Dynamics of Investment and Firm Performance : Comparative evidence in manufacturing industries*

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Abstract

In this paper we present an empirical assessment of the statistical properties of realized investment in the French and Italian manufacturing industries. In a first step we focus on the distributional properties of investment and its lumpy nature. We then look at the relation between investment episodes and a set of firm level performance variables. In this respect our results validate some previous findings, in particular the absence of a clear link between productivity growth and investment behavior.

JEL codes: C14, D92, L11, L60

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1 Introduction

Traditionally investment theory has been mostly concerned with the aggregate level of investment (starting from Clark, 1917, Keynes, 1936, or Jorgenson, 1963 to Caballero, 1999). However, the increasing availability of micro-data in recent years has given birth to an empirical literature investigating the investment decision at the firm level, whose results have in turn fed the development of theoretical models of capital accumulation. More precisely, the diffused occurence of investment spikes at the micro-level has been repeatedly questioning the theory for some years before being regarded as one of the regularity of firm behavior.

Several empirical studies of investment (or capital accumulation) have tried to estimate and compare the performance of different neoclassical theories of investment behavior (Jorgenson,

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1963 on US data, Bontempi et al., 2004 and del Boca et al., 2008 on Italian data, Chatelain and Teurlai, 2003 on French data). A common trait of these theories is that they model firms seeking to reach their "desired" or "optimal" level of capital stock. In this framework, investment is "the by-product of the process by which the capital stock catches up with its desired level" (Caballero, 1999, p. 822); therefore investment theory should aim at explaining the adjustment process chosen by the firm to do so. Or to put it as Haavelmo:

> "The demand for investment cannot simply be derived from the demand for capital. Demand for a finite addition to the stock of capital can lead to any rate of investment, from almost zero to infinity, depending on the additional hypothesis we introduce regarding the speed of reaction of capital users." (Haavelmo, 1960, p. 216)

This opened the way for models able to reflect short term dynamics of capital accumulation, considering the speed of adjustment to the desired level of capital as their central feature. Therefore standard models (Caballero and Engel, 1999) have mostly addressed the effects of changes in the shape of the adjustment cost function on the intertemporal maximization of firm value, and on the way the desired level of capital stock could be reached. If, on the one side, the assumption of *convex costs* leads to a policy of gradual investment - large investments are relatively more expensive -, on the other side, the existence of *non convex costs* does not provide any relative advantage to marginal adjustments vis a vis "jumps" in the capital accumulation process. Such non convexities, in their turn, are related to constraints in the actual level of flexibility of firms and to their responsiveness to variations of demand.

For long, the impossibility to access observed investment data has hindered empirical research on the issue. It is indeed relatively recently that scholars have started to document the lumpy nature of the investment behavior of firms. Among the first attempts is the contribution by Doms and Dunne (1998) with data on U.S. plants and firms. Inspired by this seminal paper a growing body of literature has expanded reporting similar results for other countries and industries. Among the papers using a comparable methodology to Doms and Dunne (1998) the reader might refer to Duhautois and Jamet (2001) for France, Nilsen and Schiantarelli (2003) on Norway and for Sweden Carlsson and Laséen (2005). All these studies try to answer the question of "how lumpy is investment" and conclude that non-convex cost models can explain such behavior, rejecting other types of models which infer a smooth pattern of capital accumulation. However, if they share the same method, the type of data, size of the dataset and level of analysis differ (see Table 1).

Table 1: Studies of the statistical patterns of investment

Reference	**Source**	**Nb of firms/plants**	**Investment***
Doms and Dunne 1998	US Census Bureau 1972-88	13 700 plants	Estimated
Duhautois and Jamet 2001	French fiscal data 1985-97	68 191 firms	Computed
Nilsen and Schiantarelli 2003	Statistics Norway 1978-91	1866 plants	Computed
Carlsson and Laséen 2005	Sweden CoSta database 1979-94	341 firms	Estimated

*Measure of the investment variable:

Estimated = Perpetual Inventory Method; Computed = Purchases minus sales of fixed capital

Mark Doms and Thimothy Dunne have documented the distribution of capital adjustment at the plant as well as at the firm level in a sample of 13 700 manufacturing plants. They introduce a methodology aimed at focusing on investment lumps in the time series of each firms' investment. For each plant of the balanced panel, they rank the yearly investment rates (I_t/K_{t-1}) from highest to lowest, and then compute the average and the median investment rate for each rank. They do a similar analysis with investment shares (I_t/I_{total}). This gives a picture on lumpiness: if the highest (or the two highest) investment share/rate is significantly larger than the others, it means that firms invest heavily in one year, and then very few the rest of the time.

They find that investment lumps are common to many firms, but that there is a large heterogeneity in capital accumulation patterns, which may be explained by differences in the nature of capital goods purchased in different sectors. They repeat the same analysis at higher levels of aggregation (line of business and firm level) and observe that "the higher is the level of aggregation, the smoother is the capital adjustment rank distribution" (Doms and Dunne, 1998, p. 422).

The issue of aggregating heterogeneous behaviors is particularly difficult with investment. If the volatility of aggregate investment makes it a general driver of GDP volatility (Gourio and Kashyap, 2007, Cooper et al., 1999), the more aggregated, the smoother time series of investment are (Doyle and Whited, 2001). Doms and Dunne (1998), Carlsson and Laséen (2005), Duhautois and Jamet (2001) as well as Gourio and Kashyap (2007) investigate how investment spikes at the firm level are related to the evolution of aggregate investment. They all find that aggregate investment is highly correlated with the frequency of spikes, and more precisely their *extensive margin*, i.e. the number of firms experiencing a spike rather than the *intensive margin*, i.e. the size of the spikes.

Time is indeed a strategic variable in the process of capital adjustment and econometric models of investment behavior have departed from the assumption of instantaneous capital adjustment. Jorgenson (1963) proposed an econometric technique that considers "gestation lags" between the initiation and completion of investment projects (rational distributed lags, also called "flexible" accelerator model). This representation is very close to the "time-to-build" concept where firms save money in order to buy expensive capital goods,[1] as proposed in the model by Kydland and Prescott (1982).

If investment episodes occur with lumps they might well have disrupting effects on the firm's operation: shut down and dismiss old machines, install new ones, etc. And all of that goes together with a non negligible loss - whose magnitude as well depends on how abrupt was the change - in terms of the know-how and established routines. In this respect, several studies have started to investigate the relationship between capital adjustment episodes and other firm variables, such as productivity (Power, 1998, Huggett and Ospina, 2001, Nilsen et al., 2009 and Shima, 2010) or employment growth (Letterie et al., 2010). Indeed, investment should affect productivity in the long run, as new capital embodies the latest technology (Jensen et al., 2001).

However, most of the empirical literature (Power, 1998, Huggett and Ospina, 2001, Sakellaris, 2004, Shima, 2010) reports that the effect on productivity growth is negative in the short run. This result is consistent with "learning by doing" models: it should take some time for workers to learn how to use the new technology, therefore labour productivity should follow a *U shape* curve, initially dropping and then gradually rising to a higher level than the *ex ante* one. If the initial cost has been revealed by these studies, none of them report a positive re-

[1]Indeed, a more realistic analysis of investment differentiates investment for growth and investment for capital replacement. This latter element poses a problem of the estimation of the depreciation or turnover rate of capital, which is highly heterogeneous even at the firm level, as it varies per category of capital good.

lation between investment lumps and productivity growth, even in the long run. Still, Bessen (1999) finds that in new plants, productivity increases with time, which he attributes to a learning-by-doing process. Power also finds a positive correlation between productivity and plant age, and concludes that "selection and learning could be important determinants of the pattern of productivity across plants" (Power, 1998, p. 311). In turn, Shima (2010) reports a negative relation between technical efficiency and machinery age.

In this respect, considering investment - and its timing - in the assessment of firm's performance could also be important in explaining why selection effects seem quite flat. Indeed, the relationship between firm performance (as measured by its profitability rate or productivity growth) and firm growth was found to be unsignificant on French and Italian data (Bottazzi et al., 2010). The specific role of investment in the mediation between firm performance, firm financial variables[2] and firm growth is still ambiguous. As for the link between productivity growth and investment spikes, the interrelation between the adjustment episodes and other firm variables has to be differentiated across time. In order to properly account for such dynamics, Sakellaris (2004) introduced a methodology that enables to analyze the relation between an *event* and firm characteristics before and after such event. Therefore he is able to account for the *relative* importance of the variables of interest (firm growth, productivity and the like) around the investment spike. This methodology has been later adapted by Nilsen et al. (2009) on Norwegian data and Letterie et al. (2010) on Dutch data in their studies on the interrelation between investment spike episodes and the evolution of labour productivity (Nilsen et al., 2009) or employment (Letterie et al., 2010).

In this paper we present an empirical assessment of the statistical properties of realized investment in French and Italian manufacturing industries. In a first step we focus on the distributional properties of investment and its lumpy nature. We then look at the relation between investment episodes and a set of firm level performance variables. In this respect our results validate some previous findings, in particular the absence of a clear link between productivity growth and investment behavior.

After a brief description of the data and variables, Section 2 provides an overview of the French and Italian manufacturing industries. Section 3 presents the descriptive statistics of investment patterns for both countries as well as their autocorrelation structure. Section 4 investigates the relation between investment and corporate performance. Lastly Section 5 concludes.

2 Data Description

2.1 Data and variables

This paper draws upon two similar datasets, Micro.3 and EAE,[3] reporting firm level data for Italy and France, respectively. The Micro.3 database has been developed through a collaboration between the Italian Statistical Office (ISTAT) and members of the Laboratory of Economics and Management of Scuola Superiore Sant'Anna, Pisa. The EAE databank is collected by the statistical department of the French Ministry of Industry (SESSI) and provided

[2]Extensive works have been conducted on the relation between firm investment and financial constraints, leading to major disagreements, most notably between Fazzari et al. (1988) and Kaplan and Zingales (1997). But this issue is outside of the scope of the present paper.

[3]Both databanks have been made available to the authors under the mandatory condition of censorship of any individual information. The data for Italy were accessed at the ISTAT facilities in Rome. More detailed information concerning the development of the database Micro.3 are in Grazzi et al. (2009).

by the French Statistical Office (INSEE). It contains longitudinal data on a virtually exhaustive panel of industrial French firms located on the national territory with 20 employees or more over 1989-2007. Micro.3 is an open panel combining information from census and corporate annual reports about all the firms with 20 employees or more operating in any sector of activity on the national territory over 1989-2006. In both databases, firms are classified according to their sector of principal activity. Our study focuses on the manufacturing industry i.e. from group 171 to group 366 in the ISIC rev 3.1. classification. For consistency with our previous works with these data and because we are interested in understanding the drivers of firms' investment decisions, we exclude from the analysis firms that have undergone radical restructuring such as M&A.

The variables we are focusing on are observed investment and investment rates. We define investment rates as current year investment over past year tangible assets (I_t/K_{t-1}). This corresponds to the ratio between the flow variable (investment) and the stock variable (capital), so that I_t/K_{t-1} can also be interpreted as the growth rate of capital. In each period, the stock of capital is updated with the value of new investment, linking the investment time series to the accumulation of capital over time. However, about 80% of the observations on the value of assets are missing in the French databank before 1996[4]. Therefore, when the investment rate is needed, the analysis is reduced to the 1996-2007 period. In order to undertake intertemporal comparison, we deflate the data on current value variables with output deflators at the three digit level. Also notice that the investment variable that is observed for France and Italy slightly differs. In France it is the total acquisition of tangible assets, whether for Italy it is the acquisition of plants and machineries ("Impianti e macchinari").

In the second part of the analysis we also use performance-related variables, namely the number of employees (N_t), growth of employment ($g_t^N = log(N_t - N_{t-1})$), labour productivity ($\Pi_t = VA_t/N_t$), growth of labour productivity ($g_t^{\Pi} = log(\Pi_t - \Pi_{t-1})$), total sales ($TS_t$), growth of sales ($g_t^{TS} = log(TS_t - TS_{t-1})$ and the profitability rate ($P_t = GOM_t/TS_t$).

2.2 Overview of the French and Italian manufacturing industries

In order to better understand the main results of our investigations it is worthwhile presenting briefly an outlook of the distinctive features of the French and the Italian manufacturing industries as well as their recent evolutions.

The French industries, and even more so the Italian ones, display a pervasive role of small and medium firms (SMEs). Indeed firms with less than 250 employees account for more than 95% of the total number of firms. In France they encompass more than 50% of the employment in the manufacturing industry, they generate about 40% of the total sales and they contribute to create more than 40% of the total value added. This picture is stable over time and particularly stabilized since the late nineties. In Italy if the share of SMEs is equivalent they weight more in terms of employment and total sales with more than 60% of the total sales and more than 70% of the employment in the manufacturing industry (Cf. Table 2). From the early 2000's and following a common trend with most of the OECD countries, France and Italy have undergone a slowdown in the growth rate of their manufacturing production.

Despite an efficient modernization of its productive system, the French manufacturing industry has strongly reduced its importance among OECD countries in terms of value added. This can be partly explained by its industrial specialization strongly centered on low and medium-tech sectors with rather few worldwide leaders in the high-tech industry. Nevertheless,

[4]Indeed, this variable was retrieved only for firms above 100 employees until 1996.

Table 2: Descriptive Statistics - Manufacturing - 2006

	France	Italy		France	Italy
Number of firms*	**254**	**514**	**Number of employees***	**3577**	**3834**
from 1 to 19 employees	90,8%	93%	from 1 to 19 employees	18%	30,8%
from 20 to 49 employees	5,4%	4,7%	from 20 to 49 employees	12,2%	17,8%
from 50 to 249 employees	3%	2%	from 50 to 249 employees	22,5%	25,1%
250 employees and more	0,8%	0,3%	250 employees and more	47,3%	26,2%
Total sales**	**950**	**931**	**Value addded****	**215**	**219**
from 1 to 19 employees	9,6%	20,5%	from 1 to 19 employees	13,3%	26,5%
from 20 to 49 employees	8,5%	14%	from 20 to 49 employees	10,2%	15,5%
from 50 to 249 employees	18,4%	27%	from 50 to 249 employees	19,5%	25,9%
250 employees and more	63,4%	38,5%	250 employees and more	57%	32,1%

*in thousands

** in billion euros

from the mid-nineties onwards, the French manufacturing industry appears more dynamic than the rest of the economy with an industrial constant value-added increasing at a higher rate than in the overall economy. On the contrary, the Italian industry displays worth performances in industrial sectors than in the others.

Regarding the investment issue, small and medium firms can face a higher volatility of their demand and relatively more difficulties to finance their investment projects. Also they use leasing contracts more frequently than the larger firms. About 12% of the French firms with less than 250 employees resort to leasing whereas only 2 or 3% of larger firms uses it. This proportion is stable over time and over the different size classes below the threshold of 250. Indeed leasing reduces firms' exposure to the irreversibility of investment and increases its flexibility. It can also be part of a fiscal strategic behavior. Indeed, until 2009, French companies were subjected to a tax (called “taxe professionnelle”) which base was considering total assets. There was therefore a trade-off between the cost of leasing and the amount of taxes that firms would have paid in increasing their level of assets through investment. Still, in order to allow for comparability between the French and Italian investment patterns we do not include leasing in the definition of our investment variable.

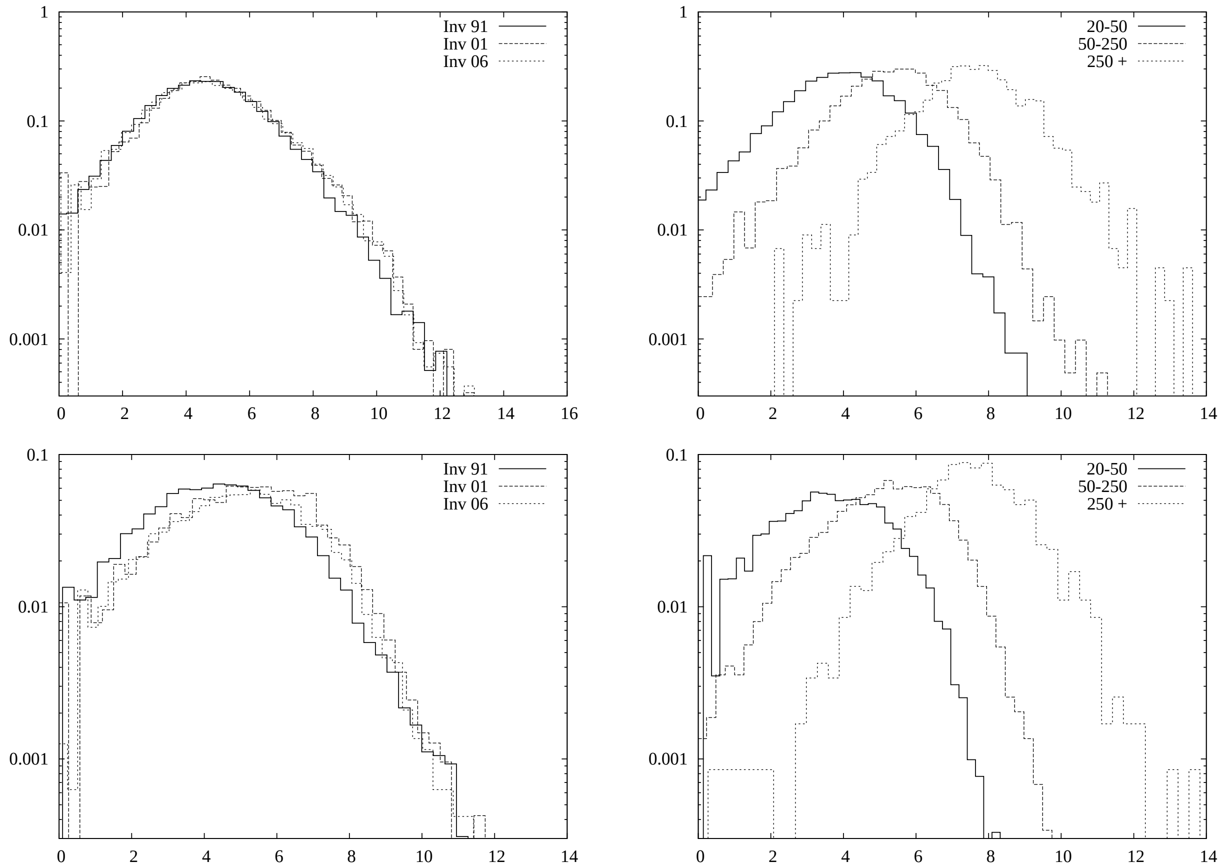
3 Investment patterns in France and Italy

In this section we present the analysis of firm investment patterns in the French and Italian manufacturing industries. After a summary of descriptive statistics, we measure investment lumpiness following the methodology of Doms and Dunne (1998). Finally we investigate the autocorrelation structure of investment rates (I_t/K_{t-1}) in both countries.

3.1 Evidence of investment lumpiness

Figure 1 shows the distribution of investment in our samples, as well as by size class. It has to be noted that the distributions are here in log scale, therefore the null investments do not appear. In France between 4 and 9% of firms do not invest in each year, while in Italy they are

Figure 1: Distribution of investment in France (top) and Italy (bottom); **Left**: all sample in 1991, 2001 and 2006; **Right**: by size class in 1991. Y-axis on log scale.



between 13 and 18%[5]. As expected, the distribution of invesment is shifted to the right when we consider larger firms, although the shape of the distribution is similar. This indicates that larger firms invest more although investment behavior continues to be highly heterogeneous also across firms in the same size class.

In turn, we observe that if most of the firms have very low investment rates, the tail of the distribution reveals that some undergo large investment episodes, this is apparent by the fat tail of the distributions of investment rates, Figure 2, left panel. More precisely, the *variance* of investment rates is smaller for larger firms, as also indicated by its negative relation with firm size (right plot).[6]. Such relation is stronger for French firms than Italian ones, for whom it is not significant, and this is also in line with other results on Italian firms (Bottazzi and Secchi, 2003).

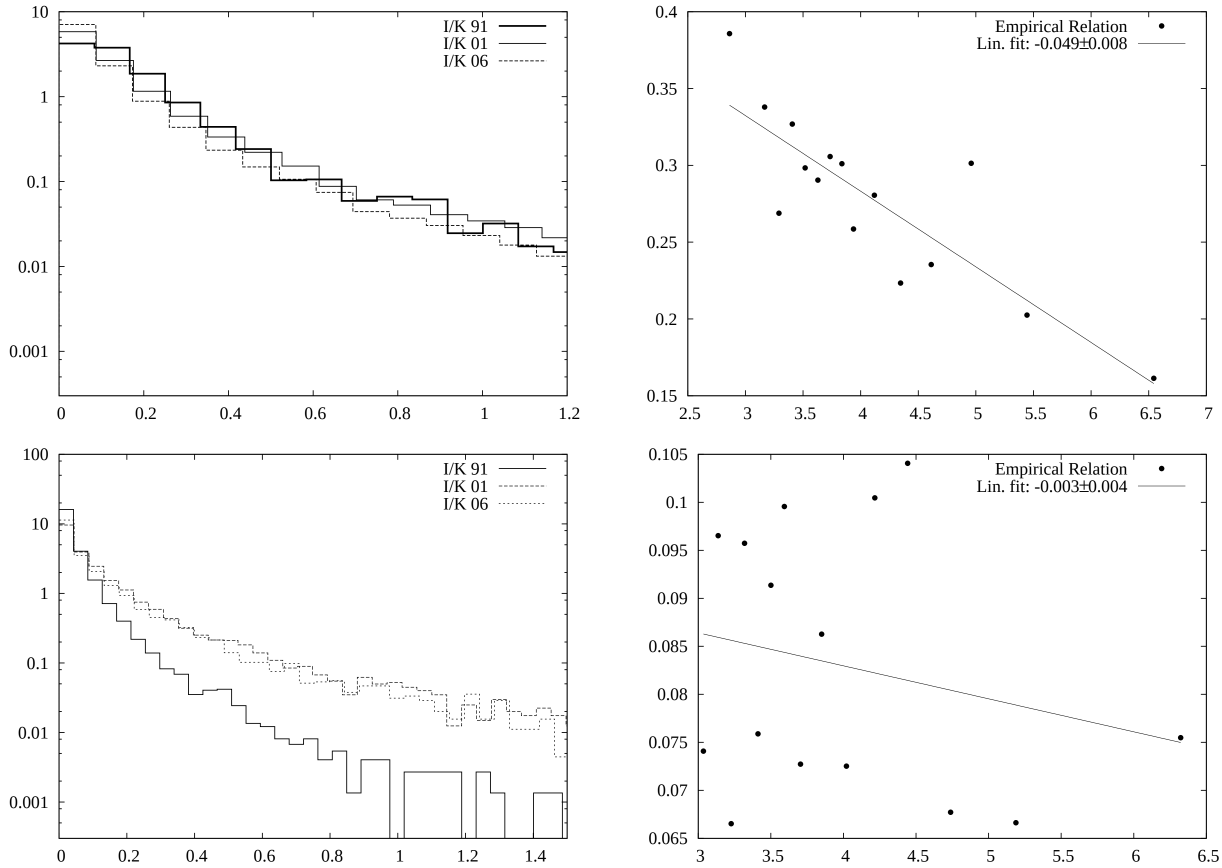
The distributional analysis of investment (and its rate) reveals substantial differences among firms, differences that do not vanish even when one is splitting the sample according to firm size.

There is, however, at least one more dimension in which the lumpy nature of investment

[5]Italian data presents a higher share of zeros. That might be related to the slight differences in the definition of the two variables (see also Section 2).

[6]Notice that this result also adds to the literature about the relationship between the dispersion of firms' growth rate dispersion and size (Hymer and Pashigian, 1962; Stanley et al., 1996)

Figure 2: **Left**: Distribution of investment rates in France (up) and Italy (down) in 1991, 2001 and 2006 ; **Right**: Log of the standard deviation of investment rates as a function of firm size.



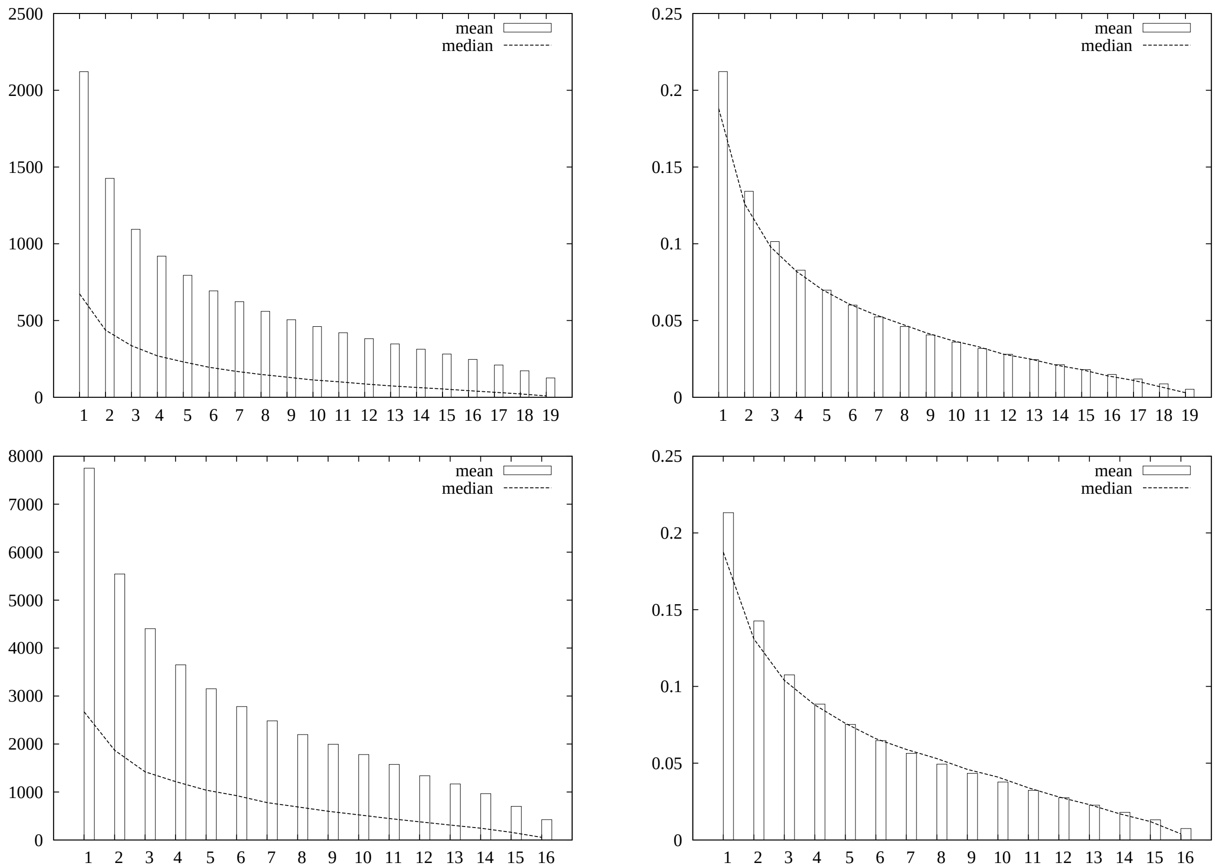
gets revealed and this has to do, within any one firm, with how firms decide to allocate investment over a certain period of time. Do firms change their capital endowment smoothly over time or, on the contrary, one does observe spikes in such patterns? It is of course this problem that generated a debate about the nature of the adjustment cost of capital, if they are convex or not (see Section 1).

In order to provide evidence on this issue, we rank, for each firm, the investment carried out in each year from the highest to the lowest[7]. Following Doms and Dunne (1998), the highest investment episode is defined as *rank 1* and the others are consequently *rank 2..19*[8]. We repeat the same operation on investment shares, the share of investment in year t being defined as investment in year t over total investment in the period : I_t/I_{tot}. Figure 3 shows the means and medians of each rank over the sample (the first bar represents the mean investment (investment share) of *rank 1*). Therefore the highest investment share on average accounts for more than 20% of total investment, while investment shares are significantly lower in other years, revealing the *lumpy* characteristic of the investment variable. Thus we will consider this methodology in order to define firms' investment peaks in our econometric analysis.

[7]Of course this requires to work on the balanced panel. To allow for intertemporal comparison investments in different years are deflated with the correspoding price index at the 2 digit level of industry disaggregation.

[8]16 in the Italian sample, as this one is available for 1991-2006.

Figure 3: **Left**: Investment by rank from 1989 to 2007 in France (up) and Italy (down; up to 2006); **Right**: investment shares by rank. Y-axis on log scale.

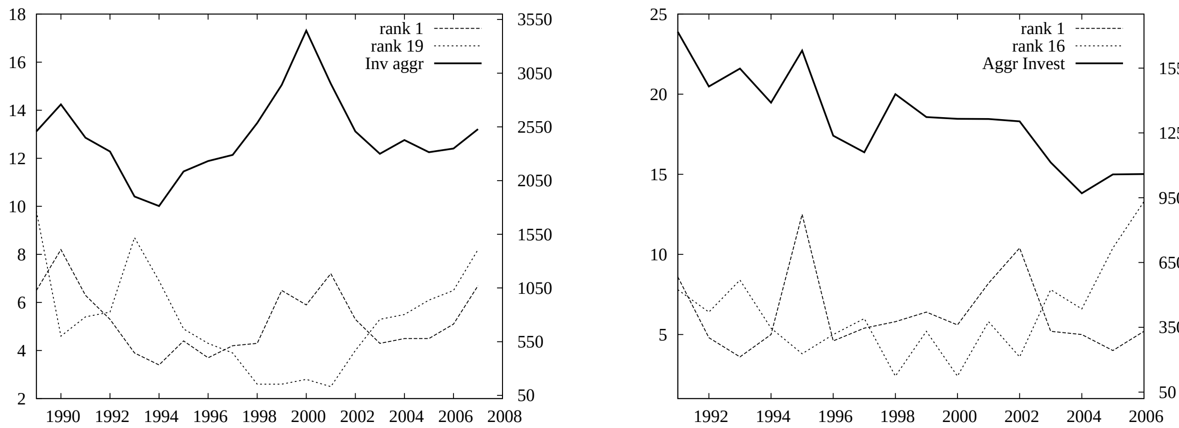


Our explorative analysis has so far confirmed the lumpy nature of investment. The volume of investment at the firm level is concentrated in a few episode accounting for a large share of firms' total investment over the observed period. There does not appear to much room left for assuming a smoothing of investment. But what are the implications of this micro-behavior on the observed aggregate trend of investment? In Figure 4 we plot the frequency of highest and lowest ranks occurring in every year, and compare them with the evolution of the aggregate variable, total investment in our French and Italian samples.

Figure 4 shows that the evolution of the aggregate variable is positively correlated with the frequency of investment spikes, and negatively correlated with the frequency of lowest values, as in Doms and Dunne (1998), Carlsson and Laséen (2005) and Gourio and Kashyap (2007). In this latter study, the authors consider as spikes all investment rates above a certain threshold[9], in their case 20%, as in Cooper et al. (1999), Cooper and Haltiwanger (2006) and Becker et al. (2006) and perform a decomposition between the extensive (i.e. the number of firms experiencing a spike) and intensive margins (i.e. the size of the spikes) of the capital adjustment process. They find that investment spikes drive total investment and that variations in the aggregate level of investment are explained by variations in the *extensive margin*. Our results are thus consistent with these previous studies: the frequency

[9]The threshold levels mostly considered in the literature are 20% and 35% and they both yield very similar results.

Figure 4: Aggregate investment and frequency of firm spikes in France (left) and Italy (right).



of investment spikes is positively correlated with aggregate investment.

3.2 Autocorrelation structure

Our preliminary analysis confirms that the investment is characterized by a lumpy process. In order to get a more precise image of investment dynamics at the firm level, we investigate the autocorrelation and autoregressive structures of the capital accumulation process. We consider the 1996-2007 period for French firms and the 1996-2006 period for Italian ones. Indeed, if investment episodes are rare, it is unclear whether they present any type of regularity.

First we investigate the presence of autocorrelation in the investment rates at the aggregate and at 2-digit levels. We perform correlation analyses using parametric and non parametric methods. The non parametric Kendall's rank correlation estimates the tendency of two variables to move in the same or opposite direction. The coefficient has a maximum value of $+1$ reflecting the strongest possible correlation between the variables. Its minimum value is -1 and corresponds to the strongest negative correlation. The independance of the variables is given by $\tau = 0$.

Contrary to the (parametric) Pearson method, the rank correlation does not require variables to be normally distributed. Indeed Pearson's ρ indicates the presence (or absence) of linear relationships, while Kendall's τ informs about the presence (or absence) of non linear relations.

We thus compute the Kendall's τ coefficient of rank correlation for the investment rate variable with its lagged values. Table 3 reports the estimates of τ which are all significant at the 1% level[10]. At the aggregate level French and Italian firms experience a clear positive autocorrelation in their investment patterns. This autocorrelation is observable for all the lags up to the ninth with a constantly decreasing coefficient. However the magnitude of the autocorrelation is still close to 10% at the ninth lag for France and close to 8% for Italy, displaying a rather strong autocorrelation of investment rates.

At the sectoral level we observe rather similar results with most of the ISIC sectors displaying a positive autocorrelation of their investment rates. Table 3 summarizes the results at the aggregate level as well as ISIC 17 (Textiles) and ISIC 29 (Machinery and Equipment).

[10]Only 2 estimates reported for Italy are not significant at 1% level

Table 3: Kendall's τ of Rank Autocorrelation of the investment rate I_t/K_{t-1}

	France			Italy		
Time	Aggregate	ISIC 17	ISIC 29	Aggregate	ISIC 17	ISIC 29
$t-1$	0,295*	0,313*	0,292*	0,259*	0,253*	0,291*
$t-2$	0,213*	0,231*	0,211*	0,174*	0,158*	0,230*
$t-3$	0,178*	0,210*	0,167*	0,155*	0,133*	0,203*
$t-4$	0,149*	0,163*	0,136*	0,130*	0,067*	0,177*
$t-5$	0,138*	0,145*	0,127*	0,107*	0,084*	0,158*
$t-6$	0,125*	0,132*	0,113*	0,104*	0,114*	0,131*
$t-7$	0,122*	0,131*	0,103*	0,102*	0,071*	0,097*
$t-8$	0,110*	0,125*	0,098*	0,108*	0,051**	0,082*
$t-9$	0,102*	0,075*	0,090*	0,081*	0,040	0,107*

*significant at 1% level; ** at 5% level

These two sectors are representative respectively of patterns in consumption-goods industries and for capital-good industries. However some sectors show a sort of cyclicity in their investment rates. Indeed we observe that for higher lags the correlation coefficients increase. This is pretty clear with the two sectors presented for Italy for which we observe that the correlation coefficient at $t-6$ for ISIC 17 is higher than the ones of the two previous lags; as it is the case for ISIC 29 at $t-9$. This suggests that their investment process would be not only persistent but also cyclical, and that the length of this cycle is quite homogeneous across firms in this sector.

Second, we want to estimate the AR(1) model of investment and investment rates, using the balanced panel. In order to exploit the longitudinal as well as the panel dimension of the data, we pool the observations over the period of analysis.

$$INV_i(t) = \beta INV_i(t-1) + \varepsilon_i(t) \tag{1}$$

In order to control for the temporal serial correlation of the error term $\varepsilon_i(t)$, we estimate the AR(1) model following the approach by Chesher (1979) also performed, among the others by Bottazzi et al. (2006), so that:

$$\varepsilon_i(t) = \rho\varepsilon_i(t-1) + u_i(t) \tag{2}$$

where $u(t)$ are iid disturbances.

We then rewrite (1) as[11]:

$$INV_i(t) = \gamma_1 INV_i(t-1) + \gamma_2 INV_i(t-2) + u_i(t) \tag{3}$$

where $\gamma_1 = \beta + \rho$ and $\gamma_2 = -(\beta\rho)$.

We thus estimate the γ_1 and γ_2 parameters using the Minimum Absolute Deviation (MAD) regression technique that minimizes the sum of the absolute values of the residuals. It is preferred to OLS here because it is more robust in the presence of outliers, as we have seen are important for our estimation. Finally we retrieve the β and ρ coefficients at the aggregate as well as sectoral level, presented in the Table 4.

Not surprisingly we find that the AR(1) coefficient for the investment variable is a lot higher than after normalizating with the level of capital (0,87 instead of 0,21). This can

[11]By rewriting (1) as $(1-\beta L^{-1})INV_i(t) = \varepsilon_i(t)$ and rewrite (2) as $(1-\rho L^{-1})\varepsilon_i(t) = u_i(t)$. Then $(1-\beta L^{-1})INV_i(t) = u_i(t)/(1-\rho L^{-1})$ and $INV_i(t) = (\beta+\rho)INV_i(t-1) - (\beta\rho)INV_i(t-2) + u_i(t)$.

Table 4: Results of the AR(1) estimation of investment and investment rates.

Dep. var	I_t					
	France			Italy		
	Aggregate	ISIC 17	ISIC 29	Aggregate	ISIC 17	ISIC 29
β	0,8630	0,7027	0,8816	0,7374	0,7127	0,7752
	(0,0001)	(0,0025)	(0,0009)	(0,0007)	(0,0062)	(0,0031)
ρ	-0,1776	-0,2640	-0,2629	-0,2791	-0,3883	-0,3464
	(0,0004)	(0,0037)	(0,0021)	(0,0008)	(0,0089)	(0,0058)

Dep. var	I_t/K_{t-1}					
	France			Italy		
	Aggregate	ISIC 17	ISIC 29	Aggregate	ISIC 17	ISIC 29
β	0,2078	0,0107	0,4524	0,5862	0,5732	0,5382
	(0,0001)	(0,0024)	(0,0022)	(0,0004)	(0,0076)	(0,0136)
ρ	-0,0040	-0,0010	-0,0251	-0,5753	-0,3152	-0,2961
	(0,0001)	(0,0023)	(0,0004)	(0,0003)	(0,0092)	(0,0134)

*standard errors in parenthesis

be explained by the fact that large firms invest more on average (as presented in Fig. 1). Instead, when considering investment rates the autoregressive coefficient drastically falls: the investment rate at time t is only partly explained by its level in the previous period. This result is in accordance with the one given by the rank correlations showing a strong autocorrelation up to the ninth lag (Cf. Table 3). This trend is common to almost all the 2-digit sectors even if some of them display a rather low coefficient[12]. However, at the 3-digit level, we realize that the sectors displaying very low autoregressive coefficients present a strong heterogeneity that is not observed in the other ones[13].

To sum up, our results clearly display a relatively weak but persistent autocorrelation of investment rates. Indeed, present investment is significantly and positively correlated with past values up to nine years before. This is the case even in the presence of multiple year investment episodes that may bias the estimation of the autocorrelation coefficient, artificially increasing the value of the coefficient. Indeed, for fiscal or accounting reasons firms may report their investment spike over two fiscal years. This is revealed by the observation of *rank 1* and *rank 2* in consecutive years, which in our samples account for 25% of the firms[14]. Therefore investment behavior seems to be lumpy but relatively smoothed around the spikes (as also illustrated in Figure 5 below).

4 Investment and firm performance

After a first part of the analysis devoted to the characteristics of investment pattern we move to an investigation of the relationship between investment and corporate performance. Then we consider the analysis between investment rates and profitability (value added over sales),

[12] In particular β for ISIC 17 and ISIC 24 are respectively 0,0107 and 0,0059. For ISIC 18 and ISIC 22, they are, respectively, 0,2137 and 0,2051.

[13] At the 3-digit level, ISIC 17 β coefficients range from 0,0314 to 0,5703 and from 0,0058 to 0,6673 for ISIC 24.

[14] For a computation of ranks on a longer period (1989-2007 in the French case) this case still accounts for 20% of the cases.

labor productivity (value added over number of employees), and firm growth (as measured by sales as well as number of employees). The first part of our analysis mirrors the study of Bottazzi et al. (2010) on the relations between firm productivity, profitability and growth.

4.1 Cross correlations

As a first inquiry into the structure of relations among our variables of interest, we perform non-parametric estimations of their probabilistic dependance. We also perform Pearson parametric correlations. The absence of significance for most of the relation tends to indicates that there is almost no linear relation between the variables under study. Thus we compute Kendall's τ coefficient of rank correlation using the same methodology than in the previous section for the autocorrelation exercice. We are interested in lead-lag relationships as it is reasonable to think that the effect of some variables on others can take time to be revealed. We look both at the correlation between the investment rate observed at t and lagged corporate variables up to the ninth lag and also to other way round. We perform this analysis at the aggregate as well as the 2-digit level, showing results for ISIC 17 and 29 by way of example.

Table 5 shows the Kendall's τ coefficients allowing to assess the strength of the various relationships. At the aggregate level, for France, almost all the relations are significant at the 1% level, with some exceptions concerning the relation between growth of productivity and the lagged investment rate. These non-linear relations are positive but decreasing with the number of lags. At the higher lags the relation is almost null, which reveals that variables become independent. In Italy the relations are not as significant but we observe the same trends as in France. Indeed, relations between the investment rate and productivity as well as profitability are especially significant, and the positive coefficients are generally decreasing with time[15].

In both countries, the magnitudes of τ displays some variation as the relations between the investment rate and the lagged corporate variables are clearly stronger than the reverse ones. Moreover, when significant, the coefficients are always higher for France than for Italy, revealing that the probability for investment rates and corporate variables to move in the same direction is higher in France than in Italy. Concerning the relation between lagged investment rates and contemporaneous corporate variables, the correlation coefficients are really lower when significant and France displays systematically higher coefficients than Italy for all the relations except the one between lagged investment rate and contemporaneous productivity.

In order to present the results at the sectoral level we report the correlations of the two sectors presented in the previous section i.e. ISIC 17 (Textiles) and ISIC 29 (Machinery and Equipment). The results are reported in the Appendix in Tables 6 and 7. In France, most of the sectors display the same trend as these two sectors. The relation between the lagged corporate variables and the contemporaneous investment rate is stronger than the reverse relation. Most of the time the relation between the variables under study are positive, non linear and decreasing. Going more in depth, the lead-lag relationships between the investment and the profitability rates are non linear, positive and decreasing in both directions and almost always significant for most of the sectors. Then the probability of investment rates and profitability to evolve in the same direction is higher than their probability to be discordant. A dynamic investment behavior seems to be a source of profitability for firms.

Regarding the relation with labor productivity, many sectors display a non linear positive and decreasing relation with investment rates. However some sectors do not show any decrease

[15]We observe six negative coefficients but their magnitude leads us to discard them.

in their correlation coefficient indicating a rather stable relation over time between lagged labor productivity and contemporaneous investment rates. In these cases labor productivity is positively linked with the investment rate even when this investment occurs many years later, as for ISIC 18 or ISIC 19 in France.

We observe fewer significant relations between the lagged growth of productivity and the investment rate. When significant the relations are mostly characterized by a coefficient below 5% and is sometimes negative. However there is almost no relation between past investment and productivity growth.

The lagged growth of sales and growth of employment display very similar positive correlation patterns with the contemporaneous investment rates. We can therefore think about a self-reinforcing process in which growth is a source of future investment and investment is a source of future growth. For some sectors we also observe higher correlation coefficients for higher lags indicating a cyclic feature of the investment rates.

Table 5: Kendall's τ of Cross Correlations at the aggregate level

	France					Italy				
I/Kt	g^N_{t-x}	g^{TS}_{t-x}	g^{Π}_{t-x}	Π_{t-x}	P_{t-x}	g^N_{t-x}	g^{TS}_{t-x}	g^{Π}_{t-x}	Π_{t-x}	P_{t-x}
t	0,165*	0,150*	0,001	0,056*	0,109*	0,055*	0,058*	0,013*	0,079*	0,043*
$t-1$	0,127*	0,142*	0,038*	0,062*	0,119*	0,034*	0,045*	0,013*	0,057*	0,042*
$t-2$	0,094*	0,111*	0,034*	0,055*	0,093*	0,020*	0,024*	0,001	0,030*	0,035*
$t-3$	0,076*	0,094*	0,029*	0,047*	0,070*	0,013*	0,014*	-0,001	0,029*	0,029*
$t-4$	0,058*	0,074*	0,025*	0,040*	0,052*	0,009*	0,009*	-0,003	0,027*	0,026*
$t-5$	0,056*	0,066*	0,017*	0,034*	0,038*	0,003	-0,008**	-0,011*	0,026*	0,022*
$t-6$	0,058*	0,062*	0,013*	0,034*	0,028*	0,011*	0,005	0,001	0,034*	0,025*
$t-7$	0,058*	0,063*	0,007**	0,036*	0,022*	0,007	-0,002	0,000	0,036*	0,027*
$t-8$	0,039*	0,056*	0,015*	0,035*	0,016*	0,014**	0,002	-0,006	0,035*	0,023*
$t-9$	0,043*	0,050*	0,011**	0,034*	0,012*	0,006	0,007	0,003	0,036*	0,031*
$I/Kt-x$	g^N_t	g^{TS}_t	g^{Π}_t	Π_t	P_t	g^N_t	g^{TS}_t	g^{Π}_t	Π_t	P_t
t	0,165*	0,150*	0,001	0,056*	0,109*	0,055*	0,057*	0,013*	0,077*	0,042*
$t-1$	0,095*	0,077*	0,007*	0,046*	0,092*	0,029*	0,020*	-0,003	0,062*	0,036*
$t-2$	0,060*	0,057*	0,012*	0,043*	0,083*	0,020*	0,029*	0,005**	0,066*	0,031*
$t-3$	0,042*	0,043*	0,013*	0,042*	0,077*	0,006**	0,001	-0,006**	0,065*	0,029*
$t-4$	0,036*	0,034*	0,008*	0,042*	0,072*	-0,001	-0,007**	-0,009*	0,064*	0,027*
$t-5$	0,035*	0,032*	0,006**	0,041*	0,067*	0,005	0,021*	-0,007**	0,060*	0,024*
$t-6$	0,034*	0,033*	0,005**	0,040*	0,067*	0,008**	0,057*	0,019*	0,065*	0,034*
$t-7$	0,026*	0,028*	0,001	0,036*	0,061*	0,013*	0,037*	0,014*	0,062*	0,037*
$t-8$	0,027*	0,019*	-0,004	0,035*	0,055*	0,014*	0,045*	0,006	0,050*	0,037*
$t-9$	0,026*	0,026*	-0,001	0,036*	0,055*	0,009**	0,007	-0,006	0,023*	0,029*

*significant at 1% level; ** at 5% level

4.2 Dynamic interrelation between investment spikes and firm performance

Building on the results of the previous section, we perform an econometric analysis aimed at understanding in a more systematic way the interrelation between investment and firm performance. Given the lumpy characteristic of the capital accumulation process as shown in the first section, we center our analysis on the investment spikes. More precisely, we are interested in the evolution of our variables of interest (here firm growth, productivity growth and the profitability rate) before and after an investment spike.

Our econometric technique relies on the one put forward by Sakellaris (2004), who was interested in the effects of capital adjustment episodes (investment spikes, but also bursts of job creation and bursts of job destruction) on the firm's utilization of *other* margins of adjustment (such as capital utilization, hours per worker, energy use...).

In order to do so, we first identify, for each firm, its highest investment episode in the period of interest [16] as defined in section 3.1 by *rank 1*. Therefore we get a *relative* definition of the investment spike, as we get one investment spike per firm. This is preferred to an *absolute* definition such as a threshold on the investment rate (for example, Sakellaris (2004) defines as a spike all investment rates above 20%). Indeed, using the highest investment rank allows us to perform the subsequent analysis on an unbiased balanced panel, as we get one spike per firm. It also removes any issues related to multiple-years spikes[17].

For each firm, we define the year of the investment spike by *t*, the previous years by *t-1* and *t-2* and the following years by *t+1* and *t+2*. This thus forms a five year window centered in the year of the event. We then recover the values of the following variables (as defined above) for this five year window: $log(N_t)$, g_t^N, Π_t, g_t^{Π}, $log(TS_t)$, g_t^{TS}, P_t, and I_t/K_{t-1}.

We then regress these dependent variables on a group of dummy variables that select years $t-2, t-1, t, t+1$ and $t+2$. Taking X_{is} as one of our variables of interest, we get:

$$X_{is} = v_s + \sum_{j=-2}^{+2} \beta_j \times SPIKE_{is}^{t+j} + \epsilon_{is} \tag{4}$$

where the dummy variable $SPIKE_{is}^{t+j}$ is equal to 1 if and only if the firm i has experienced its highest investment episode in year $t+j$. v_s are time dummies. They are needed because, as shown in Figure 4, investment spikes are unevenly distributed along the business cycle, therefore the year in which the investment spike is undertaken can bias the measure of the relation between the spike and firm performance.

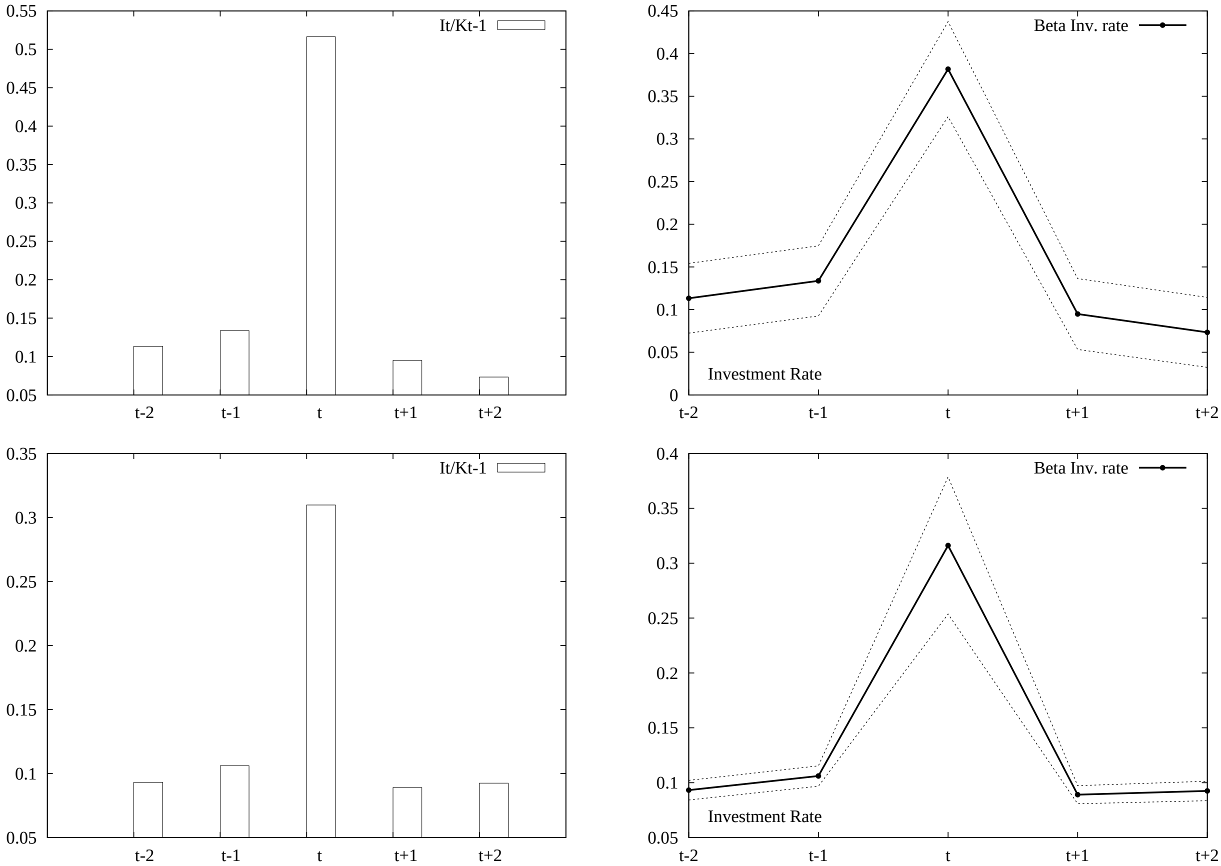
The output of such analysis is the group of five estimated coefficients $\hat{\beta}_j$, j=-2 to 2 that account for the effect of having an event in year t on the variables of interest in year $t+j$, j ranging from -2 to +2. We display our results in the form of graphs (Figures 5 to 8) where, for each dependent variable, is reported the group of coefficients from $\hat{\beta}_{t-2}$ to $\hat{\beta}_{t+2}$. Note that $\hat{\beta}_t$ is the contemporaneous effect of having a spike on the variables of interest. Moreover, $\hat{\beta}_{t-2}$ and $\hat{\beta}_{t-1}$ are to be understood as the effect of being two (one) years before an investment spike.

As a consistency check, let's see what happens when the dependent variable is the investment rate. First, let's consider its average value before and after an investment spike (cf. Figure 5, left). By defining the year in which the *rank 1* episode occurs as year t, we confirm that as in Doms and Dunne (1998), the investment rate is very low in the years before and after an investment spike. The regression results capture this through a higher coefficient at the time of the event : as shown in Figure 5 (right), $\hat{\beta}_t$ is relatively higher than $\hat{\beta}_{t-2}$, $\hat{\beta}_{t-1}$, $\hat{\beta}_{t+1}$

[16] We perform the analysis for the period 1996-2007. Indeed, the methodology requires to balance the panel, therefore a shorter period allows to include more firms. However, we also perform the analysis on the 1989-2007 period for France as shown in the Appendix.

[17] By comparison, the use of an absolute threshold on the investment ratio as a definition for the investment spike as in Sakellaris (2004) and Nilsen et al. (2009) introduces a bias towards a higher number of small firms in the sample. Indeed, as discussed by Nilsen et al. (2009), small firms present more volatility in their investment ratios, therefore the probability that the small firm exceeds the threshold is relatively higher. This is further illustrated by Figure 2, right.

Figure 5: **Left** : Investment rate before and after a spike (*rank 1* in year t); **Right** : regression results for the investment rate. **Up**: France; **Down**: Italy.



and $\hat{\beta}_{t+2}$. Indeed, the regression coefficient $\hat{\beta}_{t+j}$ captures the average effect on the dependent variable (here the investment rate) of being at time $t + j$.

As shown in Figures 6 and 7, $\hat{\beta}_t$ is generally less significant than the other ones, because it is contemporaneous to the shock. Moreover, except for the case of productivity and employment growth, the coefficients are always positive. Finally, and again except for productivity growth, the results in both countries are similar, even in terms of levels of the coefficients.

We display the estimated coefficients for the dependent variables in levels (log) as well as in growth rates for productivity, sales and employment. As it can be expected, when the impact of the spike is increasing between periods on the variable in levels, the impact on the variable in growth rates is positive. When the impact is decreasing on the variable in levels, it is negative on the variable in growth rates. For example, this latter case is illustrated by a negative coefficient $\hat{\beta}_{t+2}$ on the growth of employment.

More precisely, and consistent with the findings of Sakellaris (2004), employment grows more before the investment spike than after. The author explains that *before* a large investment (the purchase of a new machine for example), the firm that needs to expand its production first increases its capacity utilization[18]. For example, instead of using its machine ten hours a day, it uses it for fifteen hours, thus requiring to increase its demand for labour by five hours.

[18]The capacity utilization in “normal times” is around 80% in the manufacturing industry.

Figure 6: Firm performance before and after the investment spike in France (1996-2007)

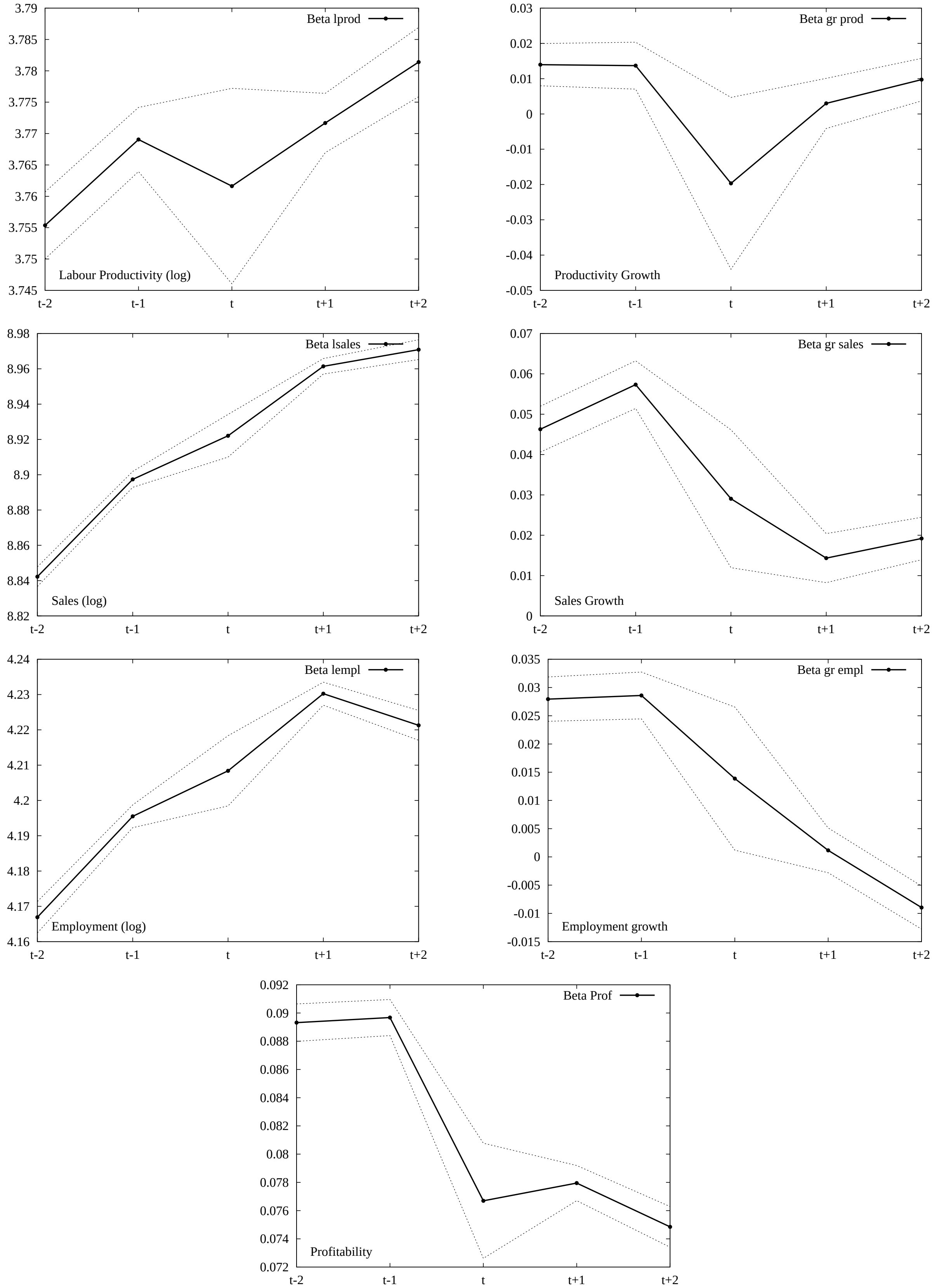
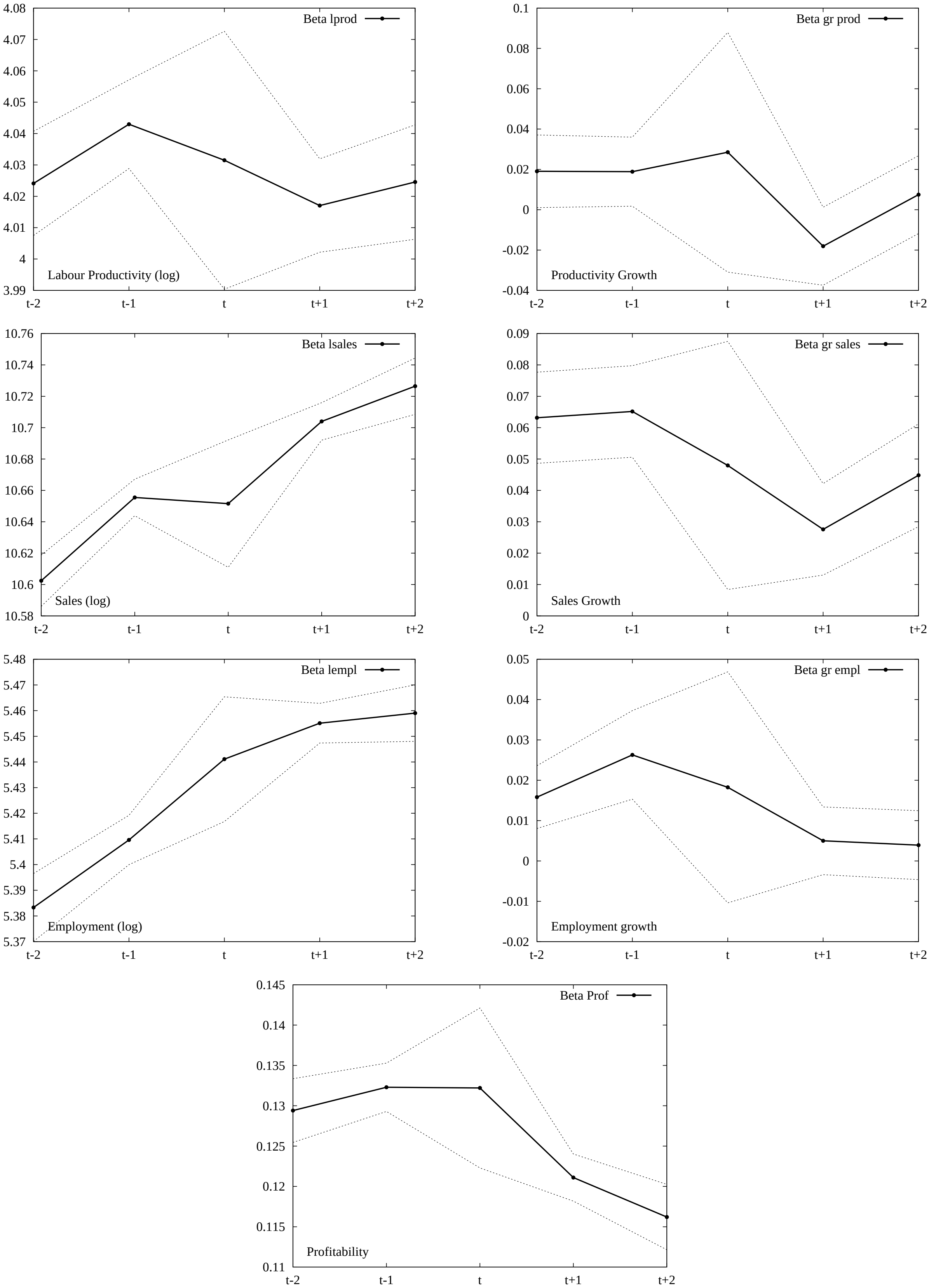


Figure 7: Firm performance before and after the investment spike in Italy (1996-2006)



Such increase can be performed through longer shifts for the employees as well as through a net increase in the number of employees. The choice between these two options affects differently the productivity levels since new employees' producitivity is generally lower. Then if the increase in demand is stable, the firm may adjust its capital level and purchase a new machine. *After* the investment the effect on employment depends on the type of capital that is purchased. Still, if the firm acquires a machine with a different technology, the labour to capital ratio needed for production might change. More precisely, as demonstrated by Freeman et al. (1982), some technologies can be labour saving. Thus, employment growth would be lower than capital growth.

Similarly, the growth of sales is high at $t-1$ but low after the spike, even up to $t+4$ as shown in the Appendix[19]. Chances are that a firm has more incentives to invest when it is growing in terms of sales, for several reasons. First the firm may need to expand in order to satisfy such growing demand, and second the high level of sales allows to finance such purchase more easily in particular because banks are more inclined to lend money to large firms. Thus, we might expect that once the investment is carried out, it may in turn affect future sales growth. However this effect, although positive, is relatively weaker.

The results on the profitability rate also point towards a higher link before the spike than after. Indeed profitability is high at $t-2$ and $t-1$ and then falls. Again past profits are a signal of the firm's financial health and an incentive as well as a facilitator for investment to occur. After the spike the relation is still positive but weaker, since the expenses related to the investment might negatively affect firm profit.

Finally the relation between the investment spike and firm productivity is the most difficult to disentangle. Indeed, other studies of such relation have pointed out the negative effect of investment on productivity growth (Power, 1998; Huggett and Ospina, 2001; Sakellaris, 2004; Shima, 2010), as justified by the learning effect related to new capital. We indeed get a negative coefficient at the time of the event for France, and at $t+1$ for Italy, although very close to zero. Still, this particular relation is the least significant among our different regressions, the sign of the coefficient is therefore unclear. However we do not conclude that the impact of investment on productivity is neutral, rather that conflicting effects make it difficult to get a clear picture at the aggregate level. Of course the learning effect might play a role, but other elements are also worthwhile considering. For instance changes in employment intensity as well as employment composition around the spike can have a negative impact on productivity growth at the firm level. Indeed, when the working day is extended to cope with demand growth, productivity falls. And when the choice of the firm is rather to hire new employees, productivity also falls. Still investment also positively relates to productivity when considering changes in the technology of production, as already mentioned above. Therefore, the net effect of the investment spike on productivity in the years around the event is undefined.

5 Final remarks

This study has investigated investment patterns at the firm level in the French and Italian manufacturing industries. We have confirmed previous studies in showing that investment is lumpy at the firm level, and that the number of investment spikes, as defined by the highest investment episode of each firm, is positively correlated with aggregate investment.

[19] We have replicated the analysis for the 1989-2007 period in France enlarging the window of the study, which enables us to see the impacts of the spike up to four years before and after the event.

We have also revealed that the investment rates are persistent. Moreover, testing a AR(1) model on our variable confirms that investment rates are weakly autocorrelated, although the coefficient of autocorrelation is significant. We have also put forward significant heterogeneity in the autoregressive structure of firms across sectors, some of which even displaying cyclical patterns of the investment rate.

Finally we have performed an econometric analysis centered on firms' investment spikes which has enabled us to uncover the impact of such events on firm growth, productivity and profitability rates. As shown in Sakellaris (2004), employment is raised before an investment spike, as firms first adjust with their more flexible factor before carrying out an investment project. Moreover, if they seem to be able to invest in good conditions (with higher growth rates and profitability rates), the effect of the spike on firm performance is weaker. Contrary to previous findings, the effect of investment episodes on productivity growth is not clearly negative.

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A Kendall Cross Correlation. Sectoral Evidence

Table 6: Kendall's τ of Cross Correlations in sector n. 17

	France					Italy				
I/Kt	g^N_{t-x}	g^{TS}_{t-x}	g^{Π}_{t-x}	Π_{t-x}	P_{t-x}	g^N_{t-x}	g^{TS}_{t-x}	g^{Π}_{t-x}	Π_{t-x}	P_{t-x}
t	0,162*	0,155*	0,015**	0,119*	0,175*	0,061*	0,056*	0,025*	0,082*	0,064*
$t-1$	0,140*	0,156*	0,044*	0,121*	0,175*	0,029*	0,060*	0,047*	0,054*	0,052*
$t-2$	0,107*	0,123*	0,044*	0,111*	0,146*	0,029*	0,032*	0,003	0,023**	0,040*
$t-3$	0,099*	0,115*	0,039*	0,093*	0,108*	0,017***	0,012	-0,016	0,005	0,024**
$t-4$	0,062*	0,093*	0,035*	0,074*	0,076*	0,020***	0,014	0,007	0,001	0,028*
$t-5$	0,058*	0,086*	0,017	0,061*	0,057*	0,006	0,013	-0,007	0,006	0,030*
$t-6$	0,054*	0,074*	0,018	0,058*	0,044*	0,008	0,004	-0,004	0,002	0,020
$t-7$	0,048*	0,091*	0,028***	0,053*	0,032*	0,015	-0,023	-0,037**	0,004	0,015
$t-8$	0,040**	0,045*	-0,010	0,038*	0,020	0,043***	-0,005	0,008	0,031	0,034***
$t-9$	0,043***	0,048**	0,001	0,064*	0,020	-0,004	-0,001	0,016	0,035	0,039
$I/Kt-x$	g^N_t	g^{TS}_t	g^{Π}_t	Π_t	P_t	g^N_t	g^{TS}_t	g^{Π}_t	Π_t	P_t
t	0,162*	0,155*	0,015**	0,119*	0,175*	0,060*	0,055*	0,025*	0,081*	0,062*
$t-1$	0,093*	0,065*	-0,011***	0,093*	0,145*	0,021*	0,005	0,013	0,070*	0,057*
$t-2$	0,067*	0,059*	0,006	0,089*	0,135*	0,016***	0,038*	0,005	0,075*	0,055*
$t-3$	0,048*	0,043*	0,010	0,091*	0,128*	-0,003	-0,011	-0,020**	0,066*	0,045*
$t-4$	0,040*	0,024*	-0,005	0,087*	0,112*	-0,042*	-0,063*	-0,026**	0,053*	0,036*
$t-5$	0,031*	0,015***	-0,001	0,087*	0,102*	-0,017	0,018	0,013	0,055*	0,038*
$t-6$	0,019***	0,012	-0,015	0,079*	0,085*	-0,030**	0,034**	0,019	0,066*	0,045*
$t-7$	0,003	0,019	0,006	0,077*	0,075*	-0,021	0,021	0,009	0,072*	0,053*
$t-8$	0,017	-0,011	-0,017	0,067*	0,069*	-0,009	0,045*	0,010	0,074*	0,047*
$t-9$	0,001	-0,017	-0,023	0,054*	0,054*	-0,025	-0,023	0,002	0,045**	0,026

*significant at 1% level; ** at 5% level

Table 7: Kendall's τ of Cross Correlations in sector n. 29

	France					Italy				
I/Kt	g^N_{t-x}	g^{TS}_{t-x}	g^{Π}_{t-x}	Π_{t-x}	P_{t-x}	g^N_{t-x}	g^{TS}_{t-x}	g^{Π}_{t-x}	Π_{t-x}	P_{t-x}
t	0,167*	0,127*	-0,001	0,036*	0,102*	0.049*	0,037*	0,008	0,072*	0,074*
$t-1$	0,130*	0,124*	0,038*	0,046*	0,114*	0.035*	0,033*	0,017**	0,055*	0,077*
$t-2$	0,092*	0,091*	0,038*	0,033*	0,086*	0.030*	0,045*	0,016**	0,029*	0,069*
$t-3$	0,064*	0,070*	0,023*	0,024*	0,057*	0.023*	0,024	0,007	0,017**	0,053*
$t-4$	0,056*	0,046*	0,022*	0,022*	0,042*	-0.000	-0,003	0,001	0,015***	0,051*
$t-5$	0,054*	0,043*	0,014***	0,018*	0,025*	0.004	-0,011	-0,013	0,016***	0,042*
$t-6$	0,067*	0,040*	-0,004	0,020*	0,011	0.011	0,005	0,003	0,022**	0,051*
$t-7$	0,049*	0,035*	-0,005	0,030*	0,013	-0.005	0,006	0,024***	0,024**	0,056*
$t-8$	0,021***	0,037*	0,016	0,028*	0,023**	0.008	0,017	0,010	0,019	0,043*
$t-9$	0,033**	0,038**	0,023	0,025**	0,029**	-0.025	-0,036	0,012	0,029	0,059*
$I/Kt-x$	g^N_t	g^{TS}_t	g^{Π}_t	Π_t	P_t	g^N_t	g^{TS}_t	g^{Π}_t	Π_t	P_t
t	0,167*	0,127*	-0,001	0,036*	0,102*	0.048*	0,036*	0,007	0,071*	0,072*
$t-1$	0,094*	0,052*	-0,004	0,026*	0,087*	0.018*	0,006	-0,006	0,056*	0,064*
$t-2$	0,052*	0,029*	-0,001	0,016*	0,067*	0.013***	0,016**	0,007	0,063*	0,061*
$t-3$	0,033*	0,022*	0,011**	0,022*	0,063*	0.013***	-0,001	-0,018**	0,058*	0,057*
$t-4$	0,027*	0,014**	0,002	0,020*	0,053*	0.004	0,001	-0,020**	0,040*	0,045*
$t-5$	0,022*	0,025*	0,016**	0,036*	0,057*	0.008	0,015***	0,000	0,032*	0,043*
$t-6$	0,038*	0,029*	-0,007	0,034*	0,059*	0.006	0,062*	0,035*	0,046*	0,076*
$t-7$	0,023*	0,019**	0,001	0,033*	0,062*	0.018***	0,036*	0,026**	0,051*	0,085*
$t-8$	0,029*	0,019***	-0,002	0,035*	0,059*	0.031*	0,020**	-0,003	0,032*	0,076*
$t-9$	0,028**	0,015	-0,016	0,026**	0,046*	0.006	0,010	-0,023**	-0,009	0,047*

*significant at 1% level; ** at 5% level

B Firm performance around investment spike. 1990-2007

Figure 8: Firm performance before and after the investment spike in France (1990-2007)