of its total production of coated mechanical paper.

  - Uncoated woodfree paper covers a wide range of end-uses, including almost all office paper, such as forms, envelopes, stationary, reprographic papers, technical papers and the like, as well as offset grades used for general commercial printing. It contains mainly wood

fibre from chemical pulping and 20-30 per cent filler. Weights range between 50 and 140 g/m^2. High brightness, stable quality and good formation are the most important properties. End-users usually purchase these grades from wholesale merchants.

- Coated woodfree paper is made mainly from chemical pulp and contains 20-30 per cent filler. These grades are for high quality, four-colour printing. Major end-uses are up-market catalogues and magazines, annual reports, books, brochures and promotion material. Two-thirds of the production are in sheets, with the remaining in reels. Most of these grades are sold through wholesale merchants.

Although the definition of the major categories has remained virtually unaltered over the decades, the subdivisions within graphic paper have changed somewhat, with newsprint today encompassing also magazine paper.

A.1.2 Industrial Classification of Paper

Industrial classifications include a number of schemes, which organise the presentation of statistical data by economic activity. The International Standard Industrial Classification (ISIC) is one of the most used. In Europe, the scheme adopted is NACE, which is an acronym[11] used to designate the various statistical classifications of economic activities developed since 1970 in the European Union. As a Member State of the European Union, Italy adopts its national version of NACE, that is, ATECO[12]. It works broadly to a level of four digits (i.e., sections, divisions, groups and classes). The first two digits identify the major economic activity, the third identifies the industrial group and the fourth the precise industry. Although two classification

[11] Nomenclature générale des Activités économiques dans les Communautés Européennes.
[12] NACE Regulations allow Member States to use a national version derived from NACE for national purposes. As though they must be entirely consistent with the structural and hierarchical framework of NACE, national versions differ from the original by including a fifth digit.

revisions[13] have occurred from 1964 to 2004, such changes have not affected the four-digit definition of the paper industry, which encompasses manufacture of paper and paperboard intended for further industrial processing. As such, it includes all the four commercial categories of paper, that is, graphic, packaging, sanitary and other papers.

A.2 Demand for Paper

Since its introduction into Europe in the eleventh century A.D., paper has been produced in growing amounts and grades for an increasing number of purposes, to the point that it is almost impossible to imagine life without it. Initially, demand in western Europe was essentially for writing paper driven by the demand for writing materials, which, in turn, was spurred by the expansion of record-keeping and literacy among the laity that characterised the High Middle Ages[14]. Subsequently, the invention of movable type and Gutenberg's printing press, in circa 1440, provided the biggest stimulus to the development of printing grades, which has continued till now.

By contrast, the development of packaging and industrial grades leapt a few centuries later, following the industrial revolution. Although brown paper for wrapping valuable commodities such as tobacco, grocery ware and fine silk was used already in the Middle Ages, packaging grades surged with the inventions of the cardboard box[15] and commercial paper bags in the second half of nineteenth century. Sanitary and household grades were the last to

[13] The first version of NACE was introduced in 1970. It offered poor comparability with other recognized international frameworks as well as within the Community, since Member States continued to provide data according to their own national classifications. To obviate this problem, the Council Regulation in 1990 launched NACE Rev.1 and established that its use should be mandatory in the EU. To account for the technological developments and structural changes of today's economy, a second revision, NACE Rev1.1, was introduced in 2002..

[14] Spufford (2002) states that, "[by the thirteenth century,] the keeping and auditing of accounts became a regular feature at every level from that of the *Recette Générale* of a kingdom to the humblest hospital. In addition, there was an explosive use of the use of written word in business … The literate nobility and entrepreneurs of the thirteenth century were joined in the fourteenth by literate artisans in the cities of northern Italy and the southern Low Countries, and by those elsewhere in the fifteenth." (p.255).

[15] Towards the end of the nineteenth century, an American, Robert Gair, had the idea of manufacturing in bulk a pre-cut cardboard panel that, once folded, would form a box. By making the transportation of goods easier than with wooden barrels, the box became the most widely used method of packaging for most of the twentieth century.

appear on the market. The introduction of toilet paper in the United States dates back to circa 1880, and the invention of disposable paper towels to 1907. Spurred on by increasing standards of living, diffusion of tissue grades for hygienic and household purposes exploded in Europe only after the Second World War.

A.2.1 Evolution of the Demand for Graphic Papers

At first approximation, the demand for paper parallels economic development. Across countries and times, most of the change in demand for paper can be attributed to changes in pro-capita Gross Domestic Product (GDP), with printing and writing paper being the most sensitive. Using panel data for 15 European countries from 1969 to 1992, Chas-Amil and Buongiorno (2000) found that the long-term elasticity of demand with respect to GDP was 1.1 and that with respect to price (measured as the weighted arithmetic average of unit values of imports and exports) was –0.9. Furthermore, the authors did not find any statistical evidence that demand elasticities were different across countries.

Even if GDP is a robust predictor of paper consumption, to forecast demand accurately is complex. Being an intermediate product, paper demand depends on the needs of the other players along the relevant value chain. In the case of printing paper, which represents the bulk of graphic paper, papermakers supply publishers and printers—directly or through large merchants—and these, in turn, produce printed materials, such as newspapers, periodicals, books, commercial printings and the like, for the public. Any changes in literary rates, reading habits, advertising expenditure or new means to disseminate and store information affect the consumption of printed materials and, therefore, the amount of paper demanded by the publishing and printing industry.

Increased literacy rates were the driving force of graphic paper demand in Italy until the 1960s. Subsequently with increasing standards of living, advertising expenditure became the most important factor. Currently, the

prospects for graphic paper are uncertain as competition from electronic media—computers, television, Internet and the like—may either increase or decrease the use of paper. On the one hand, people may consume less printed materials if they prefer to use electronic media; on the other hand, more printing paper may be demanded to make hard-copy records of what downloaded (Zhang and Buongiorno, 1997). So far, the empirical evidence does not confirm that demand for graphic paper is on the decline. However, Andersson *et al*. (2007) are of the opinion that diffusion of new information technological advances, such as increased Internet penetration and circulation of electronic paper devices, will substantially decrease worldwide demand for printing paper. In addition, defensive tactics by publishers, such as on-line publishing and lowering quality of printed materials, may also accelerate substitution, though not eliminate it.

As to the link between the graphic paper industry and the publishing-printing industry, most papermakers sell to large and moderately concentrated publishers, printers or merchants. Both parties are interested in maintaining stable long-term seller-buyer relationships and they at times agree on short-term (between three months and a year) price-volume arrangements[16].

A.2.2 Demand-side Substitution

The demand-side substitution among the four basic categories of paper is virtually non-existent. Because of their different end-uses, markets for graphic, packaging, sanitary and industrial papers are regarded as distinct, which, therefore, can be studied, from a demand-side perspective, separately. This is immediately evident. As graphic paper is not a substitute for packaging material, household paper does not replace wallpaper. Yet, subsets of grades within the same basic category may compete with each other and with products made from different materials but used for similar purposes.

[16] Alajoutsijärvi *et al*. (2001) report, “It is characteristic of buyers and sellers to agree loosely on future deliveries a maximum of one year in advance. However, eventual price levels are normally defined on a quaterly basis in accordance with global market prices.” (p. 493)

In the graphic segment of the industry, a certain amount of demand-side substitution is present both with others sectors and within this category, although it is less than a clear-cut issue. As merchandise, there is no substitute except, probably, parchment, papyrus and the like, which human civilization has long disregarded[17]. But, graphic paper is, first of all, a medium for written communication and, as such, it has faced increasing competition worldwide from electronic media as a means for dissemination, storage and processing information. The relationship between paper and electronic media is fast evolving and complex, as the previous section on evolution of demand has shown. In short, it appears that electronic newspapers and television currently represent a significant substitute for printed newspapers, thus lowering the demand for newsprint grades. On-line advertising might soon become an important substitute for printed and televised advertising (Andersson *et al.,* 2007). By contrast, computers, photocopiers, printers and fax machines have stimulated, rather than depressed, demand for reprographic office paper, showing a significant complementary with these industries.

Within printing and writing grades[18], a certain degree of substitution exists between higher and lower quality grades. According to CEPI[19], a moderate degree of demand-side substitution exits between newsprint and uncoated mechanical in directories, inserts and newspapers, uncoated and coated mechanical for magazines, and coated mechanical and coated woodfree in

[17] The use of paper and parchment as a medium for writing continued side-by-side for most of the Middle Ages. The growing demand for printing grades following the invention of movable type and Gutenberg's printing press and technical improvements in papermaking made paper an increasingly closer competitor to vellum. By the end of the fifteenth century, paper had mainly supplanted parchment as medium for printing and writing. Coleman (1958) reports, "price series show a fall of over 40 per cent in the price of paper during the fifteenth century and a rise in that of parchment…during the first eighty years of the [sixteenth] century the price of parchment rose a further 70 per cent or thereabouts, whist paper prices show an increase varying between 30 and 60 per cent." (p. 7, footnote 2)

[18] The definitions of the main grades in the graphic segment of the market, namely newsprint, uncoated, coated, mechanical and woodfree, are described in section A.1.2 of this appendix.

[19] CEPI, *Competitiveness Study of the European Pulp, Paper and Board Manufacturing Industry 1998: Executive Summary*, July 1999, retrieved from http://www.cepi.org on 19 February 2008.

catalogues and brochures. A limited degree of demand-side substitution also exits between coated and uncoated woodfree in the case of high quality advertisement and stationary. This degree of substitution reflects the current situation, as some of these grades have been developed in the last decades. Coated paper first appeared in the mid-1960s, whereas woodfree grades saw a rise in demand with the increasing demand for photocopy paper and high-quality publications in the mid-1980s.

A.3 Technology of Production, Economies of Scale and Supply-Side Substitution

Though the basic process itself differs little from the time of its invention and today's paper is remarkably similar to its predecessors, technological innovations throughout the centuries have improved enormously the quality of the product as well as the speed and reliability of the process, turning papermaking from a craft into a capital-intensive industry. This section describes the main feature of the process and equipment in order to discover how technology affects economies of scale and supply-side substitution in the industry.

A.3.1 Modern Papermaking Process

The process by which fibres are transformed into paper and paper products consists of three basic sequential stages: pulping, papermaking and converting. Pulping refers to the process by which logs and other plants are broken down into their fibre components through mechanical or chemical means. Papermaking consists of all manufacturing operations needed to reconstitute the fibres into a sheet, in conformity with the specifications that the various paper grades require. Converting comprises any manufacturing operation that transforms paper into finished or other paper products. Table A.2 summarises the basic operations at each stage.

Pulping begins with selection and procurement of raw materials, continues with separation of cellulose fibres, and finishes with reduction of the

remaining fibres to pulp. The choices for raw material are primarily wood fibres—called virgin fibres—and waste paper—called secondary fibres. Cotton and linen rag is used almost exclusively for bank-notes and papers that must withstanding considerate wear and tear and be lasting as long as possible. Straw[20], sugar cane and other grasses are virtually never used in western countries nowadays. The choice between virgin and secondary fibres, as well as between mechanical and chemical pulp, is made mainly on two accounts: strength and purity. Compared to virgin fibres, secondary fibres are generally weaker but cheaper. Compared to mechanical fibres, chemical fibres have less impurities.

Pulping	**Papermaking**			**Converting**
	stock preparation	**machine-operations**	**web modification**	
selection of raw material	refining	sheet formation	sizing	printing
separation of fibres	adding fillers, chemicals, etc.	couching	calendering	corrugating
		pressing	pigment coating	packaging
		drying		others

Source: Kline (1982, table 1.3 p.17) and FAO (1973, fig.24, p.323)

Table A.2: Basic operations in the manufacture of paper

Papermaking comprises[21] a set of sequential manufacturing operations. The first group of operations, *stock preparation*, is the initial treatment of the fibres to impart special characteristics to them. At the paper mill, pulp is diluted in water and, then, subjected to violent mechanical action using steel rotor blades. The resulting slurry is passed to holding tanks. At this stage, auxiliary chemicals and additives may be added to provide the qualities of smoothness, opacity, colour or body to the finished sheet. After its

[20] Due to its availability, Italy used to produce a significant amount of straw paper. Production was concentrated in Tuscany and carried out by small-sized paper mills. Due to its high level of pollution, this segment of the industry virtually disappeared in the mid-1980s following the introduction of new environmental regulations.
[21] Reproduced from www.paperonline.org.

preparation, the watery mixture of fibres and additives—called stock or furnish—is passed into the head-box of the paper machine.

The second group of operations is the *machine-based operations* because they are all performed on the paper machine. Representing the actual papermaking, they are organized into at least three main sub-stages: forming, pressing and drying. Forming is the process of making a sheet of paper—generally called web—, performed as soon as the stock arrives at the head-box. It determines the way in which paper fibres entwine, affecting the density, porosity and visual characteristics of the final product. Once at the head-box, the stock is squirted through a thin, horizontal slit across the full machine width onto a moving, endless wire mesh—called a mould. The water is removed through a mixture of gravity and suction in a process known as sheet formation where the fibres start spreading and consolidating into a thin mat. This operation is carried out in the former section of the paper machine, under carefully controlled conditions to ensure even distribution of the fibre and, thus, uniform thickness of the paper sheet. Once the web of wet paper is formed, the second sub-stage, pressing[22], is performed. The web is lifted from the wire to a press section of the paper machine, where it is squeeze between rolls and felts. During pressing, some 40-50 per cent of the water content is eliminated. The last sub-stage of machine-based operations is the drying process, which begins with the passage of the semidry sheet from the press section to the dryer section. Here, the sheet passes around a series of cast-iron cylinders, heated to temperatures more than 100C. The water content is reduced to between 5 and 8 per cent, depending on the level of moisture specified by users.

After drying, the third group of operations is web modification, which encompasses a number of finishing treatments for the surface of the paper. Depending on the grade, they include sizing[23], calendaring[24] or more

[22] This set of operations is also called consolidation of the web (Kline, 1982, p.17)
[23] Surface sizing consists of treating the nearly dried paper with sizing agents to improve strength and reduce water absorbency.
[24] Calendering is a process of smoothing the surface of the paper by passing it between a series of rotating, polished metal rollers so as to increase smoothness.

complicated processes as coating[25] or supercalendaring[26]. By imparting additional qualities to the final product, these finishing techniques provide variability and choice to both manufactures and end-consumers. However, compromises have to be made between cost and quality, as well as between competing properties since they cannot all be maximised simultaneously.

All grades of paper are subjected to all machine-based operations, though in varying amounts. Among them, forming is responsible for the major physical differences of the finished product: single-layer for lightweight or flexible paper and multi-layer for paperboard and heavy grades. Consequently, the first distinction among paper machines is based on forming devices.

Converting is the last group of operations. The reels from the paper machine are slit into more narrow reels, or cut into sheets, or undergo more complex converting operations.

A.3.2 Paper Mills

Papermaking has been always a mill activity, requiring a plant exclusively built for that purpose according to specific construction parameters[27]. As in the past, a paper mill is a large plant whose construction is a complex undertaking, requiring years to be completed and considerable investment. The cost for a new mill producing commodity grades is some Euro 500 million. Although the ratio of capital investment to annual production has almost halved in the last 30 years, its ratio to annual turnover has remained stable, if not, increased moderately.

[25] Coating is a complex process that can involve up to a hundred of distinct operations, ranging from preparation of the coating raw materials, application of the coating to the web, drying of the coated web and other handling operations. By varying coating pigments and methods, an impressive array of different coated grades can be obtained. Coating can be performed on- or off-machine.

[26] Supercalendering is a surface treatment that creates a polishing effect on the surface of the web.

[27] The first descriptions of paper mills and machinery date to the sixteenth century (Piccard, 1981). They describe how the process was organized and as well as the structural design of the mill.

The appearance and complexity of a paper mill is determined by the degree of integration with pulping or converting or both. Modern paper mills need to have convenient access to water resources and shipping facilities, whereas pulp plants are more suitably located near forests. Location of converting establishments is mainly determined by the relative costs of shipping paper in reels or as finished products and the speed with which products must be produced and supplied to the market. The level of integration among mills varies greatly. Some pulp plants exist primarily to produce pulp, while others are integrated with paper mills. Converting plants are more likely to be separate from paper plants. The large majority of paper mills are independent operations owned by different companies. The decision as to whether or not to build integrated facilities rests on economic convenience and tradition. Vertical integration is discussed in section A.4.2.

A.3.3 Paper Machines

With the mechanization of the industry, all papermaking operations except stock preparation are performed on paper machines. Consequently, they constitute the most important component of a paper mill, defining and limiting the mill's production capacity as well as its product mix. Today, the biggest newsprint machines are some 150m long, produce a sheet more than 10m wide and operate at speeds of over 100km/h.

The basic structure of a paper machine mirrors the process. It consists of a wet end, which comprises the headbox, the forming wire and the press section, and a dry end, which includes the dryer, the calender, the reel and the winder. Yet, no paper machine is identical to another. They differ greatly, especially with respect to the design of the wet end. This is mainly due to the difficulty of manufacturing a continuous, uniform sheet of paper since fibres tend to clump together making paper lumpy. The need for uniformity coupled with increased product variety has led to development of many different headboxes and approach-flow-systems, each designed to ensure the most successful way to deliver a specific stock mixture to the forming wire. Furthermore, paper machines differ in terms of wire width, coating devices

and control systems, all custom built to produce only a limited range of grades. In addition, they become increasingly different with time as a result of repeated upgrades to reduce their technological age. Therefore, even if one specific grade of paper is selected, machines are never identical[28].

The age of a paper machine is on average 40 years but can span several decades. Each section of the paper machine can be modified, upgraded or replaced. During their lifetime, paper machines undergo several renovations to introduce the state-of-the-art technology, improve speed or overcome production bottlenecks. Through overhauls and upgrades, the technological age of the machine is slowed down. The only parameter that cannot be altered is the width of the forming wire. This will remain the same throughout the life of the paper machine constituting a limit to capacity expansion over time.

The gross production rate of a paper machine is calculated on the basis of paper grammage[29] multiplied by wire width and speed. This rate is, however, theoretical, for it does not take into account the overall efficiency of the machine. Even in periods of high demand, paper machines are subject to downtimes for maintenance, unexpected breakdowns, wire changes, statutory holidays and the like, which reduce the amount of paper actually produced in relation to the capacity of the machine. Thus, the overall efficiency of a paper machine is a combination of time efficiency[30], which reflects the actual running time of a machine, and production efficiency, which reflects the amount of paper produced once all production losses[31] are deducted. From an historical perspective, both time and production efficiencies have been increased. Today, some mills run all year, others

[28] A detailed description of the paper machine and auxiliary equipment is provided in section II of Kline,J.E. (1985).
[29] Grammage or basic weight is the weight in grams of one square metre of paper or board.
[30] Time efficiency is calculated as the percentage of the actual running time of the machine, that is, 365 days less official and scheduled downtimes, in the maximum available operating time, that is, 365 days less official downtime (paper encyclopedia in www.risiinfo.com)
[31] Production losses originated primarily from trimming, lowering speed and broke. Trim loss is the paper discarded due to adjustments of the maximum width of the sheet to customers' needs. Speed loss is the loss of production due to lower than optimal speed levels. Broke is the amount of paper discarded or returned for reprocessing as a result of breaks or imperfections in the sheet on the paper machine.

between 330 and 355 days. Furthermore, optimal operating rates should be about 93 per cent. There are no time-series statistics for overall efficiency of paper machines in Italy. A few sources[32], however, have reported that, in the 1970s and early 1980s, the average number of working days annually was 300 in the graphic sector. This is a relatively low figure, which might reflect a downwards bias due to the relatively higher proportion of small-scale operations in the total. Unfortunately, there is neither information about the variance of these statistics, nor about the time efficiency of Italian paper mills in more recent times. However, from a number of company's annual reports, it appears that time efficiency has increased to 330-355 days annually.

A.3.4 Technological Progress

By appearance, the modern paper machine is not radically different from its twentieth century counterpart; it is faster, wider and, consequently, more specialized and computerized. Leaving grammage aside, higher production levels are achieved primarily by increasing speed or width or both. This fact has been and is at the core of technological advances in papermaking.

At the turn of the twentieth century, maximum speed was some 150-200 m/m; in the early 1950s, it was about 500 m/m. Currently, maximum speed is above 2,100 m/m for tissue machines, more than 1,900 m/m for newsprint machines and more than 1,550 m/m for woodfree grades. As a rule of thumb, it is reckoned (Ferguson, 1994, p.19) that the doubling period for paper machine speeds is approximately 30 years. Similar developments apply to machines' width. The largest paper machine at the turn of the century had a width of about 2.5m. By the early 1950s, it was some 3-3.5m wide, and, by the end of the twentieth century, about 10m wide. Unlike speed that has increased incrementally, width has risen in steps. Throughout the last century, there were periods, up to 20-30 years, during which the width of new machines changed little. These periods ended with a new wave of new machines significantly wider than the previous ones. Specifically, major

[32] See RESS (1982, p.29) and Gobbo (1974, n. 8, p. 126).

increments in width occurred between the turn of the twentieth century and the early 1920s, between 1950 and 1970 and between 1990 and 2000.
To achieve these results, specific technological hurdles had to be overcome. As a result, all sections of the paper machine as well as the chemicals used in the stock and coating process have been subjected to substantial technological innovations. However, the most important advance has been introduction of information technologies, such as computer-aided-design (CAD) and computer-aided-manufacturing (CAM), which have significantly improved productivity and created new paper grades with advanced properties. Ghosal and Nair-Reichert (2009) has found that papermaking firms that implement a greater number of investment transactions in the information technology and digital monitoring devices have recorded particularly noticeable productivity improvements. At present, the industry ranks third after semiconductors and measuring devices in terms of the number of technologies in use (Autio *et al*., 1997).

Far from being low-tech, the paper industry has developed strong linkages with the chemical and machinery industries as well as the information technology sector and electricity generation. Together, they form a cluster where technological advancement is ensured through a feedback process between the paper industry with its needs and the other players as providers of innovative solutions. Autio *et al*. (1997) report that “the importance of supplier industries for innovations in the pulp and paper industry can be seen by the fact that the costs for equipment and materials constitute between 60 and 70 percent of the total costs of capital projects” (p. 20). Furthermore, the industry’s expenditure in R&D is traditionally very modest, some 0.5 percent of the total.

A.3.5 Cost Structure

The industry faces significant fixed costs, accounting generally for some 40 percent of the total. Variable costs comprise raw materials, (both pulp and chemicals), labour, transport and energy. Pulp is the highest item, accounting for nearly one-forth of total costs. Although regarded as variable, labour and

energy costs are somewhat fixed. Because of the computerised systems controlling the paper machine, the number of skilled workers is, to a large extent, independent from the level of production. In addition, the amount of energy used when the machine is running is nearly the same whether or not producing paper.

A.3.6 Commodity and Specialty Papers

Depending on the level of value-added, paper ranges from commodity, or bulk paper, and specialty grades. Commodity grades are generally produced in large volumes and possess similar properties, which makes it possible for end-users to interchange products from different suppliers. Being a substantially homogenous product, price is the most important competitive factor. In order to survive, producers of commodity grades have pursued strategies of cost minimization through economies of scale, scope and cost reduction for raw materials. Newsprint and, currently, coated woodfree paper are examples of bulk products

By contrast, specialty grades are manufactured to satisfy specific quality requirements (e.g. ultra-lightweight, release paper, cigarette paper, etc.). Consequently, they are produced in small quantities, differ from one manufacturer to another and prices vary according to final application and end-users. They are higher value-added products. The predominant strategy in this segment is product differentiation and customized services. Many specialities have become commodities with time, though the process is gradual. A typical example of a paper grade that has become a bulk product by the mid-1980s is coated woodfree paper.

Fine paper can be regarded as a semi-commodity segment. In general, these grades are of high quality and serve a multitude of distinct end-users. Papermakers of fine papers tend to concentrate their marketing efforts on product quality improvements. Creation of brand names and management of efficient distribution systems are also strategies pursued by manufacturersin this segment (Autio *et al*., 1997).

A.4 Business Strategies and Practices

Papermaking technology continues to affect the strategic alternatives available to papermakers today, as it has since the beginning of the industry. Before the industrial revolution, supply of water and rags dictated the location of paper mills and availability of skilled labour and capital requirements their appearance and further growth[33]. In an industrialised context, availability of water supply and skilled labour has greatly diminished, while capital requirements have become comparatively more important. In addition, the use of wood pulping, rather than rags, has given an unrivalled advantage to the northern countries of Europe compared to the southern ones. This section summarises the framework within which modern firms make their decisions regarding plant investment, vertical integration and pricing.

A.4.1 Plant Investment

A paper mill is a special-purpose facility with no alternative use should it prove uneconomic. It is capital intensive, and the lifespan of paper machines is several decades. Typically, a new mill will require a capital investment of several millions of Euros. Consequently, capital investment in the paper industry is a strategic decision that, once undertaken, restricts further moves for many years after.

Options Investment projects are undertaken for a number of reasons, such as to expand production, improve the quality of the paper, enter new segments of the market, or lower costs. To achieve these objectives, papermakers face three main options. They may choose to erect a new paper machine (greenfield investment), upgrade or rebuild their existing machines (upgrading) or acquire existing plants from competitors

[33] In analysing the influence of techniques and organisation in the economics of the British paper industry from 1495 to 1860, Coleman (1958) observed how differences in skilled labour and capital requirements between the papermaking and cloth-making industries had shaped their development. “The techniques of cloth-making were ideally suited to a division of labour which allowed the ‘putting-out’ or ‘domestic’ system to flourish; those of papermaking demanded centralised work.” (p. 39). Since papermaking required both a minimum of buildings as well as skilled workers, who would learn the techniques slowly by training and application and be rewarded considerably, the industry could expand on the basis of availability of capital and skilled labour.

(acquisitions and mergers). The three options are not equal and their choice crucially depends on the specific conditions and objectives of a firm.

In principle, the attractiveness of building a new paper machine rests on being more efficient. It will produce larger quantities of paper of better quality at lower cost[34]. However, establishment of a new, larger machine implies that the overall capacity in the industry is going to increase substantially. But, if the increase is not justified in terms of increasing demand in the medium- and long-term, it will lead to overcapacity in the industry. This situation, in turn, will depress prices and destroy firms' profitability.

The second option, expansion by upgrading, is a halfway solution. It involves modernization of some segments of paper machines with or without modest increases in their overall capacity. Although they comprise only a subset of the whole range of more advanced technologies, rebuilding is a sensible option as long as the machine will be able to provide a satisfactory return (*Papermaker* 82/4, 40). If not, then the machine should be shut down. Rebuilding and upgrading of existing machines are always unique, depending both on the technical conditions of the machine and the objectives set by a papermaker for products, processes and equipment. They happen some every ten to 15 years, so as to maintain the competitiveness of the machine in terms of costs and quality.

In terms of acquisition, the choice of a firm to expand production by acquiring existing plants leaves the total capacity of the industry unchanged and, in turn, avoids pressure on market prices. However, this solution can be shortsighted. While it allows firms to expand without creating overcapacity in the industry, it postpones renewal of production capacity, which, in turn, might leave these firms behind their competitors (*Pulp and Paper International* 43/4, 20) in the medium run.

[34] New machines generally offer lower production costs than existing ones due to economies of scale and increased efficiency through improved technology and raw material optimization (*Pulp and Paper International*, April 2001, p. 19)

Choice of one rather than another is essentially financial, since, ultimately, the yardstick is whether the investment chosen will be able to provide a satisfactory return.

Timing Since paper products are cyclical in demand and price, timing of an expansion project affects considerably a firm's profitability. According to Achi *et al.* (1996), the best start-up time—when a paper machine begins production—is during the last stage of recession or when the industry is starting to recover. Full production will be achieved at the upturn of the business cycle, when product prices and demand are at their peak. On the contrary, the worst start-up time is at the zenith of the business cycle. Although prices are high, a machine will not be able to take full advantage of the favourable conditions because it is operating at reduced capacity. Full capacity will be reached when demand is low.

By contrast, modernizing existing machinery should be carried out during upturns. Although rebuilds are easier to be undertaken during downturns when capacity utilization is low and downtime is less costly, they add capacity in a time of excess supply depressing prices even further. If undertaken during the beginning of upturns, modernising may lead to loss of sales since the machine is down and prices are still high.

Considering the high debt burden and costs associated with expansion projects, any delay in implementation, technical problems or poor market conditions may cause considerable financial difficulties, threatening the survival of the firm.

Financial requirements The cost of building a new large paper mill is estimated at some Euro 500 million, while that of rebuilding a paper machine in the range of Euro 150-200 million (*Folio*, 27/3, 76). It usually takes two to three years to erect a new machine and an additional two to three before full production is achieved. Though high, if calculated per tonne of annual production, these costs have approximately halved in the last 30 years, due

to increased speed and width of the new paper machines. By contrast, investment costs in relation to annual turnover have remained constant, if not increased.

As rule of thumb, sales of a company should be at least two to three times expected investment. A US$400 million investment in a new machine may be justified by sales for up to 40 years (*Folio*, 27/3, 76). The characteristics of the investment decision are such that an erroneous expansion project is likely to jeopardise the survival of the firm, especially if small. Therefore, papermakers are generally very cautious in installing new machines and, everywhere, tend to exploit the machines they have to the maximum.

Capacity rivalry Any successful expansion project increases the industry's capacity. As these additions occur mainly in large lumps, a limited number of projects can be carried out without creating long-lasting problems of overcapacity. This begs the question of which projects are actually carried out. Christensen and Caves (1997) studied the selection among competing projects to expand capacity in North America. Using a two-stage game where market capacity was first determined and rivalry occurred within the limits of predetermined capacity, the authors found empirical evidence that, in the more competitive segment of the paper industry, "project announcements lead to a form of continuing auction in which the more uncertain projects are more likely to expire, along with those sponsored by less well-endowed firms. In the less competitive sub-markets,…fewer projects are abandoned, and the appearance of a rival project…makes the firm more likely to finish a project that it has previously announced" (p. 70-71).

A.4.2 Vertical Integration

There are many kinds of paper mills. Their appearance is determined by the degree of integration with pulping and converting, that is, whether these operations are performed on the same site as the papermaking (forwards/downwards integration). While some plants exist primarily to produce pulp and are operated by independent companies, most pulping

operations are carried out in conjunction with papermaking operations, especially in the case of commodity papers such as newsprint (integrated mills). The majority of paper mills in Europe is non-integrated in that they operate without an associated pulp mill. Downward integration is less common. Converting is more likely to be separated from papermaking, except for tissue, cut size and folding boxboard for packaging grades.

Forward integration between pulping and papermaking has often been advocated as a means to maximise profits in the long run. If the grades to be produced can be made from an almost standardised stock, the benefits of integration mainly originate from direct savings because some operations, such as pulp drying, packaging, storage and handling, become redundant and economies of scale in common auxiliary departments are achieved. Moreover, integration adds value to pulp products while evening out fluctuations in price.

However, the magnitude of these benefits crucially depends on location of the mill. Transport, labour and energy costs, as well as environment and institutional requirements, affect considerably the cost structure of manufacturing units, by decreasing the benefits of integration to the point that they become minimal. Moreover, forward integration limits the ability of a paper mill to choose optimal pulp for specific products. There is no universal prescription in favour of integration. Depending on the specifics of the situation, non-integrated mills can perform as well as, if not better, than integrated competitors[35].

Except for the first half of the twentieth century, during which the largest Italian companies pursued strategies of forward integration in order to reduce uncertainty of pulp supply and hedge companies against fluctuations in prices, almost all Italian papermakers are currently non-integrated. Without natural resources required to produce pulp economically, Italian firms cannot exploit the benefits of integration.

[35] For a critical analysis of the advantages of integration, see *Pulp and Paper International*, March 2001, p. 34-39.

A.4.3 Pricing

Like most basic material industries, the paper industry exhibits a prominent cyclical pattern: periods of high profits alternate with periods of substantial losses, yielding average returns that at times may not even cover the cost of capital. The wide fluctuations in firms' revenues and profits are hardly caused by fluctuations in demand; they are primarily the result of wide price swings[36], which appear to have become larger and faster in the last two decades.

The trade[37] describes pricing strategies as a supplier's market in up-turns and a buyer's market in down-turns; economists (Booth *et al*., 1991) as an example of barometric price leadership. Pricing strategies reflect a complex interaction between sellers' need to operate at acceptable operating rates and buyers' priorities within a competitive environment. By and large, paper prices are determined by operating rates (van Roden, 1998 and Christensen and Caves, 1997). Ideally, paper mills should aim at the optimal 93 per cent operating rate, which is the threshold at which mills begin to face excess demand. Operating rates are projected on the basis of supply and demand forecasts. If supply is largely predictable because changes in the industry's capacity are generally known in advance, demand consistently proves difficult to forecast because actual demand may diverge significantly from current demand, that is, orders on the books. The result is a substantial price volatility.

Given the extensive inventory capacities of suppliers and buyers and their commercial relationships (Section A.2.1), at the beginning of a demand up-turn for printed materials, printers and merchants find profitable to build up inventories in order to secure the required amounts of paper. Paper mills respond by increasing their operating rates beyond the optimal 93 per cent.

[36] For example, between 1988 and 1996 demand for graphic papers, measured in tonnes, rose steadily. By contrast, its value fell by 16 per cent during the recession period 1990-93 and, then, shot up by 64 per cent by mid-1995. A year later, it had fallen by 18 percent (Glass, 1997).

[37] After the mid-1980s when price instability became prominent, papermakers have become increasingly concerned with forecasting the industry's business cycles. Ingram (1996), van Dijk (1995), Achi *et al.* (1996) and van Roden (1998) provide practical suggestions on how to forecast demand and prices.

At that point, the market turns into a supplier market and papermakers are able to raise prices. The more the prices increase, the more the buyers put forward orders in an attempt to stock inventories as much as they could before the next price increase[38]. But, the more orders, the more pressure on production. This process continues until buyers observe the first signs of a decline in the demand for printed materials. At that point, printers and merchants begin to use their inventories and cancel orders, while papermakers report temporary profit losses. Since sellers are a few, as soon as a papermaker grants a discount, the others follow suit and the market turns into a buyer-market, with prices falling and operating rates declining.

[38] Because the price increases are too rapid, printers are not able to pass on the increases to their consumers.

APPENDIX B

A BRIEF ACCOUNT OF THE PAPER INDUSTRY IN ITALY

The development of papermaking in Italy extends over eight centuries, during which the industry reached a dominant position in the thirteenth and fourteenth centuries, lost it leadership in the fifteenth century, collapsed in the course of the sixteenth and seventeenth centuries and came back to a middle-level producer in the European market in the twentieth century. Today, the graphic segment of the paper sector can be regarded as a mature industry. If this segment declines in the future, it will depend chiefly on whether electronic means of communication will supplant paper as a medium.

This appendix provides an overview of the development of the Italian papermaking industry from the unification of the country in the second half of the nineteenth century to date, with emphasis on the period after Second World War. Specifically, the next section outlines the modernisation of the industry from the time of the foundation of the Italian state, in 1861, to the Second World War. Sections B2 and B3 focus on the developments of the industry after the war, the former describing the dynamics of the entire industry and the latter those of the graphic segment.

B.1 Early Stages of Modernisation

Despite the long tradition of hand-made papermaking, the organisation of this activity into an industry dates, in Italy, to the late nineteenth century, some decades later than in other European countries where the industrial revolution had already spread. At the time of the unification of the country, in 1861[1], Italy was largely an economically under-developed, rural state, where the production

[1] On 17 March 1861, the United Kingdom of Italy was proclaimed, though the Republic of Venice and the Papal State were annexed later, the former in 1866 and the latter in 1870.

system was still centred around artisanal workshops, rather than enterprises. A survey of the paper sector reported the presence of 687 vats and only 59 paper machines in 1862 (Table B.1). In the same year, production amounted to some 24,000 tonnes annually, of which about a third was high quality paper for printing and writing, with the remaining two-thirds for packaging and other uses. Production was concentrated mainly in three areas: the neighbourhoods of Naples (25.2 per cent), Piedmont (20.6 per cent) and Lombardy (18.7 per cent). Compared with other European nations, the under-development of the papermaking industry in Italy is striking. In 1861, France and Germany were equipped with some 359 and 250 paper machines and manufactured some 60,000-70,000 tonnes of paper and paperboard, respectively. Even the Austrian-Hungarian Empire, which shared some similarities with the Italian situation, appeared more industrialised. Total annual production amounted to some 45,000 tonnes and some 100 paper machines had been installed[2].

The decades that followed unification witnessed the beginning of industrialisation of the Italian economy and, in tandem, the modern papermaking industry.

	number of plants	number of vats	number of machines	production (tonnes per year)		number of employees
				pulp	paper	
1862	…	687	59	…	23.995	…
1876	521 [2]	813	168	…	60.000	17.312
1896	412	216	389	11.000	95.000	15.766
1903	…	223	371	18.000	115.000	19.088
1911	494	78 [1]	405	60.000	248.571	21.361
1927	519	30	624	100.208	298.668	24.943
1938	434	15 [1]	658	185.243	478.867	29.126

Source: *Annuario delle cartiere d' Italia*, 1964, p. 13 and Pellegrini, 1954, p. 96-146
Notes: (1) refers to the previous year. (2) includes pulp and paper mills.

Table B.1: Structure of the Italian papermaking industry before 1940

[2] Ferrari, 1999, p. 94.

As shown in Table B.1, the modernisation of the papermaking industry progressed at an unrelenting pace for more than half a century. Between 1876 and 1911, the number of paper machines increased from 168 to 405. Not surprisingly, mechanisation of production was accompanied by a sharp rise in output and a moderate increase in employment. In 1911, output was more than ten times that recorded in 1862, while employment increased less than 25 per cent. More importantly, mechanisation transformed the industry in two crucial ways. It caused the disappearance of virtually all hand-made paper mills that did not adjust to the new technological advances and, contemporaneously, fostered the use of the public limited liability company (*società anonima*) as the most appropriate legal status for enterprises that aimed at setting up large, modern plants. The result was the appearance of a number of new plants that are still active and part of today's leading papermaking groups in the country[3].

By the end of the 1920s, the mechanization of the papermaking industry could be considered to have almost been completed. Paper mills producing exclusively hand-made paper had virtually disappeared, and the average number of machines per mill had increased from 0.32 in 1876 to 1.20 in 1927.

Although mechanised, the industry was clustered around micro- and small-scale firms (Table B.2), a feature that continues to characterise the Italian industry. In 1927, a census recorded 510 paper mills, of which only 18 employed more than 251 workers each and were equipped with some hundred paper machines in total. Besides this small group of large firms, there were 48 medium-scale (between 51 and 250 workers each), 304 small-scale (between six and 50 workers) and 149 micro units employing, at most, five workers.

[3] The company Cartiere Burgo, which has dominated the Italian industry for most of the twentieth century and is today's largest group in Italy, was founded in 1905 and transformed into a stock company in 1924.

Number of employees (per mill)	pulp		paper		Total
	mills	%	mills	%	mills
up to 1 employee	4	9.3	39	90.7	43
between 2 and 5	16	13.7	101	86.3	117
between 6 and 10	10	9.6	94	90.4	104
between 11 and 50	40	16.0	210	84.0	250
between 51 and 100	15	38.5	24	61.5	39
between 101 and 250	5	17.2	24	82.8	29
between 251 and 500	3	18.8	13	81.3	16
between 501 and 1000	3	42.9	4	57.1	7
above 1000	1	50.0	1	50.0	2
Total	97	16.0	510	84.0	607

Source: Pellegrini, 1954

Table B.2: Distribution of plants by employment class, 1927

The war years, from 1940 to 1945, represented an interruption in development of the papermaking industry, which was not considered essential. However, plants did not suffer major destruction. The rehabilitation of the plants started soon after the end of the war. By the end of the 1940s, total production had regained its pre-war levels (537,553 tonnes annually by 1950). Following the post-war recovery era, the papermaking industry began a period of expansion that, with some fluctuations, has lasted to today.

B.2: The Evolution of the Paper Industry after the Second World War

Throughout the second half of the twentieth century, the Italian paper industry enjoyed a continuous expansion. Italy currently produces nearly 18 times more paper than in the early 1950s and consumes 20 times more. Figure B.1 illustrates the evolution of total capacity, production and apparent consumption between 1950 and 2003. The vertical difference between production and consumption equates trade balance.

Three major phases can be distinguished in the evolution of the Italian papermaking industry after the Second World War: the first, from 1950 to the

early 1970s, characterised by rapid steady expansion of domestic production and substantial closure to foreign markets and producers; the second, from the early 1970s to the mid-1980s, characterised by substantial fluctuations in production and timid opening of the sector to the world; and the third, from the mid-1980s to 2004, characterised by an upward trend in production accompanied by increasing import penetration and internationalisation of Italian papermaking firms.

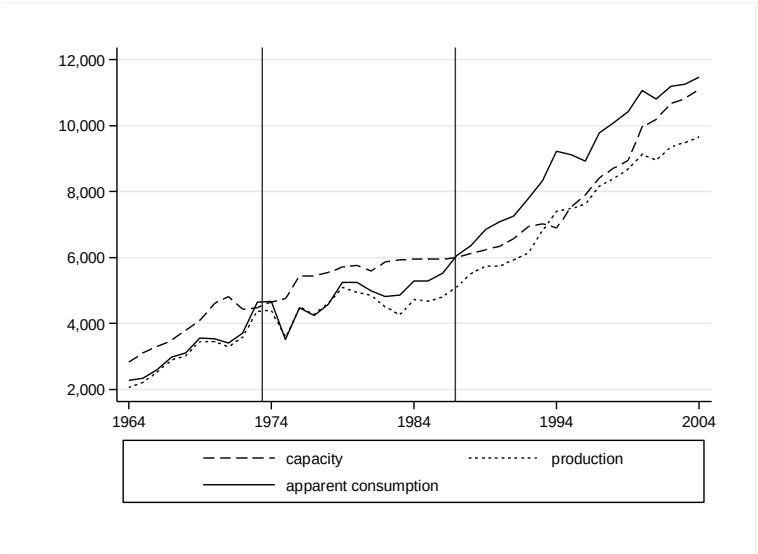

Figure B.1: Apparent consumption, production capacity and production of paper, 1954-2004 (in '000 tonnes)

First phase: 1950 to early 1970s The rapid expansion of paper production in the first phase—on average, some ten per cent annually—was driven by domestic demand from a growing manufacturing sector, consumers with rising standards of living and an expanding service sector[4]. Trade volumes remained negligible, barely exceeding 10 per cent of total production.

Stimulated by a sustained domestic demand for all types of paper as well as favourable expectations for the future of the industry, between the late 1950s

[4] Domestic consumption of paper increased from some 11.2 to 65.4 kilograms per capita (see Balliano, P. and R. Lanzetti, *Studio sull'evoluzione della concentrazione dell'industria cartaria in Italia*, 1977, p. 30).

and late 1960s, capacity grew at buoyant rates (Figure B1). The expansion of the industry's physical capital was realised through both greenfield investment and rehabilitation of a multitude of small- and medium-sized firms, in particular those producing straw or recycled papers in Lazio, Tuscany and Veneto. Between 1964 and 1971, the total number of paper machines not wider than one meter decreased from 131 to 51, whereas those wider than three meters increased from 32 to 62[5]. Meanwhile, employment of unskilled workers began declining, which boosted productivity even further.

The revamping of the industry was also accompanied by the appearance on the scene of a number of high-flying, new-to-the-industry businessmen, who built large plants with private and public funds. According to Assocarta, between 1951 and 1964, the number of plants, for both pulp and paper, increased from 556 in 1951 to a peak of 640[6] in the mid-1960s.

This wave of expansion was aimed mainly at increasing quantity, rather than quality. In fact, the majority of the new paper machines was designed for production of commodity papers, where economies of scale play a relevant role, such as for kraft paper, newsprint and magazine paper. For a country with no timber resources and expensive energy, this strategy soon revealed its shortcomings. In the second half of the 1960s, when domestic demand was slowing, the start-up of a number of large paper machines created substantial overcapacity in the market. With plants under-utilized and prices stagnating, a number of the established groups saw their profitability declining and their indebtedness to the banking system rising. To rescue them, the state stepped in

[5] Balliano, P. and R. Lanzetti, 1977, *op*. p. 90

[6] Census-based data on number of mills and firms are generally higher than those compiled by Assocarta because administrative registers include any enterprise that specifies pulp and papermaking as its principal activity as well as all local units, regardless of whether they are plants or administrative/commercial units. Moreover, the industrial census in 1951 did not differentiate pulp and paper mills from converters; therefore, the total number of mills in 1951 is an estimate by Assocarta.

by acquiring their controlling interest. This course of action merely postponed restructuring of the industry, which would emerge fully in the subsequent phase.

Second phase: early 1970s to mid-1980s For the first time after the post-war recovery era, the second phase saw substantial fluctuations in production and investment in physical capital leveling off. The sector grew at an average annual rate of 2.5 per cent, although in 1970, 1971, 1975, 1977 and most part of the first half of the 1980s the rates were negative[7]. Domestic demand continued to be largely met by domestic production. Throughout the 1970s, Italian papermakers maintained tight control of their domestic market, both because the Scandinavian producers were not interested in producing printing and writing papers and found it difficult to enter a market with a fragmented distribution system and because the Italian paper industry—primarily the printing paper segment—was sustained by a protective tariff system, a favourable exchange rate policy and direct state intervention.

Despite being protected from foreign competition, this second phase saw a substantial contraction in the population of firms in the industry, which accelerated in the early 1980s. As shown in Table B.3, the total number of plants decreased from 610 in 1971 to 477 in 1981 and to 230 in 1986. The decline in the number of paper mills, which accelerated in the early 1980s, was driven by a series of concurrent events. Technological advances in papermaking, increased energy costs and more restrictive environmental regulations made it increasingly difficult for micro- and small-scale operations to survive and nearly killed the incentive for producing pulp locally, especially straw pulp. This caused the progressive closure of most of the pulp mills, the majority of micro- and small-scale plants and virtually all companies producing straw paper for packaging[8].

[7] Growth rates in the 1970s are likely be overestimated due to under-reporting in the 1960s.
[8] Generally, these firms were small-scale operations, mainly localised in Tuscany.

year	number of mills	output (tonnes per year)	number of employees	productivity	productivity index (1971)	output index (1971)
1964	640	2,045,841	…	…	…	…
1971	610	3,288,341	40,957	80.29	100.00	100.00
1976	554	4,498,937	…	…	…	136.81
1981	477	4,841,983	34,037	142.26	177.18	147.25
1986	230	4,807,215	28,000	171.69	213.84	146.19
1991	222	5,932,188	27,900	212.62	264.83	180.40
1996	210	7,588,700	25,700	295.28	367.78	230.78
2001	200	8,926,100	24,800	359.92	448.29	271.45

Source: various sources

Table B.3: Key indicators of the Italian papermaking industry, selected years

The restructuring of the industry is explicit in Table B.4. Between 1972 and 1986, some 337 small plants—those producing between 1,000 and 5,000 tonnes annually—closed, which accounts for nearly 95 per cent of the industry's shake out in this second phase. Conversely, the presence of medium– and large-scale plants—those producing more than 50,000 tonnes annually—nearly tripled, from some 4.2 to 12.6 per cent. With the increase in plant size and decrease in employment, productivity more than doubled.

year	number of enterprises	number of mills	*of which:*					
			1,001 - 5,000	**5,001 - 10,000**	**10,001 - 25,000**	**25,001 - 50,000**	**50,001 - 100,000**	**≥ 100,001**
1972	…	586	68,6	10,9	10,8	5,5	3,2	1,0
1976	494	554	67,9	11,0	10,6	5,8	3,4	1,3
1982	445	445	62,2	13,0	14,6	6,1	4,5	1,6
1986	177	230	28,3	21,3	24,8	13,0	8,3	4,3
1992	174	219	16,4	25,1	25,6	15,1	9,1	8,7
1996	166	210	15,2	24,8	26,2	15,2	10,5	8,1
2002	156	200	16,0	18,5	24,0	17,0	12,5	12,0

Source: various sources

Note: Size classes are measured in terms of tonnes per year.

Table B.4: Distribution of paper mills by size, selected years (percentage)

Third phase: mid-1980s to 2004 The mid-1980s represented a turning point in the Italian paper industry, on several levels. By then, the bulk of micro- and small-scale firms had disappeared. New policy measures lowering tariff

protection had been adopted making the Italian market profitable for the larger Scandinavian producers, while the Government decided not to renew law 675/77, which allowed direct state intervention in the industry. Furthermore, the older generation of papermakers as well as the rampant new comers—such as the Cinque brothers and the Fabbri of Fabocart—had left the scene, replaced by new managers and stockholders. These developments paved the way for a change in strategy. Production of commodity paper, where economies of scale are central, was progressively abandoned in favour of manufacture of high-quality, value-added paper. At this time that the segment of sanitary and household paper began its rapid expansion.

As a result, the last two decades have witnessed an increasing openness of the Italian market, sustained consumption and renewed investment in the sector. Between 1984 and 2004, production grew at an average annual rate of 3.6 per cent, whereas consumption at 3.9 per cent. Imports and exports more than tripled. Investment in capacity slowly picked up in the early 1990s. With the exception of new tissue paper machines, the bulk of such investment was for upgrading existing paper machines, rather than establishing new ones. As Figure B.1 illustrates, the strategy helped to maintain healthy operating rates.

More importantly, the industry has evolved towards a more consolidated structure with fewer firms of larger size. In 1982, the total number of registered companies was 445; 20 years later, it had decreased to 156. Micro- and small-plants have nearly disappeared. By contrast, the percentage of plants producing more than 50,000 tonnes annually has increased from six per cent to more than 24 per cent of the total.

B.3 Graphic Segment

Within the paper sector, this class of grades has always made up a major segment of the industry, though its relevance has been declining. In the early 1950s, it represented more than 47 per cent of total paper production. Today, it

accounts for some one-third[9], suggesting diminishing attractiveness of this segment compared to packaging or sanitary papers. Figures B.2a and B.2b illustrate the evolution of production and apparent consumption of paper in relation to graphic paper, whereas the grey areas quantify the difference, that is, production and consumption of packaging, sanitary and industrial paper.

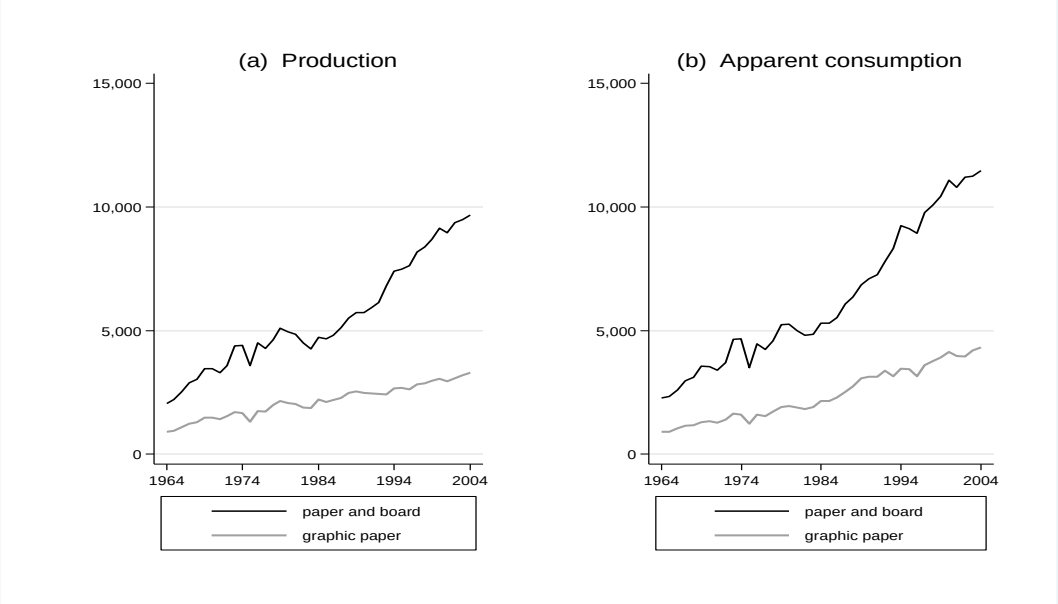

Fig. B.2: (a) Production of paper vs. production of graphic paper, 1964-2004
(b) Apparent consumption of paper vs. apparent consumption of graphic paper, 1964-2004

These figures reveal that fluctuations in production and consumption of graphic paper have been less pronounced than those exhibited by the rest of the paper industry, mainly due to the fact that demand for graphic paper is less responsive to macroeconomic business cycles that packaging paper.

Since the post-war recovery era, the graphic papermaking industry in Italy has been growing. Current production of graphic paper is nearly 13 times that in

[9] Specifically, the relevance of graphic paper in the papermaking industry as a whole has been fluctuating during the last half century. From some 47 per cent in the early 1950s, the share decreased to some 36-38 per cent in the mid-1970s and increased to some 46 per cent by the mid-1980s. Since then, it has been loosing ground, again, to paper for sanitary and household use. In 2002, on the basis of data published by ASSOCARTA, the shares of graphic, packaging, sanitary and household and industrial paper were 33 per cent, 46.5 per cent, 14.2 per cent and 6.3 per cent, respectively.

1950. Physical capital has also been enhanced in terms of the quality of the product as well as the speed, automation and reliability of the process, keeping pace with technological improvements.

B.3.1 Production, Consumption and Trade of Graphic Paper

By and large, the graphic paper sector has also evolved in three phases: uninterrupted rapid expansion, from 1950 to the early 1970s, pronounced fluctuations in production and fundamental structural changes, from the early 1970 to the mid-1980s, and moderate growth with increased opening to the rest of the world, from the mid-1980s to 2004. Table B.3 illustrates the expansion of production, apparent consumption and capacity.

Production and apparent consumption of graphic papers have expanded continuously throughout the period. Their pattern of expansion was virtually identical until the mid-1980s. Since, domestic demand was almost entirely met by domestic production. With the opening of the Italian market to foreign competition in the mid-1980s, domestic demand began to be increasingly served by imports, which is represented by the vertical difference between consumption and production in the above figure.

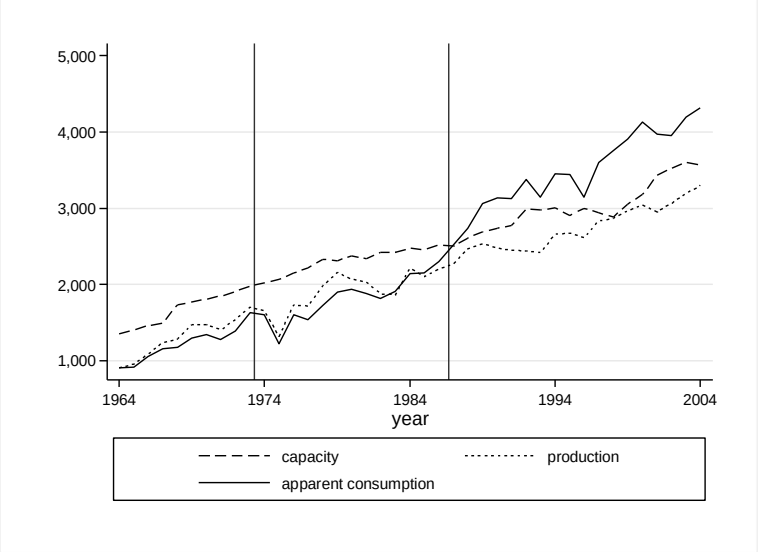

Figure B.3: Apparent consumption, production capacity and production of graphic paper, 1954-2004 (in '000 tonnes)

As shown by Figure B.3, significant fluctuations in demand and production began to appear towards the end of the 1960s. In the first two decades after the Second World War, the demand for graphic paper was dominated by the demand for printing and writing paper from the education and information sectors stimulated by the expanding literacy of the country. With the economic booming of the 1960s, demand for graphic paper began to be affected increasingly by demand for paper from the advertising sector, which is more susceptible to economic cycles. With minimal exports, at least until the mid-1980s, production virtually coincided with domestic consumption.

As for business cycles, Figure B.4 shows the de-trended times series for consumption (black line) and production (green line). Unlike production, apparent consumption seems to exhibit long-term cycles besides short-term ones. Figure B.4 shows two long periods in which deviations of consumption from its trend are persistently positive (1964-74 and 1988–2004 with the exception of a year) and one in which it is persistently negative (1975-1988). However, if the time series of deviations from trend are compared, their short-term cycles appear similar in several occasions. This suggests that the determinants of short-term fluctuations are generally similar for production and consumption.

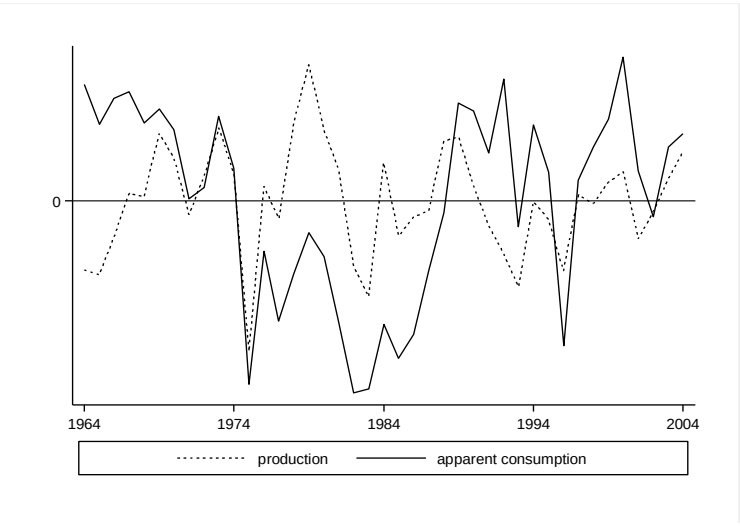

Figure B.4: De-trended times series for production and apparent consumption, 1964-2004

B.3.2 Capacity and Operating Rates

Similar to production and consumption, capacity increased at a sustained rate until the early 1970s, slowed down in the second half of the 1970s and 1980s and surged in the 1980s. The evolution of capacity is best seen through the dynamics of operating rates, which are calculated as the ratio between production and capacity. It is a measure of the utilization of the physical capital in a given year in a given industry. In the case of the paper industry, it also provides an indication of the level of profits[10]. Figure B.5 shows the evolution of the operating rate (i.e. production/capacity) in the graphic sector between 1964 and 2004. The red horizontal reference line is set at 0.83, which is the sample mean. If the period under consideration is limited to 1979 to 2004, then, the sample mean increases to 0.87[11]. The data on operating rates should be considered as indicative, rather than a precise description of the relation between capacity and production.

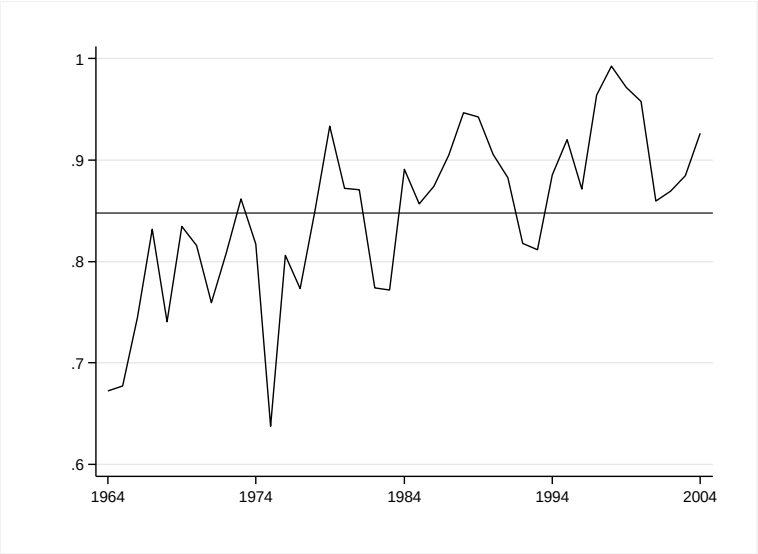

Figure B.5: Operating rates, 1964-2004

[10] Operating rates can be viewed as a proxy for profitability because when supply is above demand, papermakers generally suspend production for a short period. As prices decline and operating rates worsen, which in turn increase production costs, profits decrease. A description of the economics of papermaking is in Appendix A.

[11] Ideally, machines should operate at a minimum of a 93 per cent operating rate. At that level, the market is generally strong enough to bear price increases and mills are maximizing their manufacturing efficiencies (van Roden, 1998)

As a result of the relentless accumulation of physical capital in the 1950s and 1960s, the ratio between capacity and production had reached potentially damaging levels for the industry's profitability by the early 1970s. With depressed prospects for demand growth, capacity growth slowed down capital until profitable and sustainable operation ratios were restored in the 1980s. Since then, capacity started to grow again (see Figure B.3), while maintaining operating rates near the long term optimal level.

B.3.3 Newsprint vs. Printing and Writing Grades

This evolution is the result of two distinct and somewhat opposite dynamics of its two major segments, which have been affected differently by the investment decisions of papermakers and, more importantly, by government policies and measures in the 1980s. Figures B.6 and B.7 below illustrate the dynamics of production of, apparent consumption of and trade in graphic paper and its major segments, that is, newsprint and printing/writing (pr/wr).

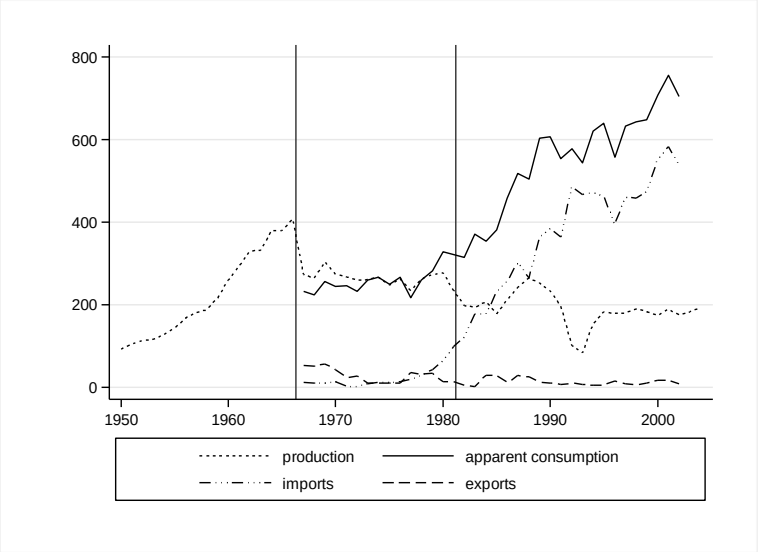

Figure B.6: Production, apparent consumption and trade of newsprint, 1950-2002

As shown in Figure B.6, the newsprint segment of the industry enjoyed remarkable expansion in the first 15 years after the post-war recovery era, when it grew at an average rate of some 9.9 per cent annually. This expansion was

the response to a set of policy measures on newsprint prices[12] and public funds, which the state put in place to foster the strategic publishing and printing industry. Between 1950 and 1965, some seven modern paper machines were installed and four new groups established, including three of the major Italian publishing houses. These new entries rapidly changed the industry, eroding the market shares of most of the traditional and smaller players, such as Cartiera Boimond, Cartiere Riunite Donzelli e Meridionali (CRDM), Cartiere Prealpine and Cartiere Tiburtine, which soon left the segment.

Companies	Firms	New plants	1960	1964	1968	1972
Cartiere Burgo	Burgo	Mantova (1964)	42	35	27	29
CRDM	Donzelli	Toscolano	10	6	6	5
C.I.R	Sertorio	Serravalle				
Cartiere Sterzi	Sterzi	Crevacuore	21	14	14	10
Soc. Idraulica del Liri	Torlonia	Avezzano (1959)				
Cartiere Prealpine	Pirelli	Verbania				
Cartiera Boimond	Boimond	Isola del Liri	6	3	2	1
Cartiere Tiburtine	UPM	Tivoli				
Cartiera del Timavo	Ferraro	Duino (1958)	11	28	31	32
Cartiera di Arbatax	Ferraro	Arbatax (1964)				
Cartiera di Marzabotto	Rizzoli	Marzabotto (1953)	9	13	14	15
Cartiera di Ascoli	Mondadori	Ascoli (1965)	1	1	6	8
Cartiera Valcerusa	Mondadori	Voltri				

Source: Reproduced from Balliano and Lanzetti, 1977, p. 109

Table B.5: Market shares in the Italian newsprint and magazine sector (percentage)

By the mid-1960s, this wave of expansion projects was exhausted. Meanwhile, the new plants had created overcapacity that the domestic economy, which was slowing and facing the first problems of a relatively chaotic post-war growth, was no longer able to absorb. Consequently, Italian papermakers were forced to look to foreign markets to utilise their plants at an acceptable level of efficiency. But

[12] The state's intervention in newsprint prices consisted of an elaborated mechanism of subsidies to the publishing industry. In practice, the *Comitato Interministeriale dei Prezzi*, a governmental committee overseeing domestic prices at national level, fixed the sale price for newsprint on the basis of the least efficient producer, while the *Ente Nazionale Cellulosa e Carta*, a public institute, was responsible for reimbursing editors through a rather complicated mechanism based on quotas. Therefore, on the supply side, this system ensured that domestic producers were shielded from foreign competition and, more importantly, the least efficient ones could survive. On the demand side, Italian publishers secured their paper requirements at a price comparable with that in international markets.

while the most modern mills could compete abroad, the old ones succumbed. However, the turning point in the evolution of the newsprint segment of the industry occurred in the early 1980s, when the Government embarked on a liberalisation policy. With tariffs on imported newsprint having been substantially lowered and government subsidies greatly diminished, the Italian producers of this grade of paper found themselves unable to compete in price with their European rivals, especially the Scandinavian producers, who were, at that time, seeking wider market shares for newsprint and magazine paper in Europe. The result was a progressive penetration of the Italian market by foreign companies, which generated overcapacity domestically. Consequently, Italian producers started, very quickly, exiting this segment of the market, mainly by converting their paper machines exclusively to production of grades with higher value-added, especially light-weight wood-free coated paper (LWC). By the mid-1980s, only two plants were still producing mainly newsprint: one at Arbatax, with a total capacity of some 200,000 tonnes annually, and another at Mantova, with a total capacity of some 128,000 tonnes annually. While the former stopped producing in the mid-1990s, the latter is still in operation, accounting for most of the domestic production.

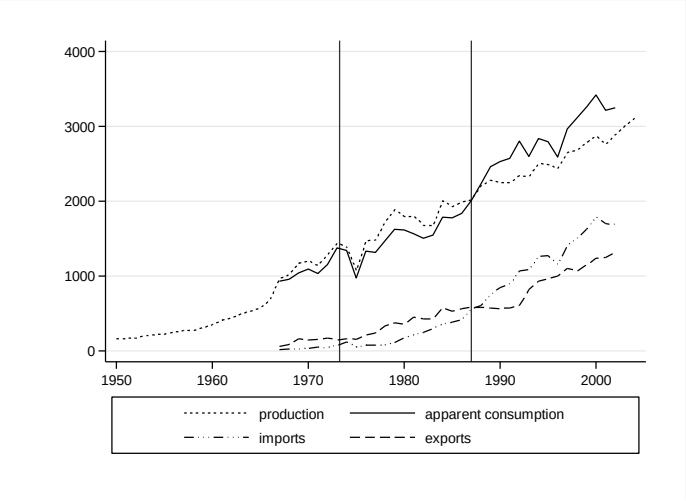

Figure B.7: Production, apparent consumption and trade of printing and writing paper, 1950-2002

Unlike newsprint, the segment of printing and writing paper[13] follows an evolution similar to that of graphic paper, of which it represents the bulk and, in turn, of the paper industry as a whole. After a rampant expansion in the first two post-war decades, the sector underwent a difficult period between the late 1970s and early 1980s. With tariff protection dramatically diminished, disinvestment of the state from the sector and Scandinavian producers seeking a wider market share for newsprint and magazine papers in Europe, for which they had substantial comparative advantage, the already compromised financial position of some groups became acute. The nadir was reached in 1982, when Fabocart and a number of the traditional groups, such as Cartiere Binda, Cartiere Sterzi, Cartiera di Marzabotto, CIR and CRDM, faced severe financial difficulties and, ultimately, went into receivership. In the years that followed, restructuring became the main challenge for those groups producing commodity grades of paper. Some of the plants were closed, while others were acquired and reorganised under different ownership.

This negative phase was overcome by a substantial change in the strategy of the surviving groups, led by a new generation of managers and stockholders. With no timber resources, high energy costs and peripheral location in reference to Europe's major paper-consuming markets, Italian producers began to concentrate on the production of high-quality, value-added paper. Following the liberalisation policies pursued by the state in the early 1980s, imports also started increasing at a sustained pace. Nevertheless, the Italian printing and printing paper industry has remained firmly in the hands of domestic producers.

[13] Whereas newsprint is a specific grade and homogenous product, printing and writing paper encompasses a variety of different grades, from quasi-commodity paper to specialty and technical paper. Structurally, it is a concoction of different plants and firms where smaller hand-made paper mills co-exist with larger modern ones for publication paper. For the purpose of this research, the producers of extra-light-weight paper are included in the graphic sector. As there is no universally employed classification, this almost specialty grade is often included in the residual category of so-called other papers or in the category of graphic paper, because it can be used for industrial purposes, such as cigarettes, as well as for printing, such as leaflets for pharmaceutical instructions.

APPENDIX D

STATISTICAL TABLES

Mill code	Mill_Avezzano
Mill address	Via Leonardo da Vinci 1, 67051 Avezzano, Aquila (AQ)
Telephone/fax	0863 04271; 0863 0509347
e-mail/website	www.burgo.it
Contact person	
Business name	Cartiere Burgo spa

HISTORICAL NOTES

	No paper mill at this location had ever been in existence before 1955.
1951 -1976	On 31 January 1951, a new company SOCIETÀ IDROELETTRICA DEL LIRI was established by the Torlonia family to use the waters of the Fucino lake. In January 1954, *Cassa per il Mezzogiorno* agreed to release aid funds to SOCIETÀ IDROELETTRICA DEL LIRI, which, together with the public administration of the Ente del Fucino, had submitted a proposal for the construction of a paper mill at Avezzano to make use of the nearby forest resources (mainly poplars). Construction work for the establishment of a new paper plant at this location began in 1955 and was concluded in 1959 with the installation of the first paper machine for the production of newsprint. The Torlonia family owned the paper mill. In 1964, the paper machine was modified to produce coated paper. During the period 1966-68, a new paper machine was installed and a coater added in 1970. With the decline of the demand for newsprint and magazine paper in the late 1970s, production at the paper mill was re-oriented to light-weight coated paper (LWC). Source : Burgo, *Paper and You : Fine Paper Division* , p. 15-16 and *Cellulosa e Carta*, January 1954, p.17;
1976 - 1982	In 1976, the mill was acquired by FABOCART (Gruppo Fabbri-Bonelli) from the Torlonia family. The mill continued to operate under the founding company (SOCIETÀ IDROELETTRICA DEL LIRI), which was subsequently renamed CARTIERA DI AVEZZANO SPA. Source : R&S (1984) *L'Industria della Carta*, p. 18; *PPI*, January 1980, p. 10.
1982 - 2001	The crisis surrounding the Fabbri's mills emerged in full in 1982. Early in the year, FABOCART group was broken up into two groups of companies: one headed by CARTIERE BURGO SPA, which controlled CARTIERA DEL SOLE, CARTIERA DEL TIMAVO, CARTIERA DI AVEZZANO and CARTIERA DI ROVERETO, and the other, CARTOSERVICE, consisting of the troubled CARTIERA DI ARBATAX, CIR, CRDM and NUOVA CARTIERA DELLA VALTELLINA. Specifically, on 1 January 1982, CARTIERA DI AVEZZANO SPA was absorbed by CARTIERE BURGO SPA.. After the government drastically reduced tariff protections and withdrew direct state intervention in the early 1980s, the convenience of producing newsprint in Italy was drastically curbed and most of the plants were converted to production of light-weight coated paper. Within this context, the Burgo group completed the conversion of the plant to LWC. In 1987, an on-line four-headed coater on PM2 was installed and the colour preparation department enlarged. With the start-up of the new coater, output increased to 130,000 tons/year of printing papers of a higher basis weight (65-150g/m2). Later on, in the context of a vast investment programme carried out by the BURGO Group in the 1990s, a turbogas power station was erected in 1999 and the second paper machine was rebuilt between 1999 and 2002. To finance a new wave of investments, in 2000, an OPA was launched. DIECI SRL, who was a bidding consortium of a Italian companies led by the agro/chemical/energy company COMPART-MONTEDISON and several other stakeholders, acquired 99.97% of the shares in CARTIERE BURGO. On 1 December 2001, CARTIERE BURGO SPA was absorbed by DIECI SRL. Source : Business Register; and *PPI*, Dec. 1987, p. 7 and, *Burgo Un secolo di carta* p. 183.

2001 to date	Following the take-over of CARTIERE BURGO SPA by the DIECI SRL, the acquiring company DIECI SRL was renamed CARTIERE BURGO SPA. All the production sites of the former CARTIERE BURGO SPA were taken over by the new company. As of 1 December 2001, the mill at this location was officially registered as a local unit of the newly founded CARTIERE BURGO SPA (formerly, DIECI SRL). The Board of Directors and senior management of the previous Cartiere Burgo remained in place. However, in 2001 COMPART-MONTEDISON left the bidding consortium and the company started looking for a new partner with a solid industrial experience, which was identified in the MARCHI group. Between 2002 and 2003, the MARCHI group acquired shares from a number of original stakeholders of the DIECI group. By December 2003, the MARCHI group held 32% of the company shares. In early 2004, the Board of Directors approved the merger of the two groups, with the MARCHI group holding a 48.3% stake in BURGO. Both firms continued to operate as two separate units with their own brand names though. The merger became effective in May 2004. Source : Business Register, visura and *Burgo Un secolo di carta* p. 188.

DEMOGRAPHIC CHARACTERISTICS

current status	ACTIVE	
year	**event**	**sector**
1959	mill construction	graphic (nesprint)

PRODUCTION CHARACTERISTICS

principal activity		ATECO 21.12				
type of operation		• pulp-making (until mid 1970s) • papermaking				
principal paper grades/ product categories		1959- 1979/81: newsprint, magazine paper 1964 on wards MWC and CWF: gloss and matt satin coated wood containing paper (65-85g/m2) and coated wood-free paper (89-200g/m2)				
		Capacity (in tons/y)		**Employment** (at this location)		**Production** (in tons/y)
	1964				467 Asso	700q/d pulp, 1000q/d paper
p 107	**1970**				540 Asso	1800q/d pulp, 2500q/d paper
	1975-76					
	1978-79	130000	90000pulp			
	1981-82	130000	75000pulp	790		
	1986				602RESS	102000t/y RESS
	1989	150000	75000pulp	790		
	1990	150000	40000pulp	474		
	1991	150000	40000pulp	665		
	1992	150000	40000pulp	665		
	1993	150000	40000pulp	661		capacity: 175000 PPI, Aug.93
	1994	180000	40000pulp	600(110)		
	1995	180000		500		
	1996	180000		500		capacity: 180000 PPI,May96
	1997	180000		500		
	1998	220000		528		
	1999	220000	40000pulp	530		
	2000	220000	40000pulp	530		
	2001	220000	40000pulp	530		
	2002	245000	40000pulp	282		
	2003	245000	275000www	511		
	2004		300000www		463 www	

PHYSICAL CAPITAL

Sources	**Paper machines**
1964 Annuario	Escher Wyss installed in 1959 [3.65m wide]
1970 Annuario	Escher Wyss [3.65m wide] Beloit [5.3 m wide],
Farinet	PM1: installed in 1958, upgraded in 1986 [3.7 m wide, 500m/min]

Sources	Paper machines
PPI	PM1: inst. 1959, rebuilt in 1976 [3.8 m wide, 500m/min] PM2: inst. 1968, rebuilt in 1986 [5.32 m wide, 830 m/min]
RESS 86	2 PM
company source	**PM1**: Escher Wyss installed in 1959 [3.65m wide; 100t/d], modified in 1964 (coated paper), upgraded in 1978/80, rebuilt in 1996 [3.8m wide, 600m/min], today [coated wood-containing, 65-85 g/m2, 785m/min, capacity 80000t/y] **PM2**: Beloit installed in 1966/68 [5.3 m wide; 150t/d], modified in 1970 (coated paper), upgraded in 1978/80, upgraded in 1987, rebuilt in 1999/02, today [89-200g/m2, 900m/min, capacity 220,000]
Note	According to Burgo, *Paper and You : Fine Paper Division* , p. 15-16, PM1 was modified to produce coated paper in 1964 and PM2 was converted to coated papers in 1970. However, the production of newsprint ended in the late 1970s. It is reasonable to assume that the production of newsprint gradually diminished.

PROPRIETORY RELATIONSHIPS

	Date APER-LU	**Data CONST**	**Data ISCR**	**Data INI-AT**	**Data CES-AT**	**Data CESSAZ**	**Data FALLIM**	**Data LIQUID**
Cartiera di Avezzano	01/11/59	31/01/51	07/03/51	31/01/51		01/01/82		
Cartiere Burgo	01/01/82	1905		21/04/11		01/12/01		
Cartiere Burgo	01/12/01	17/02/00	07/12/01					

period	**name**	**status**	**ownership**
1951 - 1976	Società Idroelettrica Liri spa - Cartiera di Avezzano	ceased	Torlonia family
1976 - 1982			Fabbri-Bonelli group
1982 - 2001	Cartiere Burgo spa	ceased	Burgo Group
2001 to date	Cartiere Burgo spa/ Dieci srl	active	Burgo Group (different shareholders)
Notes			

DATABASE REFERENCES

Company identifier		**Enterprise identifier**	
1959 - 1982	avezzano_com	1959 – 1976	torlonia_enterprise
1982 - 2001	burgoA_com	1976 – 1982	fabbri_enterprise
2001 to date	burgoB_com	1982 to date	burgo_enterprise

Table D.1: Profile of the paper mill at Avezzano

year	PRODUCTION ('000 tonnes)				APPARENT CONSUMPTION ('000 tonnes)			
	total paper & board	graphic paper			total paper & board	graphic paper		
		total graphic	of which: newsprint	of which: printing & writing		total graphic	of which: newsprint	of which: printing & writing
1938	478.9	75.0	…	…	478.2	…	…	…
1950	537.6	247.4	91.9	155.5	552.0	…	…	…
1951	572.0	268.9	104.6	164.4	528.7	…	…	…
1952	589.5	280.2	112.0	168.2	589.5	…	…	…
1953	667.1	316.6	116.2	200.4	703.7	…	…	…
1954	738.3	340.1	127.8	212.3	765.0	…	…	…
1955	815.3	366.7	143.6	223.1	840.2	…	…	…
1956	930.1	414.1	167.2	246.9	953.5	…	…	…
1957	1,061.1	449.2	181.2	268.1	1,117.6	…	…	…
1958	1,095.1	461.0	187.2	273.7	1,160.8	…	…	…
1959	1,263.0	522.7	217.3	305.4	1,329.2	…	…	…
1960	1,468.8	609.0	259.3	349.8	1,554.2	…	…	…
1961	1,599.6	697.9	293.2	404.7	1,801.4	…	…	…
1962	1,761.7	767.5	330.0	437.5	1,977.5	…	…	…
1963	1,926.5	824.9	331.6	493.3	2,217.5	…	…	…
1964	2,045.8	910.4	378.8	531.6	2,269.3	…	…	…
1965	2,208.0	953.0	379.4	573.7	2,340.8	…	…	…
1966	2,524.0	1,088.8	407.7	681.2	2,596.6	…	…	…
1967	2,890.5	1,238.4	272.7	965.7	2,977.7	1,158.8	232.9	925.9
1968	3,024.1	1,283.3	264.5	1,018.8	3,113.0	1,177.9	223.4	954.5
1969	3,452.9	1,475.7	303.6	1,172.1	3,555.9	1,296.9	256.2	1,040.7
1970	3,448.1	1,475.4	272.7	1,202.6	3,542.1	1,339.5	244.0	1,095.4
1971	3,288.3	1,404.4	267.4	1,137.1	3,403.9	1,275.1	246.1	1,029.0
1972	3,577.5	1,542.4	258.8	1,283.6	3,706.9	1,388.0	232.9	1,155.1
1973	4,369.2	1,701.8	260.9	1,440.8	4,638.7	1,630.9	260.0	1,371.0
1974	4,395.9	1,652.4	266.3	1,386.1	4,672.8	1,606.3	267.3	1,339.0
1975	3,582.9	1,318.8	247.3	1,071.5	3,508.3	1,220.9	249.2	971.7
1976	4,498.9	1,733.1	263.1	1,470.0	4,466.8	1,600.0	265.9	1,334.1
1977	4,271.8	1,715.8	234.5	1,481.3	4,235.2	1,535.2	217.5	1,317.7
1978	4,615.5	1,980.4	262.5	1,718.0	4,591.8	1,725.4	259.1	1,466.4
1979	5,100.6	2,159.3	272.3	1,887.1	5,243.8	1,904.1	282.2	1,621.9
1980	4,945.4	2,071.3	277.3	1,794.1	5,255.4	1,939.5	328.0	1,611.5
1981	4,842.0	2,034.7	233.9	1,800.8	4,983.7	1,886.0	320.5	1,565.5
1982	4,502.8	1,877.0	197.7	1,679.2	4,813.0	1,815.6	315.0	1,500.6
1983	4,259.5	1,865.1	193.8	1,671.3	4,855.0	1,913.3	370.7	1,542.6
1984	4,722.1	2,211.9	206.8	2,005.2	5,295.6	2,141.4	354.4	1,787.0
1985	4,673.5	2,105.0	178.1	1,926.8	5,297.6	2,155.2	381.3	1,773.9
1986	4,807.2	2,199.7	212.3	1,987.4	5,523.0	2,295.5	458.8	1,836.8
1987	5,107.9	2,266.4	243.0	2,023.4	6,069.0	2,522.3	517.5	2,004.8
1988	5,512.4	2,472.2	264.1	2,208.0	6,352.3	2,738.0	504.2	2,233.9
1989	5,735.1	2,535.2	252.5	2,282.7	6,852.8	3,065.8	604.5	2,461.3
1990	5,731.8	2,479.8	233.1	2,246.7	7,088.2	3,135.8	607.6	2,528.2
1991	5,932.2	2,447.8	196.2	2,251.6	7,267.2	3,131.0	553.9	2,577.1
1992	6,131.9	2,440.0	101.0	2,339.0	7,801.7	3,390.4	578.1	2,802.6
1993	6,811.0	2,419.4	83.1	2,336.3	8,327.8	3,152.0	543.9	2,601.3
1994	7,395.0	2,659.5	154.0	2,505.5	9,232.4	3,461.1	621.1	2,835.7
1995	7,477.3	2,674.7	183.0	2,491.7	9,109.8	3,445.6	640.4	2,800.0
1996	7,588.7	2,615.2	178.4	2,436.8	8,801.1	3,163.7	557.3	2,591.0
1997	8,146.7	2,833.9	179.7	2,654.2	9,751.3	3,606.9	632.5	2,966.4
1998	8,365.9	2,868.9	189.7	2,679.2	10,050.1	3,763.5	642.9	3,115.8
1999	8,676.3	2,968.9	183.3	2,785.6	10,412.9	3,917.5	648.6	3,259.5
2000	9,125.2	3,044.8	173.7	2,871.1	11,069.8	4,147.4	709.1	3,421.4
2001	8,926.1	2,951.3	188.8	2,762.5	10,772.5	3,986.6	756.9	3,213.8
2002	9,272.8	3,064.1	175.1	2,889.0	10,993.3	3,966.3	705.7	3,251.9
2003	9,373.3	3,189.0	182.0	3,007.0	11,045.8	4,197.9	…	…
2004	9,547.1	3,303.0	193.0	3,110.0	11,465.5	4,314.3	…	…

Source: *Industria della carta* and other sources (see section C.1)

Table D.2: Production and apparent consumption of paper by grade, 1938 and 1950-2004

year	IMPORTS				EXPORTS			
	total paper & board	graphic paper			total paper & board	graphic paper		
		total graphic	of which: newsprint	of which: printing & writing		total graphic	of which: newsprint	of which: printing & writing
1938	11.3	…	…	…	12.0	…	…	…
1950	32.0	…	…	…	17.6	…	…	…
1951	23.7	…	…	…	67.1	…	…	…
1952	27.8	…	…	…	27.8	…	…	…
1953	56.0	…	…	…	19.4	…	…	…
1954	55.5	…	…	…	28.8	…	…	…
1955	57.3	…	…	…	32.4	…	…	…
1956	51.7	…	…	…	28.3	…	…	…
1957	84.8	…	…	…	28.4	…	…	…
1958	88.4	…	…	…	22.7	…	…	…
1959	97.3	…	…	…	31.2	…	…	…
1960	131.5	…	…	…	46.0	…	…	…
1961	240.1	…	…	…	38.3	…	…	…
1962	254.2	…	…	…	38.4	…	…	…
1963	334.7	…	…	…	43.7	…	…	…
1964	314.0	…	…	…	90.6	…	…	…
1965	316.1	…	…	…	183.2	…	…	…
1966	292.8	…	…	…	220.2	…	…	…
1967	314.8	28.6	11.9	16.7	227.5	108.2	51.7	56.5
1968	361.2	31.9	10.3	21.6	272.3	137.3	51.4	85.9
1969	442.6	34.6	9.2	25.4	339.6	213.4	56.6	156.8
1970	462.6	46.8	13.8	32.9	368.6	182.7	42.5	140.1
1971	505.9	46.5	1.6	44.9	390.4	175.9	22.9	153.0
1972	544.1	44.4	1.5	42.9	414.7	198.8	27.4	171.4
1973	661.4	81.9	8.3	73.6	391.9	152.7	9.3	143.5
1974	757.2	127.2	11.1	116.1	480.4	173.4	10.1	163.3
1975	359.5	62.0	11.5	50.5	434.1	160.0	9.6	150.4
1976	483.5	82.5	12.3	70.2	515.7	215.7	9.5	206.1
1977	538.3	93.1	18.9	74.2	575.0	273.7	35.9	237.8
1978	626.5	103.9	27.6	76.3	650.1	358.9	31.0	327.9
1979	855.9	153.9	42.8	111.1	712.6	409.1	32.9	376.2
1980	993.5	238.1	63.7	174.4	683.5	369.9	12.9	357.0
1981	963.0	310.6	99.0	211.6	821.3	459.3	12.3	446.9
1982	1,099.6	364.8	121.6	243.2	789.5	426.2	4.4	421.8
1983	1,373.1	478.8	178.2	300.5	777.7	430.6	1.3	429.3
1984	1,601.6	536.2	176.7	359.5	1,028.0	606.7	29.0	577.6
1985	1,615.8	609.4	231.7	377.8	991.8	559.2	28.5	530.7
1986	1,791.7	672.7	257.6	415.1	1,075.8	576.8	11.1	565.7
1987	2,123.7	867.9	302.5	565.4	1,162.6	612.0	27.9	584.1
1988	2,149.2	871.7	265.1	606.6	1,309.2	605.8	25.1	580.7
1989	2,491.6	1,114.0	363.8	750.2	1,373.8	583.3	11.7	571.6
1990	2,760.7	1,227.3	384.9	842.4	1,404.3	571.4	10.4	560.9
1991	2,846.0	1,263.2	363.8	899.4	1,511.0	580.0	6.1	573.9
1992	3,299.9	1,553.4	486.8	1,066.6	1,630.1	612.7	9.7	603.0
1993	3,143.4	1,554.9	467.6	1,087.3	1,626.6	829.1	6.8	822.3
1994	3,587.3	1,734.3	471.4	1,262.9	1,749.9	937.0	4.3	932.7
1995	3,521.5	1,732.4	462.6	1,269.8	1,889.0	966.7	5.2	961.5
1996	3,325.7	1,550.5	394.3	1,156.2	2,113.3	1,017.4	15.4	1,002.0
1997	3,857.6	1,872.6	460.8	1,411.8	2,253.0	1,107.6	8.0	1,099.6
1998	3,934.9	1,960.7	458.0	1,502.7	2,250.7	1,070.9	4.8	1,066.1
1999	4,173.5	2,095.4	474.7	1,620.7	2,436.9	1,156.2	9.4	1,146.8
2000	4,543.8	2,343.1	552.3	1,790.8	2,599.2	1,257.4	16.9	1,240.5
2001	4,464.4	2,283.2	584.0	1,699.2	2,618.0	1,263.8	15.9	1,247.9
2002	4,534.9	2,226.1	539.3	1,686.8	2,814.4	1,332.6	8.7	1,323.9
2003	4,557.7	2,522.2	…	…	2,885.2	1,416.0	…	…
2004	5,046.9	2,740.7	…	…	3,248.5	1,646.2	…	…

Source: *Industria della carta* and other sources (see section C.1)

Table D.3: Imports and exports of paper by grade, 1938 and 1950-2004

	Entry		Exit		Net entry		Turbulence		Existing plants
	number	rate	number	rate	number	rate	number	rate	number
1964	2	3.0	0	0.0	2	2.9	2	3.0	69
1965	1	1.4	0	0.0	1	1.4	1	1.4	70
1966	1	1.4	1	1.4	0	0.0	2	2.9	70
1967	0	0.0	1	1.4	-1	-1.4	1	1.4	69
1968	1	1.4	2	2.9	-1	-1.5	3	4.4	68
1969	0	0.0	1	1.5	-1	-1.5	1	1.5	67
1970	0	0.0	0	0.0	0	0.0	0	0.0	67
1971	1	1.5	0	0.0	1	1.5	1	1.5	68
1972	0	0.0	2	3.0	-2	-3.0	2	3.0	66
1973	0	0.0	1	1.5	-1	-1.5	1	1.5	65
1974	1	1.5	1	1.5	0	0.0	2	3.1	65
1975	0	0.0	0	0.0	0	0.0	0	0.0	65
1976	0	0.0	0	0.0	0	0.0	0	0.0	65
1977	1	1.5	3	4.8	-2	-3.2	4	6.3	63
1978	0	0.0	1	1.6	-1	-1.6	1	1.6	62
1979	0	0.0	1	1.6	-1	-1.6	1	1.6	61
1980	1	1.6	1	1.6	0	0.0	2	3.3	61
1981	0	0.0	0	0.0	0	0.0	0	0.0	61
1982	0	0.0	3	5.2	-3	-5.2	3	5.2	58
1983	0	0.0	1	1.8	-1	-1.8	1	1.8	57
1984	0	0.0	0	0.0	0	0.0	0	0.0	57
1985	0	0.0	2	3.6	-2	-3.6	2	3.6	55
1986	1	1.8	0	0.0	1	1.8	1	1.8	56
1987	0	0.0	1	1.8	-1	-1.8	1	1.8	55
1988	0	0.0	0	0.0	0	0.0	0	0.0	55
1989	0	0.0	1	1.9	-1	-1.9	1	1.9	54
1990	0	0.0	0	0.0	0	0.0	0	0.0	54
1991	0	0.0	0	0.0	0	0.0	0	0.0	54
1992	0	0.0	1	1.9	-1	-1.9	1	1.9	53
1993	1	1.9	2	3.8	-1	-1.9	3	5.7	52
1994	0	0.0	1	2.0	-1	-2.0	1	2.0	51
1995	0	0.0	1	2.0	-1	-2.0	1	2.0	50
1996	0	0.0	0	0.0	0	0.0	0	0.0	50
1997	0	0.0	5	11.1	-5	-11.1	5	11.1	45
1998	0	0.0	1	2.3	-1	-2.3	1	2.3	44
1999	0	0.0	0	0.0	0	0.0	0	0.0	44
2000	0	0.0	0	0.0	0	0.0	0	0.0	44
2001	0	0.0	1	2.3	-1	-2.3	1	2.3	43
2002	0	0.0	0	0.0	0	0.0	0	0.0	43
2003	0	0.0	2	4.9	-2	-4.9	2	4.9	41
2004	0	0.0	1	2.5	-1	-2.5	1	2.5	40
Total	11		38		-27		49		

Table D.4: Plant entry, exit, net entry and turbulence, 1964-2004

	Entry		Exit		Net entry		Turbulence		Existing firms
	number	rate	number	rate	number	rate	number	rate	number
1964	0	0.0	0	0.0	0	0.0	0	0.0	48
1965	1	2.0	0	0.0	1	2.0	1	2.0	49
1966	1	2.0	1	2.0	0	0.0	2	4.1	49
1967	0	0.0	3	6.1	-3	-6.5	3	6.1	46
1968	1	2.3	3	6.5	-2	-4.5	4	8.8	44
1969	1	2.3	1	2.3	0	0.0	2	4.5	44
1970	0	0.0	0	0.0	0	0.0	0	0.0	44
1971	1	2.3	1	2.3	0	0.0	2	4.5	44
1972	2	4.8	4	9.1	-2	-4.8	6	13.9	42
1973	0	0.0	2	4.8	-2	-5.0	2	4.8	40
1974	0	0.0	1	2.5	-1	-2.6	1	2.5	39
1975	0	0.0	0	0.0	0	0.0	0	0.0	39
1976	0	0.0	2	5.1	-2	-5.4	2	5.1	37
1977	1	2.9	3	8.1	-2	-5.7	4	11.0	35
1978	0	0.0	1	2.9	-1	-2.9	1	2.9	34
1979	0	0.0	0	0.0	0	0.0	0	0.0	34
1980	3	8.6	2	5.9	1	2.9	5	14.5	35
1981	1	2.9	1	2.9	0	0.0	2	5.7	35
1982	0	0.0	1	2.9	-1	-2.9	1	2.9	34
1983	0	0.0	2	5.9	-2	-6.3	2	5.9	32
1984	1	3.2	2	6.3	-1	-3.2	3	9.5	31
1985	0	0.0	0	0.0	0	0.0	0	0.0	31
1986	2	6.3	1	3.2	1	3.1	3	9.5	32
1987	1	3.3	3	9.4	-2	-6.7	4	12.7	30
1988	0	0.0	0	0.0	0	0.0	0	0.0	30
1989	1	3.6	3	10.0	-2	-7.1	4	13.6	28
1990	0	0.0	1	3.6	-1	-3.7	1	3.6	27
1991	0	0.0	0	0.0	0	0.0	0	0.0	27
1992	1	3.7	1	3.7	0	0.0	2	7.4	27
1993	1	3.7	1	3.7	0	0.0	2	7.4	27
1994	0	0.0	2	7.4	-2	-8.0	2	7.4	25
1995	1	3.8	0	0.0	1	3.8	1	3.8	26
1996	0	0.0	0	0.0	0	0.0	0	0.0	26
1997	1	4.2	3	11.5	-2	-8.3	4	15.7	24
1998	3	12.5	3	12.5	0	0.0	6	25.0	24
1999	0	0.0	0	0.0	0	0.0	0	0.0	24
2000	0	0.0	0	0.0	0	0.0	0	0.0	24
2001	1	4.2	1	4.2	0	0.0	2	8.3	24
2002	0	0.0	0	0.0	0	0.0	0	0.0	24
2003	0	0.0	2	8.3	-2	-9.1	2	8.3	22
2004	1	4.5	1	4.5	0	0.0	2	9.1	22

Table D.5: Enterprise entry, exit, net entry and turbulence, 1964-2004

	Entry		Exit		Net entry		Turbulence		Existing companies
	number	rate	number	rate	number	rate	number	rate	number
1964	2	3.5	0	0.0	2	3.5	2	3.5	57
1965	1	1.7	0	0.0	1	1.7	1	1.7	58
1966	1	1.7	1	1.7	0	0.0	2	3.4	58
1967	0	0.0	4	6.9	-4	-7.4	4	6.9	54
1968	1	1.9	3	5.6	-2	-3.8	4	7.5	52
1969	2	3.8	1	1.9	1	1.9	3	5.7	53
1970	0	0.0	0	0.0	0	0.0	0	0.0	53
1971	1	1.9	0	0.0	1	1.9	1	1.9	54
1972	3	5.7	4	7.4	-1	-1.9	7	13.1	53
1973	2	3.8	3	5.7	-1	-1.9	5	9.5	52
1974	1	2.0	2	3.8	-1	-2.0	3	5.8	51
1975	0	0.0	0	0.0	0	0.0	0	0.0	51
1976	0	0.0	0	0.0	0	0.0	0	0.0	51
1977	1	2.0	3	5.9	-2	-4.1	4	7.9	49
1978	0	0.0	1	2.0	-1	-2.1	1	2.0	48
1979	2	4.4	5	10.4	-3	-6.7	7	14.9	45
1980	2	4.5	3	6.7	-1	-2.3	5	11.2	44
1981	0	0.0	1	2.3	-1	-2.3	1	2.3	43
1982	0	0.0	2	4.7	-2	-4.9	2	4.7	41
1983	1	2.4	1	2.4	0	0.0	2	4.9	41
1984	2	4.9	2	4.9	0	0.0	4	9.8	41
1985	1	2.5	2	4.9	-1	-2.5	3	7.4	40
1986	3	7.5	3	7.5	0	0.0	6	15.0	40
1987	1	2.6	3	7.5	-2	-5.3	4	10.1	38
1988	1	2.6	0	0.0	1	2.6	1	2.6	39
1989	7	18.4	8	20.5	-1	-2.6	15	38.9	38
1990	0	0.0	0	0.0	0	0.0	0	0.0	38
1991	0	0.0	1	2.6	-1	-2.7	1	2.6	37
1992	2	5.4	2	5.4	0	0.0	4	10.8	37
1993	2	5.6	3	8.1	-1	-2.8	5	13.7	36
1994	1	3.0	4	11.1	-3	-9.1	5	14.1	33
1995	2	6.1	2	6.1	0	0.0	4	12.1	33
1996	0	0.0	1	3.0	-1	-3.1	1	3.0	32
1997	0	0.0	2	6.3	-2	-6.7	2	6.3	30
1998	9	28.1	7	23.3	2	6.3	16	51.5	32
1999	0	0.0	2	6.3	-2	-6.7	2	6.3	30
2000	4	12.9	3	10.0	1	3.2	7	22.9	31
2001	3	10.3	5	16.1	-2	-6.9	8	26.5	29
2002	2	7.1	3	10.3	-1	-3.6	5	17.5	28
2003	0	0.0	4	14.3	-4	-16.7	4	14.3	24
2004	1	4.2	1	4.2	0	0.0	2	8.3	24

Table D.6: Company entry, exit, net entry and turbulence, 1964-2004

	Entry			Exit		
	total	*of which:*		**total**	*of which:*	
		construction	conversion		shutdown	conversion
1964	2	2	0	0	0	0
1965	1	1	0	0	0	0
1966	1	0	1	1	1	0
1967	0	0	0	1	1	0
1968	1	1	0	2	2	0
1969	0	0	0	1	1	0
1970	0	0	0	0	0	0
1971	1	1	0	0	0	0
1972	0	0	0	2	1	1
1973	0	0	0	1	1	0
1974	1	0	1	1	1	0
1975	0	0	0	0	0	0
1976	0	0	0	0	0	0
1977	1	1	0	3	3	0
1978	0	0	0	1	1	0
1979	0	0	0	1	1	0
1980	1	0	1	1	1	0
1981	0	0	0	0	0	0
1982	0	0	0	3	3	0
1983	0	0	0	1	1	0
1984	0	0	0	0	0	0
1985	0	0	0	2	2	0
1986	1	0	1	0	0	0
1987	0	0	0	1	1	0
1988	0	0	0	0	0	0
1989	0	0	0	1	1	0
1990	0	0	0	0	0	0
1991	0	0	0	0	0	0
1992	0	0	0	1	1	0
1993	1	1	0	2	2	0
1994	0	0	0	1	1	0
1995	0	0	0	1	1	0
1996	0	0	0	0	0	0
1997	0	0	0	5	5	0
1998	0	0	0	1	1	0
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	1	1	0
2002	0	0	0	0	0	0
2003	0	0	0	2	1	1
2004	0	0	0	1	0	1

Table D.7: Plant entry and exit by mode, 1964-2004

	Entry			Exit		
	total	*of which:*		**total**	*of which:*	
		greenfield	acquisition		shutdown	sale
1964	0	0	0	0	0	0
1965	1	1	0	0	0	0
1966	1	1	0	1	1	0
1967	0	0	0	3	1	2
1968	1	1	0	3	1	2
1969	1	0	1	1	0	1
1970	0	0	0	0	0	0
1971	1	0	1	1	0	1
1972	2	0	2	4	1	3
1973	0	0	0	2	1	1
1974	0	0	0	1	1	0
1975	0	0	0	0	0	0
1976	0	0	0	2	0	2
1977	1	1	0	3	3	0
1978	0	0	0	1	1	0
1979	0	0	0	0	0	0
1980	3	1	2	2	1	1
1981	1	0	1	1	0	1
1982	0	0	0	1	1	0
1983	0	0	0	2	0	2
1984	1	0	1	2	0	2
1985	0	0	0	0	0	0
1986	2	1	1	1	0	1
1987	1	0	1	3	0	3
1988	0	0	0	0	0	0
1989	1	0	1	3	0	3
1990	0	0	0	1	0	1
1991	0	0	0	0	0	0
1992	1	0	1	1	0	1
1993	1	1	0	1	1	0
1994	0	0	0	2	1	1
1995	1	0	1	0	0	0
1996	0	0	0	0	0	0
1997	1	0	1	3	2	1
1998	3	0	3	3	1	2
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	1	0	1	1	1	0
2002	0	0	0	0	0	0
2003	0	0	0	2	2	0
2004	1	0	1	1	0	1

Table D.8: Enterprise entry and exit by mode, 1964-2004

	Entry				Exit			
	total	*of which:*			**total**	*of which:*		
		greenfield	acquisition	re-organization		shutdown	sale	re-organization
1964	2	2	0	0	0	0	0	0
1965	1	1	0	0	0	0	0	0
1966	1	1	0	0	1	1	0	0
1967	0	0	0	0	4	1	2	1
1968	1	1	0	0	3	1	2	0
1969	2	0	1	1	1	0	0	1
1970	0	0	0	0	0	0	0	0
1971	1	1	0	0	0	0	0	0
1972	3	0	3	0	4	1	2	1
1973	2	0	0	2	3	1	0	2
1974	1	0	1	0	2	1	0	1
1975	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0
1977	1	1	0	0	3	3	0	0
1978	0	0	0	0	1	1	0	0
1979	2	0	0	2	5	1	0	4
1980	2	1	1	0	3	1	1	1
1981	0	0	0	0	1	0	1	0
1982	0	0	0	0	2	2	0	0
1983	1	0	1	0	1	0	1	0
1984	2	0	2	0	2	0	2	0
1985	1	0	0	1	2	0	0	2
1986	3	1	1	1	3	0	2	1
1987	1	0	1	0	3	0	3	0
1988	1	0	1	0	0	0	0	0
1989	7	0	5	2	8	0	5	3
1990	0	0	0	0	0	0	0	0
1991	0	0	0	0	1	0	0	1
1992	2	0	1	1	2	0	1	1
1993	2	1	0	1	3	1	0	2
1994	1	0	0	1	4	1	1	2
1995	2	0	1	1	2	1	0	1
1996	0	0	0	0	1	0	0	1
1997	0	0	0	0	2	2	0	0
1998	9	0	8	1	7	1	4	2
1999	0	0	0	0	2	0	0	2
2000	4	0	0	4	3	0	0	3
2001	3	0	1	2	5	1	1	3
2002	2	0	0	2	3	0	0	3
2003	0	0	0	0	4	2	0	2
2004	1	0	1	0	1	0	1	0

Table D.9: Company entry and exit by mode, 1964-2004

	PSIZEMRK	PSIZEG	GSIZEMRK	VINTAGE	EFFICIENT	LPAGE	LGAGE	OWN25TOT	OWN40TOT	COM25TOT	COM40TOT
PSIZEMRK	1.000										
PSIZEG	-0.247	1.000									
GSIZEMRK	0.675	-0.586	1.000								
VINTAGE	0.318	-0.075	0.209	1.000							
EFFICIENT	0.674	-0.223	0.532	0.397	1.000						
LPAGE	-0.117	0.021	-0.087	-0.214	-0.147	1.000					
LGAGE	0.092	-0.260	0.243	-0.026	-0.056	0.339	1.000				
OWN25TOT	0.088	-0.019	-0.025	0.186	0.354	0.243	-0.348	1.000			
OWN40TOT	0.185	-0.012	0.034	0.171	0.357	0.219	-0.364	0.946	1.000		
COM25TOT	0.295	-0.077	0.173	0.303	0.464	0.165	0.027	0.683	0.683	1.000	
COM40TOT	0.239	-0.076	0.172	0.227	0.396	0.146	0.005	0.631	0.665	0.941	1.000

	OWNCOM 10TOT	OWNCOM 25TOT	OWNCOM 40TOT	OWNONLY 10TOT	OWNONLY 25TOT	OWNONLY 40TOT	COMONLY 10TOT	COMONLY 25TOT	COMONLY 40TOT
OWNCOM10TOT	1.000								
OWNCOM25TOT	0.739	1.000							
OWNCOM40TOT	0.746	0.949	1.000						
OWNONLY10TOT	-0.165	0.046	0.018	1.000					
OWNONLY25TOT	0.271	0.367	0.291	0.628	1.000				
OWNONLY40TOT	0.261	0.353	0.253	0.447	0.860	1.000			
COMONLY10TOT	0.163	0.304	0.274	-0.264	0.144	0.128	1.000		
COMONLY25TOT	0.108	0.209	0.193	-0.235	0.125	0.168	0.860	1.000	
COMONLY40TOT	0.074	0.193	0.168	-0.267	0.097	0.153	0.796	0.905	1.000

Table D.10: Correlation matrix for selected variables

	PDIVER			GTYPE			GDIVER			GCORE		
	graphic only	graphic & other	total	single-plant firm	multi-plant firm	total	graphic only	graphic & other	total	graphic	other than graphic	total
PSPEC												
commodity	38	17	55	19	34	53	36	17	53	24	29	53
specialty	15	8	23	9	16	25	15	10	25	16	9	25
total	53	25	78	28	50	78	51	27	78	40	38	78
Pearson chi-squared test	chi2(1) = 0.1117		Pr = 0.74	chi2(1) = 0.0002		Pr = 0.99	chi2(1) = 0.4713		Pr = 0.492	chi2(1) = 2.3820		Pr = 0.12
PDIVER												
graphic only				17	38	55	42	13	55	28	27	55
graphic & other				11	12	23	9	14	23	12	11	23
total				28	50	78	51	27	78	40	38	78
Pearson chi-squared test				chi2(1) = 2.0170		Pr = 0.16	chi2(1) = 9.9337		Pr < 0.01	chi2(1) = 0.0104		Pr = 0.92
GTYPE												
single-plant firm							20	8	28	16	12	28
multi-plant firm							31	19	50	24	26	50
total							51	27	78	40	38	78
Pearson chi-squared test							chi2(1) = 0.7050		Pr = 0.40	chi2(1) = 0.6005		Pr = 0.44
GDIVER												
graphic only										34	17	51
graphic & other										6	21	27
total										40	38	78
Pearson chi-squared test										chi2(1) = 13.9579		Pr < 0.01

Table D.11: Cross-tabulation of selected plant- and firm-level variables

	Centre and South Italy	North West Italy	North East Italy	Italy
PMVINTAGE				
before 1945	11	3	3	17
1945-1963	7	17	9	33
1964-2004	11	8	9	28
total	29	28	21	78
Pearson chi2 test	Chi2(4) = 10.827 Pr = 0.029			
PSPEC				
commodity	18	21	14	53
specialty	11	7	7	25
total	29	28	21	78
Pearson chi2 test	Chi2(2) = 1.1154 Pr = 0.573			
PDIVER				
graphic only	21	22	12	55
graphic & other	8	6	9	23
total	29	28	21	78
Pearson chi2 test	Chi2(2) = 2.7304 Pr = 0.255			
GTYPE				
single-plant firm	16	10	2	28
multi-plant firm	13	18	19	50
Total	29	28	21	78
Pearson chi2 test	Chi2(2) = 11.0303 Pr = 0.004			
GDIVER				
graphic only	18	18	15	51
graphic & other	11	10	6	27
total	29	28	21	78
Pearson chi2 test	Chi2(2) = 0.4947 Pr = 0.781			
GCORE				
graphic	16	12	12	40
other than graphic	13	16	9	38
total	29	28	21	78
Pearson chi2 test	Chi2(2) = 1.2599 Pr = 0.533			
GPAST				
papermaker	12	11	7	30
industrialist	4	6	3	13
capitalist	13	11	11	35
total	29	28	21	78
Pearson chi2 test	Chi2(4) = 1.2674 Pr = 0.867			
OWN25				
no ownership change	15	15	15	45
ownership change	14	13	6	33
total	29	28	21	78
Pearson chi2 test	Chi2(2) = 2.2414 Pr = 0.326			
COM25				
no registration change	15	11	5	31
registration change	14	17	16	47
total	29	28	21	78
Pearson chi2 test	Chi2(2) = 3.9670 Pr = 0.138			

Table D.12: Cross-tabulation between plant location and selected categorical variables

	Centre and South Italy	North West Italy	North East Italy	Italy
OWN25TOT				
0 change	15	15	15	45
1 change	6	5	5	16
2 changes	6	4	0	10
3 changes	1	3	1	5
4 changes	1	1	0	2
total	29	28	21	78
Pearson chi2 test	Chi2(8) = 7.3289 Pr = 0.502			
OWNCOM25TOT				
0 change	19	17	17	53
1 change	5	7	3	15
2 changes	5	3	1	9
3 changes	0	1	0	1
total	29	28	21	78
Pearson chi2 test	Chi2(8) = 5.0302 Pr = 0.540			
OWNONLY25TOT				
0 change	20	20	18	58
1 change	8	6	3	17
2 changes	1	2	0	3
Total	29	28	21	78
Pearson chi2 test	Chi2(8) = 3.1121 Pr = 0.539			
COM25TOT				
0 change	15	11	5	31
1 change	4	11	8	23
2 changes	6	2	7	15
3 changes	3	2	0	5
4 changes	1	0	1	2
5 changes	0	2	0	2
total	29	28	21	78
Pearson chi2 test	Chi2(8) = 17.4268 Pr = 0.065			
COMONLY25TOT				
0 change	20	17	5	42
1 change	5	9	11	25
2 changes	3	0	5	8
3 changes	1	2	0	3
total	29	28	21	78
Pearson chi2 test	Chi2(8) = 17.9314 Pr = 0.006			

Table D.13: Cross-tabulation between plant location and selected history-level variables

	Before 1945	Between 1945-1963	Between 1964-2004	Total
OWN25				
no ownership change	11	23	11	45
ownership change	4	12	17	33
Total	15	35	28	78
Pearson chi2 test	Chi2(2) = 1.2674 Pr = 0.043			
COM25				
no registration change	9	15	7	31
registration change	6	20	21	47
Total	15	35	28	78
Pearson chi2 test	Chi2(2) = 5.2533 Pr = 0.072			
OWNONLY25				
no mere ownership change	13	29	16	58
mere ownership change	2	6	12	20
Total	15	35	28	78
Pearson chi2 test	Chi2(2) = 6.8701 Pr = 0.032			
OWNCOM25				
no ownership/registration change	12	26	15	53
ownership/registration change	3	9	13	25
Total	15	35	28	78
Pearson chi2 test	Chi2(2) = 4.3032 Pr = 0.116			
COMONLY25				
no mere registration change	12	19	11	42
registration change	3	16	17	36
Total	15	35	28	78
Pearson chi2 test	Chi2(2) = 6.5199 Pr = 0.038			

Table D14: Cross-tabulation between technological vintage and selected history-level variables

	PDIVER			PSPEC			PMMAX		
	graphic only	graphic & other	P-value	commodity	specialty	P-value	above 3m wide	less than 3m wide	P-value
PSIZEMRK	1.97	0.71	0.00	2.10	0.54	0.00	3.62	0.47	0.00
PSIZEG	52.92	63.27	0.35	58.78	50.01	0.41	44.75	62.25	0.08
GSIZEMRK	12.39	6.85	0.17	14.07	3.74	0.00	21.42	4.78	0.00
OWN25TOT	0.67	0.96	0.38	0.77	0.72	0.85	1.29	0.46	0.00
COM25TOT	1.00	1.35	0.34	1.09	1.12	0.93	1.71	0.76	0.00
	GTYPE			GDIVER			GCORE		
	single-plant firm	multi-plant firm	P-value	graphic only	graphic & other	P-value	graphic only	graphic & other	P-value
PSIZEMRK	0.54	2.19	0.00	2.09	0.67	0.00	1.81	1.38	0.43
PSIZEG	100.00	31.31	0.00	54.15	59.41	0.63	52.88	59.21	0.53
GSIZEMRK	0.54	16.48	0.00	13.81	4.98	0.01	15.35	5.92	0.02
OWN25TOT	0.43	0.94	0.04	0.59	1.07	0.10	0.40	1.13	0.00
COM25TOT	0.61	1.38	0.00	1.02	1.26	0.47	0.95	1.26	0.26
	OWN25			COM25					
	no change	change	P-value	no change	change	P-value			
PSIZEMRK	1.13	2.24	0.05	0.65	2.23	0.00			

Table D.15: Two-sample tests for group mean

		Means		Ha: diff≠0	
		Leavers	Survivors	P-value	
Regional-level variables	AREAREST	0.447	0.300	0.178	
	AREANW	0.447	0.275	0.113	
	AREANE	0.105	0.425	0.002	***
Plant-level variables	PSIZEMRK	0.007	0.025	0.001	***
	PSIZEG	0.059	0.527	0.506	
	PDIVER	0.316	0.275	0.693	
	PSPEC	0.342	0.300	0.690	
	LPAGE	4.537	4.390	0.474	
	VINTAGE45	0.316	0.075	0.007	***
	VINTAGE64	0.500	0.400	0.375	
	VINATGE04	0.184	0.525	0.002	***
	PMMAX	0.763	0.525	0.028	**
	PMMIN	0.237	0.475	0.028	**
	VINTAGE	65.789	87.917	0.012	**
	EFFICIENT	17.105	44.250	0.006	***
Firm-level variables	GTYPE	0.579	0.700	0.265	
	GDIVER	0.500	0.200	0.005	***
	GCORE	0.605	0.375	0.042	**
	LGAGE	4.046	3.562	0.041	**
	GSIZEMRK	0.062	0.151	0.023	**
History-level variables	GPAST1	0.474	0.425	0.666	
	GPAST2	0.158	0.175	0.839	
	GPAST3	0.500	0.395	0.356	
	CHANGE	1.368	2.025	0.082	*
	OWN25	0.395	0.450	0.627	
	COM25	0.421	0.775	0.001	***
	OWNCOM25	0.289	0.350	0.572	
	OWNONLY25	0.263	0.250	0.896	
	COMONLY25	0.237	0.675	0.000	***
	OWN25TOT	0.763	0.750	0.957	
	COM25TOT	0.711	1.475	0.005	***
	OWNCOM25TOT	0.421	0.500	0.645	
	OWNONLY25TOT	0.342	0.250	0.457	
	COMONLY25TOT	0.289	0.975	0.000	***

Table D.16: Statistics for selected variables

	CR4	CR8	CR2-4	CR5-8	HHI	**Total Capacity** in tonnes
1964	50.133	68.001	28.648	17.868	929.824	1,354,390
1965	48.245	65.440	27.569	17.195	872.336	1,407,390
1966	49.307	66.380	29.434	17.073	858.874	1,464,290
1967	50.131	71.574	29.918	21.443	904.599	1,489,090
1968	49.302	70.268	31.711	20.966	894.779	1,733,790
1969	53.880	73.672	36.632	19.792	958.137	1,768,390
1970	53.330	73.231	36.474	19.901	938.526	1,809,490
1971	52.155	71.627	35.149	19.472	911.166	1,849,290
1972	58.447	77.352	39.989	18.905	1085.075	1,904,290
1973	62.836	80.311	41.460	17.476	1237.286	1,974,190
1974	62.986	80.296	41.521	17.311	1239.472	2,021,890
1975	62.742	80.371	40.862	17.630	1239.474	2,070,390
1976	67.329	83.548	40.676	16.219	1437.695	2,149,890
1977	67.688	84.164	40.514	16.476	1461.912	2,218,990
1978	68.458	84.564	46.454	16.106	1433.293	2,269,990
1979	68.731	84.746	35.305	16.015	1830.857	2,314,090
1980	67.400	83.717	34.626	16.317	1783.934	2,375,370
1981	67.055	83.808	32.179	16.753	1818.640	2,465,870
1982	67.994	84.142	32.316	16.148	1868.752	2,424,470
1983	69.792	84.814	32.796	15.022	1963.427	2,416,470
1984	68.253	84.204	32.244	15.951	1879.618	2,482,670
1985	67.547	83.670	30.129	16.123	1883.226	2,456,070
1986	66.645	83.063	26.833	16.418	1969.000	2,515,570
1987	67.589	86.805	27.647	19.216	2000.921	2,549,970
1988	67.616	86.765	27.651	19.149	2000.873	2,611,070
1989	73.518	91.249	25.421	17.731	2647.887	2,678,920
1990	73.944	91.397	26.278	17.453	2625.003	2,738,820
1991	73.840	91.433	25.946	17.593	2640.020	2,773,820
1992	74.242	91.888	25.211	17.646	2735.104	2,984,820
1993	72.149	90.185	25.408	18.036	2517.845	2,981,320
1994	73.668	91.583	25.572	17.915	2644.717	3,001,320
1995	76.134	91.209	26.473	15.075	2787.819	2,906,720
1996	76.652	91.419	27.672	14.767	2733.038	3,001,220
1997	78.902	92.718	26.617	13.815	3036.539	2,849,720
1998	75.301	87.277	25.290	11.975	2785.458	2,889,320
1999	75.978	87.711	25.439	11.733	2840.550	3,076,820
2000	76.504	87.952	26.187	11.447	2832.901	3,179,820
2001	78.641	89.214	25.194	10.573	3136.535	3,433,320
2002	81.837	90.261	29.501	8.425	3068.354	3,525,320
2003	82.457	90.724	29.603	8.268	3121.666	3,604,320
2004	84.328	91.918	30.275	7.590	3258.811	3,524,320

Table D.17: Concentration indexes and market shares of the first eight largest firms, 1964-2004

	1st Largest Firm	2nd Largest Firm	3rd Largest Firm	4th Largest Firm	5th Largest Firm	6th Largest Firm	7th Largest Firm	8th Largest Firm
1964	21.486	15.136	7.125	6.387	4.799	4.799	4.430	3.839
1965	20.677	14.566	6.857	6.146	4.618	4.618	4.263	3.695
1966	19.873	14.000	9.527	5.907	4.780	4.439	4.098	3.756
1967	20.214	13.767	9.368	6.783	6.212	6.165	4.701	4.365
1968	17.592	17.476	8.104	6.131	5.825	5.335	5.191	4.614
1969	17.247	17.247	13.176	6.209	5.938	5.089	4.524	4.241
1970	16.856	16.856	13.263	6.355	6.085	4.974	4.697	4.145
1971	17.007	16.493	12.437	6.219	5.954	4.867	4.596	4.056
1972	18.458	17.828	16.016	6.144	6.039	4.726	4.201	3.938
1973	21.376	18.438	17.197	5.825	5.065	4.559	4.052	3.799
1974	21.465	18.003	17.583	5.935	4.946	4.699	3.957	3.709
1975	21.880	17.654	17.412	5.796	4.830	4.589	4.589	3.623
1976	26.653	17.396	17.233	6.047	4.651	4.586	3.954	3.028
1977	27.175	17.328	17.102	6.084	4.957	4.443	3.831	3.245
1978	22.005	21.498	19.009	5.947	4.846	4.344	3.745	3.172
1979	33.426	23.573	5.899	5.834	4.753	4.477	3.673	3.111
1980	32.774	23.575	5.683	5.368	4.782	4.631	3.831	3.073
1981	34.876	21.027	5.678	5.475	5.454	4.607	3.690	3.001
1982	35.678	20.974	5.774	5.568	5.548	4.537	3.052	3.011
1983	36.996	21.043	5.959	5.794	5.173	3.931	3.021	2.897
1984	36.010	20.482	6.122	5.639	5.156	5.035	2.940	2.820
1985	37.418	17.508	6.514	6.107	5.212	5.089	2.972	2.850
1986	39.812	14.510	6.360	5.963	5.088	4.969	3.180	3.180
1987	39.942	14.314	7.059	6.275	5.882	5.098	4.902	3.333
1988	39.964	13.979	7.315	6.358	5.745	5.170	4.979	3.255
1989	48.098	12.206	6.906	6.309	6.159	5.973	3.173	2.426
1990	47.667	13.071	6.755	6.452	6.024	5.842	3.213	2.373
1991	47.894	12.906	6.670	6.370	5.948	5.768	3.353	2.524
1992	49.031	12.245	6.701	6.265	6.198	5.987	3.116	2.345
1993	46.741	11.589	7.111	6.708	6.205	6.128	3.354	2.348
1994	48.096	11.512	7.397	6.664	6.164	6.087	3.332	2.332
1995	49.661	11.955	7.637	6.881	5.959	3.612	3.096	2.408
1996	48.980	11.579	8.330	7.764	5.871	3.565	2.999	2.332
1997	52.286	9.492	8.773	8.352	5.885	3.930	2.456	1.544
1998	50.012	11.006	8.653	5.631	4.222	2.665	2.665	2.423
1999	50.539	11.050	9.100	5.288	3.965	2.828	2.503	2.438
2000	50.317	11.950	8.806	5.431	3.931	2.736	2.422	2.359
2001	53.447	12.087	8.155	4.951	3.786	2.534	2.184	2.068
2002	52.336	12.339	9.361	7.801	2.468	2.127	2.014	1.815
2003	52.853	12.208	9.156	8.240	2.442	2.081	1.970	1.776
2004	54.053	12.485	9.364	8.427	2.128	2.015	1.816	1.632

Table D.18: Market shares of the first eight largest firms, 1964-2004

	Arbatax	Bertelsman	Burgo	Donzelli	Fabbri	Fedrigoni
1964	0	0	21.486	6.387	0	2.916
1965	0	0	20.677	6.146	3.197	3.162
1966	0	0	19.873	5.907	3.073	3.039
1967	0	0	20.214	6.165	3.022	2.988
1968	0	0	17.476	6.131	5.191	2.970
1969	0	0	17.247	6.209	5.089	2.912
1970	0	0	16.856	6.085	4.974	2.846
1971	0	2.433	17.007	5.954	4.867	3.272
1972	0	2.363	17.828	0.110	6.144	3.177
1973	0	5.065	17.197	0.127	21.376	3.065
1974	0	4.946	17.583	0.124	21.465	3.066
1975	0	4.830	17.412	0.121	21.880	2.995
1976	0	4.651	17.233	0.140	26.653	3.028
1977	0	4.957	17.328	0.135	27.175	2.934
1978	0	4.846	22.005	0.132	21.498	2.868
1979	0	4.753	23.573	0.156	33.426	2.813
1980	0	4.631	23.575	0.152	32.774	3.073
1981	0	5.678	31.252	0.146	21.027	2.960
1982	0	5.774	35.678	0.177	20.974	3.011
1983	0	5.794	36.996	0.178	21.043	3.021
1984	0	5.639	36.010	0.777	20.482	2.940
1985	0	6.107	37.418	1.026	17.508	2.972
1986	0	5.963	39.812	1.002	14.510	3.180
1987	0	5.882	39.942	0.988	14.314	3.333
1988	0	5.745	39.964	1.007	13.979	3.255
1989	6.906	5.973	48.098	0.982	0	3.173
1990	6.755	5.842	47.667	1.008	0	3.213
1991	6.670	5.768	47.894	0.995	0	3.353
1992	6.198	6.701	49.031	0.975	0	3.116
1993	6.205	6.708	46.741	1.110	0	3.354
1994	6.164	6.664	48.096	1.103	0	3.332
1995	3.096	6.881	49.661	1.170	0	3.612
1996	2.999	8.330	48.980	1.133	0	3.565
1997	0	8.773	52.286	1.193	0	3.930
1998	0	0	50.012	1.246	0	4.222
1999	0	0	50.539	1.170	0	3.965
2000	0	0	50.317	1.132	0	3.931
2001	0	0	53.447	1.180	0	3.786
2002	0	0	52.336	1.149	0	7.801
2003	0	0	52.853	1.124	0	8.240
2004	0	0	54.053	1.149	0	8.427

Table D.19: Market shares of the largest firms, 1964-2004

	Ferraro	Lecta	Marchi	Pirelli	Sottrici	State
1964	15.136	0	0.886	3.692	0.554	7.125
1965	14.566	0	0.853	3.553	0.533	6.857
1966	14.000	0	0.922	3.415	0.512	9.527
1967	13.767	0	0.907	6.783	0.504	9.368
1968	17.592	0	0.779	5.825	1.298	8.104
1969	17.247	0	0.848	5.938	1.470	13.176
1970	16.856	0	0.829	6.355	1.437	13.263
1971	16.493	0	2.163	6.219	1.406	12.437
1972	16.016	0	2.101	6.039	1.365	18.458
1973	0.000	0	2.026	5.825	1.393	18.438
1974	0.000	0	2.053	5.935	1.459	18.003
1975	0.000	0	2.149	5.796	1.425	17.654
1976	0.000	0	2.070	6.047	1.372	17.396
1977	0.000	0	2.005	6.084	1.893	17.102
1978	0.000	0	2.026	5.947	1.850	19.009
1979	0.000	0	2.074	5.834	1.815	5.899
1980	0.000	0	2.021	5.683	1.768	5.368
1981	0.000	0	2.028	5.475	1.825	5.454
1982	0.000	0	2.062	5.568	1.856	5.548
1983	0.000	0	2.069	2.897	1.862	5.959
1984	0.000	0	2.336	2.820	2.215	6.122
1985	0.000	0	2.361	2.850	2.239	6.514
1986	0.000	0	2.385	0	3.180	6.360
1987	0.000	0	2.353	0	7.059	6.275
1988	0.000	0	2.489	0	7.315	6.358
1989	0.000	0	6.159	0	12.206	6.309
1990	0.000	0	6.024	0	13.071	6.452
1991	0.000	0	5.948	0	12.906	6.370
1992	0.000	0	6.265	0	12.245	5.987
1993	0.000	0	7.111	0	11.589	6.128
1994	0.000	0	7.397	0	11.512	6.087
1995	0.000	0	7.637	0	11.955	5.959
1996	0.000	0	7.764	0	11.579	5.871
1997	0.000	0	8.352	0	9.492	5.885
1998	0.000	8.653	11.006	0	0	5.631
1999	0.000	9.100	11.050	0	0	5.288
2000	0.000	8.806	11.950	0	0	5.431
2001	0.000	8.155	12.087	0	0	4.951
2002	0.000	9.361	12.339	0	0	0.993
2003	0.000	9.156	12.208	0	0	0.971
2004	0.000	9.364	12.485	0	0	0.993

Table D.19: *Cont.*

APPENDIX C

DATA SOURCES AND MEASURES

This Appendix lists and defines all variables used in the quantitative analyses of the thesis. It is organised into five sections, according to their scope.

C.1 Industrial Structure Variables (Chapter 4 and Appendix B)

This section contains the variables referring to the industry's structural evolution. These time-series data have been compiled from a number of official publications, with only the exception of the time series of total capacity of the graphic sector, which has been assembled using the thesis's dataset. They have been mainly used in Chapter 4 and Appendix B.

Variables		Sources and Technical Notes
Code	**Definition**	
PROD_pb	Annual production of paper and paperboard in tonnes	The time-series for 1954 to 2004 is drawn from *L'industria della carta*.
PROD_gr	Annual production of graphic paper in tonnes	The time-series for 1954 to 2004 is drawn *L'industria della carta.*
KAP_pb	Annual capacity of paper and paperboard in tonnes	The time-series for 1964 to 2004 is that published by FAO. FAO is the primary source for data on production capacity in the paper industry. Since 1961, FAO has published the annual survey as *World Pulp and Paper Capacities*, which contains country tables for capacity (in tonnes) by major grade categories. FAO figures are based on information received early in the year of publication from national correspondents, which, in Italy, is ASSOCARTA.
KAP_gr	Annual capacity of graphic paper in tonnes	The time-series for 1964 to 2004 is drawn from the thesis' plant database by aggregating the estimated annual capacity of each plant manufacturing graphic paper. Compared to the time-series published by FAO, there are minor discrepancies.
IMP_pb	Annual imports of paper and paperboard in tonnes	The time-series for 1954 to 2004 is drawn from *L'industria della carta.*
IMP_gr	Annual imports of graphic paper in tonnes	The time series on imports are those published in *Industria della Carta* for 1966 to 1994, *Industria Cartaria: Rassegna statistica 1993-2002* for 1995 to 2002. Figures for 2003 and 2004 have been obtained by interpolation . As both publications were published by ASSOCARTA, figures over time are

Variables		Sources and Technical Notes
Code	**Definition**	
		consistent. For 1951 to 1965, no comparable data on imports are available. Following the transfer of responsibility for data collection from the Ministry of Industry to ISTAT, in 1966 more detailed classification and wider coverage were introduced, which made it difficult to reconcile trade data prior to and after 1966.
EXP_pb	Annual exports of paper and paperboard in tonnes	The time-series for 1954 to 2004 is drawn from *L'industria della carta*.
EXP_gr	Annual exports of graphic paper in tonnes	The time series on exports are those published in *Industria della Carta* for 1966 to 1994 and *Industria Cartaria: Rassegna statistica 1993-2002* for 1995 to 2002. Figures for 2003 and 2004 have been obtained by interpolation. As both publications were published by ASSOCARTA, figures over times are entirely consistent. For 1951 to 1965, see note on IMP_gr
CON_pb	Annual apparent consumption of paper and paperboard in tonnes	Apparent consumption of paper and paperboard was calculated directly from the time-series of production, exports and imports published by ASSOCARTA
CON_gr	Annual apparent consumption of graphic paper in tonnes	Apparent consumption of graphic paper was calculated directly from the time-series of production, exports and imports as published by ASSOCARTA, with two major exceptions due to the unavailability of trade figures for the years prior to 1967 and subsequent to 2002 (see technical notes for imports and exports above). (1) For 1951 to 1966, the times series reproduces figures published in *Carta e Cellulosa*, 9/1976, p. 5. Since there is no difference between figures published by ASSOCARTA and *Carta e Cellulosa* for the overlapping years (1967-72), it is reasonable to assume that figures prior to and after 1967 are consistent. (2) For 2003 to 2004, figures are calculated by dividing FAO data on apparent consumption by 1.007. For 1961 to 2002, apparent consumption on the basis of FAO data was, on average, 1.007 more than apparent consumption calculated on the basis of ASSOCARTA data.
OP_pb	Annual operating rate in the paper and paperboard industry	Operating rates are calculated as the ratio of annual production to annual capacity of paper and paperboard
OP_gr	Annual operating rate in the graphic paper industry	Operating rates are calculated as the ratio of annual production to annual capacity of graphic paper

C.2 Demographic Business Variables (Chapters 3 and 4)

Besides economics, the study of entry and exit has been a playground for scholars from other disciplines, most notably, demography, organisational

sociology and economic geography. Firms can be seen as a specific type of organisations (organisational sociology), located in a specific geographical area (economic geography and regional studies) and going through stages between the two events of foundation and dissolution (demography)[1]. As a result of this cross-fertilisation, economists have borrowed a number of terms from these disciplines, especially demography. This section defines the demographic business variables.

Turbulence In the literature of entry and exit, especially firm creation, turbulence has come to denote, "the flux created in an industry's total composition by flows of births and deaths" (Beesley and Hamilton, 1984, p. 220). Though widely adopted, this usage is not universal. In discussing the empirical evidence on entry and exit patterns and resulting churning of population, Caves uses, instead, generational turnover (1976) or, simply, firm mobility (1998). On the contrary, for Davies and Geroski (1997) turbulence indicates changes in market shares of individual firms. In this research, turbulence follows the definition used by Sutton (1997), that is, the sum of gross entry and gross exit rates. Beesly and Hamilton (1984) propose a similar measurement. They define turbulence as the ratio between gross entry and exit and total number of establishments in the industry before the start of the birth and death flows.

Firm As noted in Chapter 3, firm designates the generic profit-making legal entity of a decentralised economy. Firm and enterprise are used interchangeably throughout the thesis.

Enterprise As detailed in Chapter 3, enterprise is the empirical counterpart of the firm, as one of the unit of analysis of the thesis' research.

[1] van Wissen (2002) provides an overview of the demography of the firm as an interdisciplinary research field of economics, sociology and economic geography. By highlighting similarities and differences between the birth and death processes in firm and human populations, the author discusses the application of demographic concepts and tools to the study of firms and their extent.

Company Company, or registered company, is used exclusively to indicate the reporting unit of the dataset of legal personalities.

Turnover In general terms, the turnover of subjects in a particular population or group is the pace at which subjects leave it and are replaced by others. As such, this term could be used, "to embrace three processes: the births and deaths of business units…, variations in sizes and market shares of continuing units…, and shifts between enterprises in the control of continuing business units" (Caves, 1998, p.1948). However, in this thesis, this term has a restricted usage. It denotes the change in the market share of the top-ranked firms.

Demographic events, turnover Drawing on the analogy of the birth-death process between firms and people, demographic is added to qualify the corresponding noun as pertaining to the process of population change. For example, demographic events refer to firm entry, birth, exit and death and demographic turnover to the churning of the population through the entry of new firms and exit of old ones.

Firm mobility As defined by Caves (1998), firm mobility indicates changes in configuration of the industry's incumbent population as some firms grow and others shrink.

Variables		**Sources and Technical notes**
code	**definition**	
EN_firm **EN_com** **EN_plant**	Total number of firms, companies and plants that entered the industry in a year	The times series for 1964 to 2004 are drawn from the thesis' database
EX_firm **EX_com** **EX_plant**	Total number of firms, companies and plants that exited the industry in a year	ibidem.
NEN_firm **NEN_com** **NEN_plant**	Difference between total number of firms, companies and plants that entered the industry and those that have exited in a year	ibidem.

Variables		Sources and Technical notes
code	**definition**	
TUR_firm **TUR_com** **TUR_plant**	Sum of total number of firms, companies and plants that entered and exited the industry in a year	ibidem.
REN_	Entry rate calculated as the percentage of total number of exits out of total number of existing of firms, companies and plants in a year	ibidem.
REX_	Exit rate calculated as the percentage of total number of exits out of total number of existing of firms, companies and plants in a year	ibidem.
RNEN_	Net entry rate calculated as the percentage of net entries out of total number of existing firms, companies and plants in a year	ibidem.
RTUR_	Turbulence rate calculated as the sum of entry and exit in a year	ibidem.

C.3 Variables for Chapter 5

This section defines the variables used for the econometric analysis of plant closure presented in Chapter 5. All variables are measured as at end-of-year, if not indicated otherwise. They are drawn from the thesis dataset.

Variables	
Code	**Definition**
EXIT	Indicator variable that equals 1 if plant *j* exits the industry during year *t* and zero otherwise.
	Plant level variables
PSIZEMRK	Ratio between plant *j*'s estimated capacity (in tonnes) and total estimated capacity of the Italian graphic paper industry
PSIZEG	Ratio between plant *j*'s estimated capacity (in tonnes) and total estimated capacity of the firm owning plant *j*
PSPEC	Indicator variable that equals 1 if plant *j* produces technical or specialty grades, and 0 otherwise
LPAGE	Logarithm of number of years of existence of plant *j* in the Italian graphic paper industry

Variables	
Code	**Definition**
PDIVER	Indicator variable that equals 1 if the plant produces only graphic paper and 0 if it produces a mix of graphic and other paper grades (packaging, tissue and industrial, etc.)
PMMAX	Indicator variables that equals 1 if the width of the largest paper machine in operation at plant *j* is less than 3m and 0 otherwise
VINTAGE45 **VINTAGE64** **VINTAGE04**	Dummy variables indicating age class of the newest paper machine in operation at plant *j.* Paper machines are grouped by installation year into three categories: before 1945, between 1945 and 1963 and from 1964 onwards.
VINTAGE	Percentage of functioning paper machines installed before 1945 out of the total number of machines in operation at plant *j*
EFFICIENT	Percentage of paper machines at least 3m wide out of the total number in operation at plant *j*.
	Firm level variables
GTYPE	Indicator variable that equals 1 if plant *j* is owned/controlled by a firm with more than one papermaking plant (regardless of paper category) and 0 otherwise.
LGAGE	Logarithm of number of years of existence of the firm owning/controlling plant *j*
GCORE	Indicator variable that equals 1 if the sector of origin of the firm owning/controlling plant *j* was other than graphic papermaking and 0 if firm was making graphic paper or started as graphic papermaker.
GDIVER	Indicator variable that equals 1 if the firm owning/controlling plant *j* produced a mix of graphic and other paper grades, such as packaging, tissue and industrial, etc..
GSIZE	Logarithm of estimated total estimated capacity (in tonnes) of the firm owing plant *j.*
GSIZEMRK	Ratio of estimated total capacity (in tonnes) of the firm owning/controlling plant *j* to the industry's estimated capacity.
	Regional level variables
AREAREST **AREANW** **AREANE**	Dummy variables indicating the geographical area where the plant is located, grouped into three regions: AREANNE including Veneto, Trentino-Alto Adige, Friuli-Venezia Giulia and Emilia-Romagna, AREANW including Aosta valley, Liguria, Lombardy and Piedmont, and AREAREST including the rest of Italy.
	Plant-firm history variables
GPAST1 **GPAST2** **GPAST3**	Dummy variables indicating the background of the founder of plant *j*, grouped into three categories: GPAST1 including all founders whose background was neither in manufacturing nor paper-related activities, GPAST2 including all who were industrialists and GPAST3 including all whose background was in paper-related activities
OWN25	Dummy variables indicating whether plant *j* had undergone an ownership change in the last 25 years of existence
COM25	Dummy variables indicating whether plant *j* had undergone registration changes in the last 25 years of existence
OWN25TOT	Number of ownership changes that plant *j* had undergone in its last 25 years of existence
COM25TOT	Number of registration changes that plant *j* had undergone in its last 25 years of existence
OWNCOM25TOT	Number of ownership changes accompanied by registration changes that plant *j*

Variables	
Code	**Definition**
	had undergone in its last 25 years of existence
OWNONLY25TOT	Number of ownership changes without registration changes that plant *j* had undergone in its last 25 years of existence
COMONLY25TOT	Number of registration changes without ownership changes that plant *j* had undergone in its last 25 years of existence

C.4 Variables for Chapter 6

This section defines the variables used for the econometric analysis of firm survival as presented in Chapter 6. For each variable, some descriptive statistics (namely mean, standard deviation, minimum and maximum values) are also reported.

Variables	
Code	**Definition**
SURVIVAL	Length of time (in days) from entry to exit from the industry of firm *i*.
EVENT	Indicator variable that equals 1 if the firm exits and 0 otherwise
	Demographic variables
ENMODE	Indicator variable if the firm *i* entered by plant acquisition and 0 if by plant construction or conversion.
ENSTATE	Indicator variable if the firm *i* was a *de novo* entrant and 0 if it was a diversifying one.
	Size variables
LSIZE	Logarithm of current estimated total capacity (in tones) of firm *i*.
SIZEMRK	Ratio of firm *i*'s current capacity to total capacity of the industry
SIZECLASS1 **SIZECLASS2** **SIZECLASS3**	Dummy variables indicating current size class of firm *i*, grouped into three classes: SIZECLASS1 including all firms whose current annual capacity was up to 25,000 tonnes, SIZECLASS2 including all those with annual capacity was between 25,000 and 100,000 tonnes and SIZECLASS3 including all those with capacity more than 100,000 tonnes
	Technical variables
PMAGE	Number of paper machines installed after 1945
PMAGE%	Number of paper machines installed after 1945 and wider than 3m.
PMEFFICIENT	Share of paper machines installed after 1945 in total number of machines in use

Variables	
Code	**Definition**
PMEFFICIENT%	Share of paper machines installed after 1945 and wider than 3m in total number of machines in use
	Firm strategic and location variables
DIVER	Indicator variable that equals 1 if firm *i* has been producing a mixture of different categories of paper and 0 if it has been producing only graphic paper.
TYPE	Indicator variable that equals 1 if firm *i* was multi-plant operation and 0 if a single-plant
EXPAND	Number of times when firm *i* acquired or construct plants, excluding any acquisition at time of entry
SHRINK	Number of times when firm *i* shut down or sold plants during its life, excluding sales or shutdowns at time of exit
REORG	Number of times when firm *i* underwent a reorganization during its life.
AREANE	Indicator variable that equals 1 if all plants belonging to firm *i* are located in North-East Italy and 0 in any other part of the country.
	Firm history variables
PAST	Indicator variable indicating the background of firm *i*. It takes the value 1 if firm j' was a papermaker and 0 otherwise
CORE	Indicator variable that equals 1 if the sector of origin of firm *i* was other than graphic papermaking, and 0 if it was graphic papermaking
ORIGINCORE	Indicator variable that equals 1 if the entering firm was foreign or a diversifying firm with a major core business in another sector
COHORT1 **COHORT2** **COHORT3**	Dummy variables indicating the period in which firm *i* was established, grouped into three cohorts: COHORT1 including firms established prior to 1950, COHORT2 including those established between 1950 and 1963 and COHORT3 from 1964 onward

C.5 Variables for Chapter 7

This section presents the definition of concentration measures used in Chapter 7 and their corresponding method of calculation.

Variables	
Code	**Definition**
CR4 **CR8**	Sum of the annual market share of the top four and eight firms. Market shares are calculated as percentage ratio of firm *j's* total capacity (in tonnes) to industry's total capacity.
HHI	Herfindahl-Hirschman index, calculated as the sum of the squared individual firm market shares

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