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FIRMS' HETEROGENEITY AND PERFORMANCE IN MANUFACTURING DURING THE GREAT RECESSION

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Abstract

This paper highlights how the heterogeneity of manufacturing firms impacted their performance and survival during the "Great Recession". The findings indicate that firms that assumed a strategically proactive and innovative strategy in the pre-crisis period showed better economic performance during the crisis in terms of both sales and value added. The evidence also shows that the youngest firms and those that had a lower level of financial exposure were favored in terms of performance. Finally, the results also confirm the increased importance of different technological regimes. In contrast, survival estimates demonstrate the non-significance of pre-crisis strategic profiles: *ceteris paribus*, the results indicate that the most innovative, internationalized and dynamic firms did not register a greater likelihood of survival than other businesses. This result casts doubt on the efficiency and direction of the selection process.

Keywords: Crisis and Restructuring; Heterogeneity, Growth; Firms' Performance; Firms' Survival; Manufacturing Industry; Italy

1. Introduction

The debate regarding the relationship between firm strategies and performance has increased relevance in the aftermath of one the most dramatic crises in the modern economic era. The aim of this work is to analyze how the heterogeneous strategies implemented by firms influenced their performance and survival in a strongly recessionary environment. Thus, we want to test whether positive economic performance was homogeneous among firms as well as whether such performance was driven by the same factors that led to businesses' survival, as indicated in the empirical literature (Bartelsman, Scarpetta, Schivardi, 2003). Using a representative sample of firms, we compare companies' pre-crisis strategies with their 2007-13 economic outcome in terms of both growth rates and survival status.

The heterogeneity of firms and the variety of their conduct represent two border (and conflicting) issues between the industrial economics and management literature (Nelson, 1991; Mauri and Michaels, 1998). The former stream of literature stresses the binding role of technological regimes in shaping firms behaviors, while the latter focuses more on the internal capabilities pertaining to a single firm. Several empirical contributions highlight the presence of a wide variety of firm behaviors within many industries (Helper and Kleiner, 2007; Syverson, 2004; Thomas and D'Aveni, 2009) together with an increased variance in performance and profitability (Whitford, 2005; Luria, 2002; McNamara et al., 2003, Syverson, 2004; Foster et al., 2008; Mathew, 2012; Accetturo et al., 2011). Furthermore, firms' heterogeneity in terms of innovation, export capacity, productivity and profitability has been detected in several works in reference to many industrialized countries (Kirner el al., 2009; Bartelsman et al., 2015,Campbell et al., 2001; Comin and Philippon, 2006; Wei and Zhang, 2006; Syverson, 2004;Thesmar and Thoenig, 2004; Defever and Toubal, 2007).

This paper addresses several aspects that are worth emphasizing. First, it conceives of firms' behavioral heterogeneity in terms of a global business attitude rather than a set of specific and unrelated activities. Thus, we apply a multidimensional approach (cluster analysis) to classify firms according to their strategic profile. Second, the analysis focuses on the Italian economy, which represents a very interesting case for two reasons. On the one hand, its industrial system is well known for being populated by highly heterogeneous businesses (Tundis et al., 2012; Arrighetti and Traù, 2013; Dosi et al., 2015; De Nardis and Cipolletta, 2014). On the other hand, aggregate data clearly show that the crisis in Italy has been exceptionally deep and prolonged (Bank of Italy, 2014). Third, this work exploits a newly available database – the MET survey on Italian companies – which is based on a sample of firms that are representative of the national industrial system. The dataset comes from the widest survey administered in a single European country that even allows us to study the behavior of micro-sized companies with less than ten employees. It also provides information on firms' structural characteristics, choices, and strategies, thus allowing us to explore several dimensions of firms' strategic profile.

With regard to the growth rate model's empirical estimation, we faced a sample selection bias arising from the fact that the dependent variable could only be measured for those businesses that were still in operation and active in 2013. We addressed this bias via a two-stage estimation à la Heckman (Heckman 1976, 1979). We further deepened the analysis by studying whether growth rate determinants change at different levels of distribution of the performance variables through a quantile regression technique (Koenker and Bassett, 1978; Buchinsky, 1998).

The results show that firms that undertook proactive and innovative behaviors in the pre-crisis period demonstrated better economic performance during the crisis in terms of both sales and value added. The findings also indicate that the youngest firms and those with a lower level of financial exposure were favored by the markets. Notwithstanding this evidence, technological regimes

apparently play a central role as well. When focusing solely on firm survival, in contrast, the effect of pre-crisis strategic profiles appears to be non-significant: *ceteris paribus*, the findings show that the most innovative, internationalized and dynamic firms did not demonstrate a greater likelihood of survival than the other firms. This result can be attributed to the cost and risk of exposing a firm to strategic and organizational change and to the attempt to enter distant and less known foreign markets. The variables of pre-crisis financial reliability and profitability seem to dominate by closely and permanently influencing the likelihood of survival: the crisis had the effect of selecting the segment of the more financially solid firms, but that does not mean that those firms were the most innovative and internationalized.

The paper is organized as follows. Section 2 discusses the background literature. Sections 3 and 4 describe the empirical approach: in Section 3, we analyze the database employed, and we illustrate the use of cluster analysis to elaborate a business taxonomy on the basis of the revealed strategies; Section 4 discusses the econometric approach used to distinguish the two models, one dedicated to the estimation of the determinants of performance and one to the determinants of survival. Section 5 closes the work with some synthesizing comments.

2. The background literature

In the attempt to explain differences in firm performance and firms' survival rates, an extensive stream of research has accumulated. Some contributions emphasize the role of sectoral variables, while others highlight the importance of factors that act at the firm level and differentiate among firms' competitive strategies. Traditional studies on industrial organization stress that firms basically converge toward similar behaviors and performance (Schmalensee, 1985). Firms, especially in contexts of uncertainty, can adopt different behaviors, but institutional constraints, economic incentives and the effects of "natural selection" quickly narrow the range of sustainable alternatives at the industry (or technological regime) level. The result is that performance and rates of survival are different for enterprises under different technological regimes but are equal within the same regime (Nelson and Winter, 1982; Pavitt, 1984; Malerba and Orsenigo, 1993, 1996) or in the same sector (Ghemawat, 2002).

In contrast, the resource-based view and some of the management literature note the importance of specific strategic and organizational variables that operate at the firm level and that affect both performance and business survival (Barney, 1986 1991; Rumelt, 1991; McGahan and Porter, 1997, 2002; Mauri and Michaels, 1998). From this perspective, the industrial structure is less important in influencing choices at the plant level, and firms are allowed to consider multiple options that can generate differentiated conduct, heterogeneous performance and dissimilar mortality rates (Powell, 1996; McGahan and Porter, 1997; Brush et al., 1999). This approach does not dispute the role played by technological regimes by recognizing that such regimes influence firms' choices through peculiar constraints and opportunities. Nevertheless, it emphasizes that knowledge and the variety of resources that are accumulated within single firms engender different competitive modes between different companies, even inside the same industry/technological regime (Wernerfelt, 1984; Rumelt, 1991; Teece et al., 1997). Finally, in a "rugged environment" such as that characterizing the current competitive context, the local optima are multiple and *ex ante* substantially equivalent (Levinthal, 1997; Leiponen and Drejer, 2007). Therefore, firms adopt different strategies because they are influenced by the extent of their internal resources, by the way they believe those resources should be enhanced, by the exploitation of differences with other companies and, finally, by their degree of risk aversion (Lee, 2003).

The processes of globalization and the financial crisis differently impacted the heterogeneity of conduct. On the one hand, forces operating in the direction of limiting the variety of behaviors are

active. On the other hand, variables that favor the extension of heterogeneity appear to be strengthening.

The new manufacturing landscape is the result of the increasing volume of international exchanges and the reduction in geographic concentration (Baldwin, 2006). This new landscape seems to be characterized by a set of phenomena that are common to different sectors and firms: fluctuating, uncertain and fragmented demand, a reduction in production lots, the prevalence of customized products, the employment of flexible production systems, and the widespread use of IT and modular product architectures (Koren, 2010). It would appear that a dominant if not unique pattern is emerging. Global competition, in fact, forces companies to primarily focus their business strategies on innovation (Gunday et al., 2011; Kuratko and Hodgetts, 1998), on the exploitation of internal, intangible assets, on adjustments to the organizational structure toward greater reactivity with respect to demand (Hayes and Pisano, 1996; Volberda, 1998; Teece et al., 1997; Scranton, 2006; Koren, 2010) and on the geographic extension of markets beyond national borders (Hashi and Stojcic, 2013). From this perspective, globalization seemed to compress companies' degrees of freedom just as the financial crisis, by emphasizing constraints on access to credit, apparently reduced the variety of viable options[1].

If globalization apparently encourages firms to adopt similar behaviors, it left room for heterogeneity. In fact, change relies on endogenous resources, mainly of an immaterial nature, that require repeated investments over time. Not all firms in the recent past have moved in this way and have accumulated expertise and adequate resources on which to rely in the present to activate such change. Second, additional investments are necessary to give continuity to innovation and to align business functions with the premises of flexibility and reconfigurability required by the ongoing transformations (Volberda; 1999; Teece et al., 1997). Third, change calls for overcoming existing routines and patterns of consolidated decision-making and management, which has a cost and can create extraordinary tension within an organization. Moreover, in the presence of a severe and prolonged recession, the industrial dynamic also depends on the perception of the intensity of current changes by the entrepreneur/management (Coriat, 2001), on the reactivity of individual firms to the economic crisis (Archibugi, Filippetti and Frenz, 2013), on the preference of management for passive vs. active learning (Ericson and Pakes, 1995; Ortega- Argiles and Moreno, 2007) and on the diversity of thresholds of profit that can be considered acceptable to continue the activity (D'Elia et al., 2011)[2].

In summary, the changes in the competitive paradigm demonstrate the importance of firms' strategies based on tangible and intangible investments and the increase in the size of the geographic markets. At the same time, the changes provide different strategic opportunities, such as those based on cost reduction and the risk of change, the selection of the most profitable product lines followed by downsizing, reductions in fixed investment, and containment of the quality and the cost of labor (Helper et al., 2012; Arrighetti and Traù, 2013; Arrighetti and Ninni, 2014).

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[1] The effectiveness of these strategies of *global engagement* is supported by a number of empirical studies (among others, Bridges and Guariglia, 2008; Criscuolo et al., 2010). Using data for the United Kingdom, Guariglia and Mateut (2010) conclude that small, young, highly risk-oriented and internationally committed firms are less sensitive to changes in financial variables than are businesses that operate on domestic markets. In a similar way, Desai et al. (2007) show that companies affiliated with multinational companies, in contrast to their local counterparts, are able to increase output even in contexts of growing financial constraints (Blalock et al., 2004).

[2] Lawless and Anderson (1996) note that the adoption of new technologies results in an initial disadvantage for a firm. Similarly, the results found by Damanpour and Evan (1984) emphasize that innovation often produces positive effects on firm performance only after quite a long time.

This interpretative framework suggests that firms' survival and economic performance can be correlated by referring to the types of conduct developed by the firms before the recession[3]. The non-uniqueness of the predictable outcomes of innovation and organizational change, the importance of the resources and expertise accumulated and the presence of strong complementarity between a firm's resources lead us to empirically test the impact on performance and on the probability of survival not of individual variables and behaviors, but of a set of choices combined in a specific taxonomy of conduct. Based on these considerations, the first hypothesis we will test is as follows:

Hp 1: The performance and survival of firms are affected by the different types of conduct adopted during the pre-crisis period.

Many empirical studies that analyze the relationship between innovation and performance find mixed results (Rosenbuch et al., 2011): some contributions show that innovation does not significantly affect an enterprise's performance (Birley and Westhead, 1990; Heunks, 1998) or that the influence is negative (McGee et al., 1995; Vermeulen et al., 2005). Moreover, as observed by Simpson et al. (2006), innovation is an expensive and risky activity with uncertain effects that can lead to disaffection among employees, increased exposure to market risks and higher costs

Even the role of innovation and R&D as a determinant of survival remains ambiguous. The empirical results are very heterogeneous and are critically linked to the way in which the target variable is identified. In some cases, the positive role of innovation and R&D for the survival of enterprises with innovative activities is emphasized (Cefis and Marsili, 2006). In other cases, the results are questionable (Audretsch et al., 2000) or negative (Agarwal, 1998). Giovannetti et al. (2011), in a work focused on Italian firms, confirm the ambiguity of the effects on survival and indicate a positive influence of size and technological level and a negative impact of internationalization, at least during the first half of the first decade of the twenty-first century.

Following the approach introduced by Nelson and Winter (1977, 1982), mechanisms of natural selection, search, imitation, and implementation of internal knowledge and skills determine the amount of available opportunities and affect the rate of growth of firms (Pavitt, 1984; Malerba and Orsenigo, 1993; Dosi et al., 1995; Marsili and Verspagen, 2002). By operating within technological regimes characterized by a high level of investment in innovation, the differentiation of firms is strengthened, and the number of exploitable opportunities increase (Malerba and Orsenigo, 1993, 1996). As a consequence, some technological regimes, unlike others, improve the performance (Audretsch and Mahmood, 1994) and survival rates of firms. More generally, differences between sectors and regimes affect the role of innovation in firm performance: in fact, in some regimes, technological innovation plays such a crucial role that it becomes *a matter of life or death* (Brusoni et al., 2006). It is therefore appropriate to verify the following:

[3] Generally, taxonomies are designed to reduce the complexity and variety of observed empirical phenomena (Bailey, 1994; Peneder, 2003; De Jong and Marsili, 2006) through the identification of a few traits that characterize and unify groups of individuals, organizations or general observation units to differentiate them from other groups (Archibugi, 2001). Some taxonomies have been developed recently with regard to innovation and technological regimes (Cesaratto and Mangano, 1993; Avarnitis and Hollenstein, 2001; Archibugi, 2001; De Jong and Marsili, 2006). In addition, many works have considered variables such as managerial orientation, the characteristics of a business in terms of capital, labor and raw material intensity, the quality of human capital and expenditures on R&D (Legler,1982; Peneder, 2003), and investments in intangible assets (De Jong and Marsili, 2006; Davis and Lyons, 1996; Peneder, 2001, 2003; O'Mahony and Vecchi, 2009; Souitaris, 2002).

Hp 2: The effect exerted by innovative and, more generally, pro-active behaviors on firm performance and survival hinges on the technological regime to which the firm belongs.

The financial status of a firm not only influences its prospects for survival but also the extent of its growth (Musso and Schiavo, 2008; Carreira and Silva, 2010). Becchetti and Trovato (2002) note that access to external financing (leverage, credit rationing) limits the growth of smaller businesses, while it is neutral for the growth of larger firms. Similar results have been obtained by Oliveira and Fortunato (2006), who note that, with reference to Portuguese manufacturing firms, the extent of growth greatly depends on the available cash flow and then on the external financial constraints that these firms must bear. In the recent crisis, the effects due to financial constraints and access to credit had a great influence, and, contrary to the provisions of the theory of "creative destruction" (Caballero and Hammour, 1996), led to the inefficient allocation of resources (Barlevy, 2003; Ouyang, 2009). These remarks lead to the definition of the following hypothesis:

Hp 3: The performance of firms and their likelihood of survival are conditioned by their financial status and their level of profitability before the crisis.

Productivity and capital intensity impact the performance of firms (Doms et al., 1995). The general conclusion reached by some studies is that in manufacturing firms a high level of productivity is correlated with higher growth rates and lower failure rates. Following Olley and Pakes (1996), capital intensity can be considered a proxy of different sources of efficiency; therefore, it is not surprising that capital intensity is negatively correlated with the likelihood of exit and is positively associated with the growth rate of a production unit (Doms et al., 1995). Coad (2007) suggests that the relationship between productivity and performance is more complex than it appears at first glance. In fact, productivity gains can be associated with both increases in firm size and decisions to downsize (Baily et al., 1996). These findings are indirectly confirmed in some other studies (Bottazzi et al., 2002 and 2006; Foster et al., 1998) that are unable to find a significant relationship between productivity and growth. In conclusion, Coad (2007) notes that while ample evidence is available showing that low productivity can assist in predicting market exit (Griliches and Regev, 1995; Foster et al., 1998), productivity levels are not very helpful in predicting firms' growth rates. Based on the foregoing considerations the following hypothesis will be tested:

Hp4: The performance and survival of firms depend on the efficiency of the management of internal resources and capital intensity.

The relationship between firm size and performance is the subject of a large number of studies (among others, Geroski et al., 2010; Caves, 1998). Simultaneously with the abandonment of the conventional approach that associates growth in firm size to a sort of *random walk*, explanations for the variation in firm size are increasingly attributed to the difficulties that small businesses face in exploiting economies of scale and reducing the differential in efficiency compared with larger firms. In addition, Coad (2007) notes that Gibrat's Law is confirmed only above a given size threshold. In this regard, Lotti et al. (2003) follows a cohort of newly established Italian companies and concludes that although smaller firms initially grow faster than the average, it is difficult to deny the independence of size and growth as time passes. Similar results are reported by Becchetti and Trovato (2002) with regard to Italian manufacturing firms, by Geroski and Gugler (2004) for large European companies and by Cefis et al. (2006) for the pharmaceutical industry throughout the world. With regard to survival, it is diffusely confirmed that small businesses are more likely to leave the market than larger firms (Esteve-Perez et al., 2004; Strotmann, 2007). The foregoing considerations lead to the following hypothesis:

Hp 5: Firm performance and survival depend on the size and resources accumulated by a firm itself.

Finally, age differently influences firms' performance. The younger the firm is, the higher its rate of growth will be (Variyam and Kraybill, 1992; Dunne and Hughes, 1994; Delmar et al., 2003; Yasuda, 2005). The need to adjust the actual entry size to the minimum optimum size and the opportunity to exploit new products and internal technological competences both push start-ups to grow (Lee 2010). Although there are exceptions (among others, Das, 1995), the prevailing relationship between age and growth in firm size is negative (Evans, 1987; Coad, 2007). The relationship between age and profitability, however, remains more uncertain (Honjo, 2000). The literature on survival does not report unanimous evidence regarding firm age, which is partly justified by the possible presence of an inverse U-shaped relationship between the two variables (Esteve and Mañez-Perez, 2008). These considerations lead to the last hypothesis:

Hp.6: Firm performance is negatively correlated with firm age, but survival is positively related to firm age.

The hypotheses described above are entered directly into the estimation of two models: one for the probability of survival and a second focused on the performance of firms that remain active in the market.

3 Empirical methodology

3.1 The data

The main data source for the analysis is the MET survey of Italian firms, which is available for different waves (2008, 2009, 2011, 2013). The sample contains approximately 25,000 cross-sectional observations for each wave of firms in manufacturing industries. The sampling design is intended to be representative of the Italian industrial population by size (4 classes), region (20), and industry level (12 sectors based on the 3-digit NACE classification). In contrast to other Italian datasets, the sample contains information on firms of all size classes, even micro firms with less than ten employees. The survey obtains data on firms' structural characteristics and their main strategies in terms of investments, R&D, innovation and internationalization processes. Quantitative economic and financial variables are included by merging balance sheet data[4] with the data from the MET survey.

The starting point of the sample is the 2008 wave to measure survival at the end of the period and performance between 2007 and 2013. Overall, the dataset includes approximately 9,000 observations; the main reason for the loss of observations is the absence of yearly balance sheet data. We impose a further requirement to study only active firms at the starting year on the basis of the information contained in the 2007 balance sheet data[5].

3.2 Cluster analysis

[4] Balance sheet data are from CRIBIS D&B.

[5]We filtered out not only inactive/dead firms at the end of 2007 but also companies with economic values representative of firms in crisis, then we removed firms with negative or null values for turnover, value added and total assets. Most highly levered firms (above the 99th percentile) have also been removed.

To synthesize the different strategies adopted by firms during the 2005-2007 period, a cluster analysis was undertaken to identify specific profiles according to different firms' competitive behavior. Cluster analysis is used to group a set of objects (firms in our case) such that the degree of similarity is high among members within the same group and low between members of different groups (Everitt, 1993; Peneder 2003). According to both the scope of the analysis and the characteristics of the dataset, a *two-step cluster analysis* (Chiu et. al., 2001) was employed to manage the mixed variable types (both categorical and continuous data) and the large dataset.

The first step identifies pre-clusters to reduce the size of the matrix containing the distances between all of the possible pairs of cases[6]. When pre-clustering is complete, all cases in the same pre-cluster are treated as a single entity. In the second step, a standard hierarchical clustering algorithm is exploited on the pre-clusters. The hierarchical method allows one to explore a range of solutions with different numbers of groups[7]. Beyond the method selection, one of the main aspects of this study is related to the selection of the variables to be included in the analysis: in our case, the variables have been selected on the basis of the strategies and behaviors adopted by firms rather than on the basis of their structural characteristics (size, sector, region, etc.).

The variables considered for the grouping represent firms' strategies in terms of markets, investments and R&D activities (see Table 1 and Table 2). Specifically, they describe four types of firm characteristics:

- *Extent of the market*. This characteristic is described by 2 quantitative variables. The first represents the share of export revenue over total sales, while the second variable describes the share of total turnover derived from local markets.
- *Innovation and R&D expenses*. Dichotomous variables represent firms' innovative capacity in terms of product, process and organizational innovations. R&D intensity is measured by the share of firms' turnover devoted to R&D expenditures.
- *Investments.* To evaluate firms' investments decisions (not directly related to innovation and R&D activities), two dichotomous variables are included that indicate whether material or immaterial investments were undertaken.
- *Relative competitive advantage*. An indicator representing competitive advantage has also been included to represent firms' characteristics in comparison with competitors in terms of networking capacity with other firms, know-how and proprietary knowledge, marketing strategies and commercial networks. Respondents were asked to answer each factor on a three-point scale, where 1 indicates a disadvantage and 3 represents a strong competitive advantage. Finally, the firms' scores were summed to obtain a single indicator.

[6]For each case, the algorithm decides, based on a distance measure, whether the current case should be merged with a previously formed pre-cluster or a new pre-cluster should be started. The distance measure is represented by a log-likelihood criterion. The distance between two clusters depends on the decrease in the log-likelihood when they are combined into a single cluster.

[7] It is possible to choose the number of clusters to be formed, or the algorithm can select the optimal number based on the Schwarz Bayesian Criterion.

Table 1. Cluster analysis: the list of variables used.

Type of variable	Variable
Categorial variables (dichotomous)	Productive internationalization
	Tangible assets
	Intangible assets
	Product innovation
	Process innovation
	Organization/management innovation
Continuous variables	Percentage of turnover sold in local markets
	Percentage turnover sold in export markets
	Competitive advantages (sintethic index)
	R&D expenditure (% of turnover)

Table 2. Cluster analysis: the number of firms classified in each group.

	Nr. firms	%
Cluster 1	1,517	16.4%
Cluster 2	4,069	44.1%
Cluster 3	3,645	39.5%
Total	9,231	100,0%

Table 3 shows descriptive statistics for each of the three clusters together with tests of the mean comparison. The Welch F test[8] for continuous variables and the Chi-squared test for categorical variables show that the means of all of the clustering variables differ significantly across at least two of the three groups.

[8] Because the assumption of variance homogeneity among clusters was violated for all of the variables, which was tested using the Levene Statistic, the Welch's correction was used to compare groups of means for homogeneity. To determine which clusters have statistically different means per variable, Tamhane's T2 post hoc test was used.

Table 3. Clusters' profile: descriptive statitics and variance analysis.

		Cluster 1	Cluster 2	Cluster 3	Test F (Welch' correction)	Test Chi-square	P value.
Percentage of turnover sold in local markets	mean	27.3	52.6	55.0	330.99	-	0.000
	S.E.	0.91	0.66	0.71			
Percentage turnover sold in export markets	mean	34.7	15.6	12.1	298.92	-	0.000
	S.E.	0.84	0.39	0.39			
R&D expenditure (% of turnover)	mean	2.6	2.0	0.6	271.97	-	0.000
	S.E.	0.11	0.06	0.04			
Competitive advantages (sintethic index)	Mean	6.00	4.82	3.91	194.68	-	0.000
	S.E.	.097	.054	.054			
Nominal variables							
Productive internationalization	%	40.0	0.0	0.0	-	3302.07	0.000
Tangible assets	%	75.1	66.9	45.6	-	538.65	0.000
Intangible assets	%	67.2	0.0	1.9	-	5353.54	0.000
Product innovation	%	50.0	44.6	16.4	-	873.89	0.000
Process innovation	%	56.3	73.6	0.0	-	4446.71	0.000
Organization/management innovation	%	45.9	62.9	0.0	-	3418.19	0.000

Note: For each quantitative variable, the mean values, the standard error of the mean, the F Welch test (the assumption of homogeneity of variance was rejected for all quantitative variables) and the associated p-value are shown in table.
The post-hoc contrasts of multiple comparisons were also undertook using the T2 of Tamhane test was used in cases in which the equality conditions of variances among groups were not assumed.
For categorical variables the percentage distribution, Chi-square test - that compares the observed distribution of a variable within a cluster to the overall distribution- and the associated p-value are shown.

On the basis of the characteristics of the clusters, we are able to summarize the three strategic profiles of firms:

Cluster #1. *Most dynamic firms* (16.4% of the sample). This group represents the most dynamic firms in terms of strategies and behaviors. These firms are engaged in several activities with a high degree of strategic complementarity to improve their competitiveness. Investments in immaterial assets, a high degree of internationalization activities, and significant R&D expenditures are common features of this cluster. These firms represent the "excellence" of the Italian industrial system.

Cluster #2. *Moderately* d*ynamic firms* (44.1% of the sample). The activities representative of dynamic behavior are present, but they do not cover all of the features considered. Export activities are mainly carried out without any other internationalization process; R&D is present, but at levels that are consistently below those of cluster #1. Often, companies belonging to cluster #2 struggle to engage in R&D, innovation and internationalization all at once. Many of them, for instance, undertake innovation without investing in research, or they reach foreign markets without the due support of R&D activities.

Cluster #3. *Static firms* (39.5% of the sample). The last group refers to static firms: they sell mainly on a local market basis, and they have no dynamic strategies (in terms of investments, innovation or R&D, and internationalization activities or exports).

To gather additional information on firms' main characteristics, several tests were conducted on other relevant variables (not used in determining the clusters). As shown in Table 4, the groups are significantly different in terms of size (number of employees and turnover), leverage, profitability (ROA), age, and labor productivity (value added per employee).

On average, the "excellence cluster" includes older firms, firms with a higher degree of productivity and firms with the best performance indicators. Firms belonging to cluster 2 can be placed at an intermediate position in terms of size, age and productivity. Cluster 3, which consists of static firms, is mainly represented by companies that are smaller in size, younger and less productive than average. Leverage levels and credit utilization do not differ statistically among the groups, and the profit rates of the static firms are not lower than the level shown in the other clusters (perhaps due to the presence of niches and protected markets).

The clusters identified by following the previous procedure represent a pre-crisis strategy taxonomy. This taxonomy is used to estimate the performance and the survival likelihood of the manufacturing firms during the economic downturn.

4. Empirical analysis

For the sake of simplicity, we organize the presentation of our empirical results into two sub-sections that focus on the two different models to be tested. The first sub-section is devoted to the analysis of firm performance, while the second is dedicated to the study of firm survival. We decided to employ (at least in the base model) essentially the same set of explanatory variables, the same sample of firms and the same reference period for both the performance and survival regressions.

We paid special attention to the identification of business exits (see Appendix 1). The aim is to separate those firms that actually failed from others that were officially recorded as "cleared" but that are not "failed" or "ceased". In contrast to other studies, we are able to exclude from the

analysis some “apparent” exits such as M&As, the mere transfer into another province, or a change of firm name.

Table 4. ANOVA table between clusters

		Mean	S.E.	ANOVA test F
Employees 2007 (log)	Cluster 1	3.87	0.03	182.64***
	Cluster 2	3.49	0.02	
	Cluster 3	3.25	0.02	
Turnover 2007 (log)	Cluster 1	15.98	0.03	146.33***
	Cluster 2	15.50	0.02	
	Cluster 3	15.29	0.02	
Leverage 2007	Cluster 1	7.45	0.41	2.25
	Cluster 2	7.75	0.27	
	Cluster 3	8.64	0.42	
ROA 2007	Cluster 1	0.055	0.002	3.67**
	Cluster 2	0.058	0.001	
	Cluster 3	0.061	0.001	
Age	Cluster 1	34.30	0.52	3910.1***
	Cluster 2	32.43	0.27	
	Cluster 3	30.74	0.27	
Value added per employee 2007 (log)	Cluster 1	10.72	0.02	8.02***
	Cluster 2	10.64	0.01	
	Cluster 3	10.66	0.01	

*Note: for Turnover, ROA and Age Welch's Test was applied as the assumption of homogeneity of variance was rejected. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level.*

4.1 Explaining firm performance

This section examines the association between the strategic choices of Italian firms and their performance. The conceptual model is divided into three different estimation procedures in which the proxy variable of firm performance (the growth in turnover, the growth in value added and the dynamics of profitability[9]) is regressed on a vector of explanatory variables and other variables. In particular, our main specification corresponds to expression (1):

[9] We measure the dependent variable as an index: the numerator is the difference between the value of the gross operating profit (EBITDA) in 2012-2013 (average) compared with the same value in 2007, while the numerator is the average value of total assets in the period from 2007-2013.

$$Y_i = c + b_1' X1_i + b_2' X2_i + b_3' X3_i + b_4 X4_i + b_5' X5_i + b_6 X6_i + + b_7' Z_i + \varepsilon \quad (1)$$

where the regressors X1-X6 are included to test the significance of Hp1-Hp6 (discussed above), while we include all of the other controls in other vector of regressors Z. We include the first set of regressors (X1) to identify the possible relationships between the various types of conduct adopted by firms and their corresponding performance (Hp1). To this end, we include three dummy variables in the model to indicate the membership of each firm in the three identified clusters (the most dynamic firms, moderately dynamic firms, and static firms)[10]. With regard to the second hypothesis, i.e., the effect of technological systems on firm performance, the X2 regressors are the dummies for the Pavitt classification of sectors (*Pavitt 1, Pavitt 2* and *Pavitt 3*)[11]. According to hypothesis Hp3, firm performance may be affected by the corporate financial structure and by the initial level of profitability, so as the X3 regressors we include two variables: leverage net of credits measured in 2007 (*Leverage 2007*)[12] and the ROA value in 2007 (*Profitability 2007*).

To analyze the empirical relevance of hypothesis Hp4 (impact of productivity and efficiency on firm performance), we selected regressor X4 as the value added per employee (in 2007). According to hypothesis Hp5, firm performance is affected by firm size and accumulated resources. Thus, we introduced the vector of regressors X5: the level of turnover (in logarithm form, 2007) and the ratio of tangible assets to turnover (in 2007). Finally, as suggested by hypothesis Hp6, as a measure for regressor X6, we used firm age[13] (in logarithm form). Formula (1) also includes other controls (Z) that correspond to some dummies for the location of the firm in geographic macro-areas (north, center and south of Italy).

Furthermore, our OLS estimate could be affected by a sample selection bias due to firms' death phenomena. Indeed, the dependent variable, representing firm performance, is observable only for firms that are still active in 2013. Traditionally in the literature, it is common to tackle this bias by using a two-stage sample selection à la Heckman (Heckman 1976, 1979).

This approach involves an estimation of a probit model representing the selection process for all firms in the sample (surviving or not). The fitted values of this model are then used to compute the inverse Mills ratio to correct for the distortion introduced in the main OLS equation. Thus, the final model we want to estimate becomes

$$\Pr(S_i = 1) = \Phi\,(c + b_1' X1_i + b_2' X2_i + b_3' X3_i + b_4 X4_i + b_5' X5_i + b_6 X6_i + b_7 X7_i + b_8' Z_i + \delta\, Liq_i + \mu) \quad (2)$$

$$Y_i = c + b_1' X1_i + b_2' X2_i + b_3' X3_i + b_4 X4_i + b_5' X5_i + b_6 X6_i + b_7 X7_i + b_8' Z_i + \gamma \hat{\lambda}_i + \varepsilon \quad (3)$$

[10] In all regressions, the excluded dummy is that for intermediate group of firms (cluster 2).

[11] Based on Pavitt's taxonomy, we adopt the following firm categories: Pavitt 1= Supplier-dominated; Pavitt 2= Scale-intensive; Pavitt 3= Specialized suppliers; and Pavitt 4= Science-based.

[12] This index was calculated based on the following formula: (total liabilities – equity – total credits)/total assets. This index is a leverage indicator that takes into account the presence of financial claims in measuring the degree of exposure.

[13] Firm age is calculated as the difference between the year 2008 and the year of the firm's founding.

where equation (2) represents the first-step probit model, while equation (3) is equivalent to equation (1) except for the $\widehat{\lambda}(\cdot)$ term, which amounts to the inverse of the Mill's ratio.

Identification of selection is based on the nonlinearity of the Mill's ratio and on the "exclusion restrictions", that is, including in the first step at least one variable that is assumed to have an important influence on S (survival) but that does not have an influence on the dependent variable in equation (3) so that the MILLS variable yields a powerful test for selection bias.

In our case, the exclusion restriction variable is represented by an index for firm asset liquidity[14] (Liq_i in eq. (2)).

In the second step, we estimated coefficients using data only for surviving firms (i.e., those that are the result of the selection process). Finally, the period under consideration is characterized by the strong impact of the global crisis, and the generalized variance in the performance variables is conditioned by the presence of outliers. Therefore, we estimate our models (with the Heckman technique and OLS as a control) while excluding extreme outliers in the dependent variable[15]. Table 5 provides the correlations table.

Table 5. Correlations between dependent variables and other regressors.

		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
[1]	Turnover growth 2007-2013 (log)	1.000							
[2]	Value added growth 2007-2013 (log)	0.760***	1.000						
[3]	Profitability dynamics 2007-20013 **	0.543***	0.704***	1.000					
[4]	HP 3 – Leverage	-0.009	0.001	0.008	1.000				
[5]	HP 3 – Profitability level_2007	0.007	-0.001***	-0.245***	-0.095***	1.000			
[6]	HP 4 – Value added per employee at 2007 (log)	0.038***	0.045***	0.077***	0.053***	0.241***	1.000		
[7]	HP 5 – Turnover 2007 (log)	0.066***	0.042***	0.037***	-0.082***	-0.053***	0.379***	1.000	
[8]	HP 5 –Tangib.asset/turnover	-0.017	-0.028***	-0.030***	-0.032***	-0.093***	-0.012	-0.125***	1.000
[9]	HP 6 – Age (log)	0.024**	0.052***	0.007	0.072***	-0.015	0.071***	0.240***	0.041***

Note: *, **, *** denote, respectively, significance at 10%, 5%, and 1% level.

[14] The liquidity indicator is the ratio between current assets and total equity. Models with exclusion restrictions lend themselves to a more explicit approach to the problem of selection bias. They also reduce the problematic correlation introduced by Heckman's correction factor, which would lead to large standard errors (Little 1985; Puhani 2000).

[15] More specific details about outlier detection are available from the authors upon request.

By testing for the correlation between the error terms of the two equations, we obtain a rho=0, which suggests the absence of sample selection bias. With this in mind, a comparison with the results of an OLS estimate seems useful to confirm the consistency of our framework (column 3 in tables 6-8).

Tables 6-8 report the eq. (3) estimates. In particular, table 6 refers to turnover growth, table 7 to value-added growth and table 8 to profitability. In all of the tables, the "reference group" is the Cluster #2 firms, i.e., those undertaking an intermediate strategical profile.

In accordance with Hypothesis 1, we found evidence that the heterogeneity in strategic approaches affected companies' growth rates since the outbreak of the crisis. Firms engaging in a "non-static" strategic profile (Cluster #2 and Cluster #1) before the crisis showed a higher turnover growth rate during the 2007-2013 period. Indeed, in Table 6, Cluster #3 (static firms) is negative and statistically significant, while Cluster #1 is positive but not different from 0.

Conversely, the value-added growth analysis (Table 7) suggests that only Cluster #1 companies, i.e., those committed to the most proactive strategic profile, outperformed Cluster #3 firms, although the Cluster #3 coefficient is not significant.

However, given that the range of economic performance widened after the crisis, we further enriched the analysis by studying whether the growth rate determinants changed at different levels of distribution of the performance variables. Thus, we adopted a quantile regression technique (Koenker and Bassett, 1978; Buchinsky, 1998) that allows the characterization of an entire conditional distribution rather than only its mean (as in the case of OLS). Indeed, because a quantile regression approach is less sensitive to outliers than OLS, it enables us to carry out our analysis on the entire sample of firms.

Columns (4)-(6) in tables (6) and (7) show that the cluster dummies' estimated coefficients vary over the conditional growth rate distribution. In particular, when we focus on low and median-growth firms (25^{th} and 50^{th} percentiles, respectively), we observe that static companies (Cluster #3) experienced the worst performance in terms of both turnover and value-added growth rates. Conversely, we do not find any significant difference between the "intermediate" and "most dynamic" profiles.

However, when we shift to the highest growth rates within the distribution, the "most dynamic" group displays better performance than both Cluster #3 and Cluster #2, meaning that proactive strategies represent a pivotal factor for outperforming firms.

Overall, when performance is measured in terms of profitability, the empirical support does not appear to be solid either when using regressions with the Heckman approach or when using quantile regression techniques (Tab. 8).

The explanation for this result may be associated to two different considerations. The first closely relates to the characteristics of the different groups of firms and their profitability. The descriptive analysis for the clusters (see Tab. 4) shows a profitability level that is higher, on average, for the group of less dynamic (static) firms. In the medium-long term, marked competition in efficiency improvements and extension of market share is expected in open markets; however, in limited time horizons (above all in periods of severe contraction in demand), the impact of productivity on profitability may be weak. Second, less dynamic businesses can operate in relatively low growth but protected market niches that allow them to obtain significant profit margins even in the absence of investment and relevant innovation.

Table 6. Firm performance: OLS, Heckman and quantile regression estimating turnover growth.

	HECK-01	HECK-02	OLS	QREG25	QREG50	QREG75
	(1)	(2)	(3)	(4)	(5)	(6)
HP 1 - Cluster #1 - most dynamic firms (dummy)		0.021	0.021	0.008	0.028	0.042**
		(0.02)	(0.02)	(0.03)	(0.02)	(0.02)
HP 1 - Cluster #3 – static firms (dummy)		-0.037***	-0.038***	-0.044**	-0.044***	-0.028*
		(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
HP2 PAVITT 1 - Supplier-dominated	-0.080***	-0.081***	-0.084***	-0.157***	-0.118***	-0.065*
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.04)
HP2 PAVITT 2 – Specialized suppliers	-0.106***	-0.110***	-0.111***	-0.163***	-0.126***	-0.109***
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.04)
HP2 PAVITT 3 – Scale intensive	-0.095***	-0.095***	-0.096***	-0.104**	-0.111***	-0.100***
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.04)
HP 3 – Profitability (ROA) 2007	-0.079	-0.105	-0.075	-0.008	-0.164**	-0.238**
	(0.08)	(0.12)	(0.07)	(0.09)	(0.08)	(0.10)
HP 3 – Leverage 2007	0.00	0.000	0.000	0.000	0.000	-0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
HP 4 - Value added per employee at 2007 (log)	0.011	0.010	0.012	0.031**	0.012	0.001
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
HP 5 – Turnover 2007 (log)	0.025***	0.020***	0.020***	0.027***	0.032***	0.019***
	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
HP 5 – Physical capital/turnover average 2007-2008	0.003	0.002	0.003	-0.067	0.001	-0.004
	(0.01)	(0.01)	(0.01)	(0.05)	(0.01)	(0.01)
HP 6 – Age (log)	-0.044***	-0.047***	-0.045***	-0.009	0.047***	0.077***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Geographical area (regions dummies)	yes	yes	yes	yes	yes	yes
Costant	-0.381***	-0.236	-0.271***	0.986***	0.414***	0.282**
	(0.10)	(0.15)	(0.10)	(0.19)	(0.10)	(0.12)
Nr obs.	6,842	6,842	6,250	6,594	6,594	6,594

Note: The dependent variable used is the difference in the logarithms of turnover between 2013-2012 (average) and 2007. For the estimates obtained by the method à la Heckman (columns 1 and 2), the results of the first stage (selection equation) were omitted for reasons of space. In the case of the estimates obtained with quantile regressions (columns 4-6) it has been included all the observations, that have not been excluded outliers (see note 12 in the text). *, **, *** denote, respectively, significance at 10%, 5%, and 1% level.

Table 7. Firm performance: OLS, Heckman and quantile regression estimating value added growth.

	HECK-01	HECK-02	OLS	QREG25	QREG50	QREG75
	(1)	(2)	(3)	(4)	(5)	(6)
HP 1 - Cluster #1 (dummy)		0.048***	0.049***	0.019	0.023	0.039**
		(0.02)	(0.02)	(0.03)	(0.02)	(0.02)
HP 1 - Cluster #3 (dummy)		-0.022	-0.017	-0.057**	0.041***	-0.009
		(0.01)	(0.01)	(0.03)	(0.02)	(0.02)
HP2 PAVITT 1 - Supplier-dominated	- 0.151***	- 0.148***	- 0.134***	- 0.196***	- 0.138***	- 0.132***
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.04)
HP2 PAVITT 2 - – Specialized suppliers	- 0.116***	- 0.104***	- 0.098***	- 0.128***	- -0.086**	- -0.102**
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.04)
HP2 PAVITT 3 - – Scale intensive	- 0.142***	- 0.131***	- 0.127***	- 0.130***	- 0.137***	- 0.145***
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.04)
HP 3 - Profitability (ROA) 2007	0.629***	0.446***	0.606***	0.938***	0.812***	0.669***
	(0.08)	(0.13)	(0.08)	(0.14)	(0.11)	(0.09)
HP 3 - Leverage 2007	0.00	-0.001**	-0.001	-0.001	-0.001	0.001
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
HP 4 - Value added per employee at 2007 (log)	- 0.028***	-0.008	-0.017**	-0.015	-0.018*	- 0.037***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
HP 5 - Turnover 2007 (log)	0.026***	0.017***	0.017***	0.014	0.015**	0.020***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
HP 5 - Physical capital/turnover average 2007-2008	-0.027**	-0.018*	-0.022	-0.116**	-0.061*	-0.025
	(0.01)	(0.01)	(0.02)	(0.05)	(0.03)	(0.02)
HP 6 - Age (log)	- 0.073***	- 0.067***	- 0.076***	- 0.065***	- 0.067***	- 0.101***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)
Geographical area (regions dummies)	yes	yes	yes	yes	yes	yes
Costant	0.279**	0.108	0.300***	0.025	0.366***	0.863***
	(0.11)	(0.16)	(0.10)	(0.18)	(0.12)	(0.16)
Nr obs.	6,637	6,637	5,866	6,253	6,253	6,253

Note: The dependent variable used is the difference in the logarithms of value added between 2013-2012 (average) and 2007. For the estimates obtained by the method à la Heckman (columns 1 and 2), the results of the first stage (selection equation) were omitted for reasons of space. In the case of the estimates obtained with quantile regressions (columns 4-6) it has been included all the observations, that have not been excluded outliers (see note 12 in the text). *, **, *** denote, respectively, significance at 10%, 5%, and 1% level.

Table 8. Firm performance: OLS, Heckman and quantile regression estimating dynamics of profitability.

	HECK-01	HECK-02	OLS	QREG25	QREG50	QREG75
	(1)	(2)	(3)	(4)	(5)	(6)
HP 1 - Cluster #1 (dummy)		0.003	0.003	0.003	-0.001	0.003
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
HP 1 - Cluster #3 (dummy)		-0.003	-0.002	-0.005	-0.005**	-0.001
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
HP2 PAVITT 1 - Supplier-dominated	-0.021***	-0.021***	-0.019***	-0.023***	-0.015**	-0.018**
	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
HP2 PAVITT 2 - Specialized suppliers	-0.016***	-0.016***	-0.015***	-0.021***	-0.016**	-0.015**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
HP2 PAVITT 3 - – Scale intensive	-0.021***	-0.020***	-0.020***	-0.022***	-0.015**	-0.020***
	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
HP 3 - Profitability (ROA) 2007	-0.248***	-0.248***	-0.271***	-0.530***	-0.396***	-0.178***
	(0.01)	(0.01)	(0.02)	(0.03)	(0.03)	(0.02)
HP 3 - Leverage 2007	-0.000	-0.000	-0.000	0.000	-0.000	-0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
HP 4 - Value added per employee at 2007 (log)	-0.006***	-0.006***	-0.007***	-0.006***	-0.004***	-0.006***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
HP 5 - Turnover 2007 (log)	-0.005***	-0.005***	-0.005***	-0.005***	-0.004***	-0.003***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
HP 5 - Physical capital/turnover average 2007-2008	0.001	0.001	-0.000	0.000	-0.001	-0.001
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
HP 6 - Age (log)	-0.002	-0.002	-0.003	0.000	-0.006***	-0.007***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Geographical area (regions dummies)	yes	yes	yes	yes	yes	yes
Costant	-0.009	-0.005	0.024	-0.014	0.014	0.083***
	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)
Nr obs.	6,751	6,751	6,159	6,159	6,159	6,159

Note: The dependent variable is as an index in the numerator is the difference between the value of the gross operating profit (EBITDA) in 2013-2012 (average) compared with the same value in 2007, while the numerator was placed the average value of the total assets in the period 2013 -2007. For the estimates obtained with the method à la Heckman (columns 1 and 2), the results of the first stage (estimate selection) have been omitted for reasons of space. In the case of the estimates obtained with quantile regressions (columns 4-9) it has been included all the observations, that have not been excluded outliers (see note 12 in the text). *, **, *** denote, respectively, significance at 10%, 5%, and 1% level.

Moving on to discuss the results for hypotheses Hp 2-6, the turnover growth model shows that the estimated coefficients for the dummy variable for the Pavitt sectors are strongly significant; therefore, the technological regime matters (Hp2). We find that the role of initial profitability (*Profitability 2007*) is not supported in our data, but negative effects are present in the quantile regression. In addition, the effects of leverage on performance in terms of sales are not significant. With regard to the interaction between productivity and performance, our results do not show any statistically robust linkage. At the same time, hypothesis Hp5 (size and resources accumulated) is confirmed, but only with respect to the initial value of the turnover. In contrast, it does not appear that performance is related to the ratio of fixed assets to turnover (capital intensity). Finally, the evidence in Table 6 shows a result that is consistent with some of the literature: sales growth is negatively correlated with firm age. It is interesting to note that the effect is relatively higher when (in quantile regressions) the highest values of the dependent variable are considered.

The results are also very similar for Hp2 (technological regimes), Hp5 (size)[16] and Hp6 (firm age). It is noteworthy that for Hp3 (profitability) and Hp4 (productivity), we found significant coefficients, but with a negative sign. In both cases, therefore, it seems that performance in terms of value added during the crisis was better for firms that initially had lower levels of efficiency and lower profits.

4.2 Explaining firm survival

This section describes the model that examines the survival rate of manufacturing firms. The aim is to estimate the effects of pre-crisis strategic behavior on the probability of firms' survival. The estimated model is represented by the following equation:

$$Survival_{2012} = c + b_1' X1_i + b_2' X2_i + b_3' X3_i + b_4 X4_i + b_5' X5_i + b_6 X6_i + + b_7' Z_i + \varepsilon \quad (4)$$

where the regressors X1-X6 are included to verify the assumptions in Hp1-Hp6 illustrated above, and we include all of the other controls in the vector of regressors Z. Equation (4) was estimated using a logit estimator,[17] where the dependent variable is a dummy variable that takes the value 1 if the firm was still active in 2013. The process used to identify firms that "ceased" and those that were "active" from data provided by the AIDA Bureau Van Dick database is described in Appendix 1. It is worth noting, however, that exits that do not refer to firm "failure" (such as M&As, transfers of headquarters, and legal form or company name changes) were excluded from the sample.

The basic assumptions in Hp1-Hp6 are related to the corresponding six vectors of regressors. All of these variables refer to the pre-crisis year (2007). The group X1 is included to identify the possible relationships between the various types of conduct adopted by firms and the corresponding

[16] For the size variable measured by the ratio of fixed assets and turnover, the effects are significant, but with a negative sign. This result could be interpreted as a signal associated with the reduced flexibility of the more structured firms, in a period of sharp fluctuations and market dynamism.

[17] It was not possible to carry out a survival analysis for each year of the considered period due to a lack of data on companies' status throughout the period.

probability of survival (Hp1). As before, we use three dummy variables to indicate the membership of each firm in three identified clusters: the most dynamic firms, moderately dynamic firms, and static firms. To examine the relationship between technological systems and firm survival (Hp2), we include the group X2 regressors: the dummies for the Pavitt classification of sectors (labelled Pavitt 1, Pavitt 2 and Pavitt 3). Hp3 is tested by including the leverage (*Leverage 2007*) and ROA indices (*Profitability 2007*). To analyze the empirical relevance of hypothesis Hp4, we selected the group X4 regressors as the value added per employee. We introduced the group X5 regressors for the number of employees and the ratio of tangible assets to turnover. Finally, firm age in logarithmic form is included to test Hp6. The expression (4) also includes location controls (Z) for the 20 Italian NUTS regions.

The results, which are shown in Table 9, reveal a diverging pattern from that highlighted in the study of firm performance. With regard to hypothesis Hp1, the different clusters do not appear to have any significant effect on survival probability. In particular, neither Cluster #1 nor Cluster #3 show significant coefficients.

Ceteris paribus, our results suggest that the most proactive firms in terms of strategy did not have greater chances of survival. In our opinion, this result follows from the intrinsically high degree of uncertainty involved in the most proactive, dynamic strategies. Indeed, R&D, innovation and internationalization are characterized by a high level of uncertainty (Knight, 1921; Rosenberg, 1994). Furthermore, the recent crisis negatively affected the profitability of investments by widening the gap between realized and expected revenues.

In addition, R&D and innovation activities were hampered by the presence of financial constraints caused by the crisis (Mohnen et al., 2008; Campello et al., 2010; Paunov, 2012; Brancati E., 2015). The role played by financial constraints is highlighted by the Hp3 coefficients. The financial reliability and profitability proxies appear to dominate the scenario and are closely correlated to the likelihood of survival. In particular, a positive and statistically significant coefficient for the liquidity index and profitability is found, while, in line with the assumption, leverage shows a negative and statistically significant coefficient.

With regard to the effects of sectors and technological regimes (Hp2), we find significantly different behaviors between the traditional sectors and those with high economies of scale, with a higher chance of survival in the latter. The results confirm the hypothesis of a direct relationship between survival and productivity (Hp4); in our case, in fact, the proxy of labor productivity shows a positive and significant coefficient. Conversely, the results do not show, other things being equal, any effect of firm size (Hp5) on the probability of survival. This result, in contrast with the evidence found in many empirical studies, is likely connected to the ability of the smallest firms to promptly adapt to new scenarios due to their flexibility (Dean et al., 1998; Varum and Rocha, 2013) as well as to their ability to sell their products in niche markets (Hodorogel, 2009). Finally, in line with the literature, the coefficient for the firm age variable suggests that mature companies have higher chances of survival.

5. Robustness checks

To check the robustness of our main results, we now discuss an additional set of findings obtained by modifying some of the characteristics of the baseline empirical framework. We essentially repeat our analysis after introducing some changes to the set of regressors or to other technical aspects.

First, we consider our firm performance empirical models, and we run new regressions with equation (1) with cluster-group dummies substituted for the original variables (see Table 1 for the

list) included in the cluster analysis. We found no major discrepancies in the results for Hp1. On the one hand, some

Table 9. Firm survival: logit regression estimating the probability of a firm surviving.

	Model 1	Model 2
HP 1 - Cluster #1 (dummy)		-0.043
		(0.13)
HP 1 - Cluster #3 (dummy)		-0.131
		(0.10)
HP2 PAVITT 1 - Supplier-dominated	-0.323	-0.318
	(0.25)	(0.25)
HP2 PAVITT 2 - Specialized suppliers	-0.102	-0.093
	(0.26)	(0.26)
HP2 PAVITT 3 - – Scale intensive	-0.099	-0.090
	(0.26)	(0.26)
HP 3 - Profitability (ROA) 2007	5.311***	5.297***
	(0.72)	(0.72)
HP 3 – Leverage 2007	-0.003**	-0.003**
	(0.00)	(0.00)
HP 3 – Liquidity index 2007	1.415***	1.425***
	(0.54)	(0.54)
HP 4 - Value added per employee at 2007 (log)	0.206***	0.202***
	(0.07)	(0.07)
HP 5 – Employees (log)	-0.027	-0.033
	(0.04)	(0.04)
HP 5 - Physical capital/turnover average 2007-2008	0.142	0.141
	(0.10)	(0.10)
HP 6 - Age (log)	0.228**	0.226**
	(0.09)	(0.09)
Geographical area (regions dummies)	Yes	Yes
Costant	-0.911	-0.799
	(0.81)	(0.82)
Nr obs.	7,596	7,596
Pseudo R^2	0.04	0.04

Note: the dependent variable is a dummy equal to 1 if the firm was classsified as “active” (see Appendix) and it is equal to 0 otherwise. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level.

of the variables associated with pre-crisis pro-active conduct are positively correlated with growth in turnover or value added (for instance, the percentage of turnover sold in export markets and R&D expenditures). On the other hand, we found that the percentage of turnover sold in local markets is negatively correlated with firm performance.

Second, we carried out our sensitivity analysis tests focusing on the model measuring the determinants of firms’ survival. Initially, we replace the dummy representing the groups with the variables that were used to generate the clusters (investments, spending on R&D, export share, competitive advantages, etc.). The results are confirmed: we found that the variables associated with pre-crisis conduct are not significantly correlated with the probability of survival. To check the possible presence of heteroscedasticity of the residuals, we perform some additional estimates using clustered standard errors at the level of technology and region of location. In both cases, the results

are confirmed. In the case of clustering at the level of the region, we found a trend toward greater significance of the coefficient relative to the second group. As a further check, we estimated a linear probability model that confirmed the results obtained from the main model. Finally, to check for different behaviors within the different technological regimes, we repeated our regressions while selecting only firms belonging to a single Pavitt classification group. In this case as well, the results were confirmed: we found that the likelihood of survival is higher for firms classified in Pavitt 2 with respect to the other Pavitt sectors. Given the characteristics of the crisis and the deep impact since its early stages, we attempted to determine whether possible responses implemented in 2009 had specific effects. We quantify (using combinations derived from the 2009 MET survey) three possible responses to the crisis: a "proactive radical" response that includes a significant commitment to R&D, an "intermediate" response that is focused on improving the variety and quality of products, and a "purely defensive" response that is focused on cost savings. Nevertheless, we found that the introduction of variables related to during-the-crisis dynamic strategies did not enhance the significance of cluster membership on the likelihood of survival.

6. Discussion and conclusion

In this work, we attempted to assess how an exogenous shock (the recession) was mediated by the strategic conduct of firms before the recession and how these strategies affected the survival and performance of firms during the recession. The research question was formalized in a set of assumptions (Hp1 to Hp 6) that were subjected to empirical testing using a dataset on a large sample of Italian manufacturing firms.

The results indicate that firms that adopted a strategically proactive and innovative strategy in the period immediately preceding the outbreak of the crisis showed better economic performance between 2007 and 2013 on the basis of both sales and value added (see also Nunes and Lopes, 2013). The findings also indicate that the youngest firms and those with a lower level of financial exposure were favored. The results also confirm the impact of different technological regimes. In contrast, the estimates measuring the determinants of firm survival showed that the pre-crisis strategic profiles were not significant: *ceteris paribus*, the findings indicate that the most innovative, internationalized and dynamic firms did not have a greater likelihood of survival than other firms. This result can be attributed to the cost and risk of exposing a firm to strategic and organizational change and to entering distant and less known foreign markets. The variables of pre-crisis financial reliability and profitability appear to dominate and are moderated by the reduced availability of external financing (Claessens et al., 2010; Askenazy et al., 2011), which closely and permanently influenced the likelihood of survival. Thus, the crisis selected the segment of more financially solid firms, but such firms are not directly correlated with the most innovative and internationalized firms.

Specifically, hypothesis Hp1 (the relationship between conduct and performance) is substantially confirmed. In fact, all things being equal, we find that being classified in cluster #1 (the most dynamic firms) or in cluster #2 (moderately dynamic firms) is associated with significantly better performance in terms of the growth in turnover and value added. However, when performance is measured in terms of the dynamics of profitability, hypothesis Hp1 is not confirmed with the same strength.

Regarding hypothesis Hp2, our results highlight that effects related to the technological regime are relevant and can significantly influence firm performance. Based on Hp3, firm performance is expected to be influenced by a firm's financial structure and the starting level of profitability. The results also show that leverage does not play a significant role. The initial level of profitability shows significant effects, but the sign is negative with reference to both growth in value added and the dynamics of profitability. In our opinion, this result can be considered consistent with the fact that for the least profitable firms, the size of the slowdown related to the global crisis was less

relevant than for other firms. In other words, it could be that the least profitable businesses were also the least risky, which may be correlated with their lower-than-average decrease in performance.

The empirical estimates for hypothesis Hp4 (role of productivity and capital intensity) led to different conclusions based on which proxy of performance was adopted. In the case of growth in turnover, we did not find any effect, while for growth in value added, the hypothesis is confirmed to some extent: in fact, initial productivity is negatively associated with performance. Finally, when performance is measured in terms of the dynamics of profitability, we found a negative relationship. Indeed, the most efficient firms are significantly associated with large decreases in profits. From the perspective of hypothesis Hp5 (initial size and resources accumulated within the firm), the results again reveal a scenario that varies depending on which proxy for performance is used. On the one hand, the perspective offered by the estimates for revenue growth and value added seems to highlight a "premium" performance for larger firms, while capital endowment does not show a significantly positive (sometimes negative) impact on firms. On the other hand, the estimates of performance measured in terms of profitability in 2012 do not confirm the existence of marked differences between large and small businesses. These findings seem to be consistent with the results of Smallbone et al. (2012), which show an underlying resilience to the crisis by small firms and in most cases a high level of adaptability and flexibility. Finally, the results related to Hp6 appear to be very sharp and partially conflict with the findings of Fort et al. (2013), such that performance is better for relatively younger firms.

When we apply the same framework with the same assumptions to the analysis of firm survival, substantial differences appear. If we examine the firms classifiable as "proactive" (in innovation, research, and entering new markets, for example) and distinguish between the hypotheses that are strongly focused on growth and those aimed at measuring the impact of income and financial balance, we see that only the latter seem to be strongly influential on market exit. In particular, the pre-crisis adoption of innovative and proactive strategies (Hp2, Hp1) did not have a significant impact on the probability of survival. Similarly, firm size (Hp5) is not relevant. Partially confirming the findings of Ferretti et al. (2014) and Knudsen (2011), our results highlight the role of the initial financial structure (Hp3) in influencing the likelihood of firm survival. Similarly, productivity (Hp4), together with firm age, reduces the risk of failure.

In conclusion, it can be observed that all of the available evidence does not show a clear signal regarding the functioning of the mechanism of creative destruction. As was noted by Foster et al. (2014) and Riley et al. (2014), the Great Recession only partially helped to reallocate resources from less efficient to more productive and innovative firms. The crisis seems to have been relatively more favorable to financially sound companies than technologically advanced firms (see also Archibugi and Filippetti, 2013). It will be up to future research to verify the effects of the crisis on the accumulation of knowledge and the pursuit of innovative strategies over time (Knudsen and Lien, 2012). Another potential area for future research could be an analysis of firms that showed impressively positive performance during the crisis: examining these trajectories might offer additional support for the existing evidence on firms' heterogeneous behavior.

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Appendix 1 – The identification of surviving firms

As described in Section 3 of the text, two main sources of data are used to analyze the firms in this paper:

- the MET survey from 2008, which collects answers to a questionnaire applied to a representative sample of 25,000 companies interviewed in the summer of 2008;
- the AIDA Bureau Van Dick database, which analyzes the corporate balance sheets of firms interviewed for the MET survey during the period from 2008-2012.

The procedure used to identify the sample firms from the 2008 MET survey that are still active in 2012 is based on information contained in the AIDA Bureau Van Dick database. In fact, for each company, the database allows us to determine a company's "status" as provided in any court proceedings. The classification is used to identify companies with the status of "active", "inactive", or "firm in liquidation".

Next, for each firm (regardless of the "status" attributed), we verified whether the AIDA Bureau Van Dick database provided any information about the "procedures", that is, whether there was a court case involving the firm. Although the database was not always able to provide the exact date of the closure of any judicial proceedings related to a company, it is reasonable to assume that the initiation of certain proceedings (e.g., liquidation or bankruptcy) is a signal associated with the reorganization or cessation of an enterprise's operations. Thus, we decided to use a set of criteria in this work that was based on the information gathered in relation to legal proceedings to classify the sample firms from the 2008 to 2012 MET surveys as "survivors" and "did not survive".

Accordingly, for the category of business "survivors", we used the following criteria:

- we included firms in this category that have the status of "active", with no open legal proceedings;
- we included firms in this category that have the status of "active" for which there are legal proceedings that concern only transfer to another province.

For the category of businesses that "did not survive", we used the following criteria:

- we included firms in this category that have the status of a "firm in liquidation";
- we included firms in this category all that have the status of a "dormant company" and for which there are no legal proceedings such as a merger through the formation of a new company or a merger through incorporation into another company;
- we included firms in this category that have the status of "active" for which there are legal proceedings such as a debt restructuring agreement, closure in the local courts, bankruptcy, liquidation, dissolution and liquidation, and insolvency.

For the category of an enterprise "in transformation", we used the following criteria:

- we included firms in this category that have the status of "active" for which there are legal proceedings such as a merger through the formation of a new company, merger through incorporation into another company, or the transfer of its headquarters abroad;
- we included firms in this category that have the status of "inactive" for which there are legal proceedings such as a merger through the formation of a new company or a merger through incorporation into another company.

In this paper, the data used in the estimates refer to firms that were "active" or that "did not survive"; thus, the empirical analysis excluded businesses "in transformation".