Interrelationships Between Labor and Capital Adjustment Decisions

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Abstract

This paper intends to provide empirical evidence on the interrelationship between employment and capital adjustment decisions. A fixed-effect logit model is employed to estimate this interrelationship using a data set of large Italian firms. Whereas some firms prefer to hire substantially in the same time the investments spike occurs, the others find profitable to anticipate the investments episodes as well. Also, the augmented adjustment-cost function for employment and capital is extended to express the inaction range of employment (capital) adjustment in terms of the inactions range of capital (employment) adjustment and validate the use of a discrete choice modelling thereafter. Investment process occurs more smoothly than employment adjustment process, while hiring process is less smooth that firing process. Convex components seem to be important in the adjustment process of capital. Firms investing in R&D products, MNEs and those older than 25 years prefer to anticipate the investment spikes by hiring one year in advance in addition to the simultaneous hiring. These firms possess a plant-specific asset that allow them to use a higher technology level than the other firms. In turn, this higher technology level requires more skilled labor and thus workers to be trained and used efficiently in their organizational structure. Therefore, these firms will take employment decisions under a longer time horizon and will be inclined to plan carefully their investment decisions and hiring (expansion) strategies on a longer time period. Likewise, it may indicate that they possess superior management expertise that allows them to predict market fluctuations and plan the expansion and investment strategies in advance. Business cycle trend seems correlated with the simultaneous dynamics of factor demands such as it gets stronger in upturns and weaker in downturns.

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Introduction

The economic literature on adjustment processes of the most important determinant of production function supports the existence of lumpiness at micro level. Firms are inclined to adjust their factor demand at infrequent steps. Several studies provide empirical evidence with respect to how firms feel reluctant to adjust their stock of capital due to uncertainty and irreversibility conditions.[2] Their reluctance lasts until the deviations of the actual capital stock from its optimal value reaches a certain threshold. Such a threshold is imposed by the demand and the degree of irreversibility and uncertainty. Hamermesh and Pfann (1996) provide a rich summary with reference to adjustment costs in factor demand introducing all functional forms these costs would theoretically take and draw the conclusion that factor demand adjustment at firm level is slow and not characterized by symmetric quadratic costs. Doms and Dunne (1998), Cooper, Haltiwanger and Power (1995, 1999), Nilsen and Schiantarelli (2003) and Letterie and Pfann (2002) show convincing evidences that investment process is nonconvex and irreversible at firm level probably due to the presence of the fixed component in the adjustment cost function.[3] Thus, firms will not invest smoothly, but they wait until sufficiently big changes are needed to make it profitable to pay the fixed costs and then they adjust abruptly in a large "spike". [4]

The literature of labor markets recognizes the sluggish behaviour of adjustment process also under the traditional justification of adjustment costs.[5] Hamermesh (1989), Davis and Haltiwanger (1992), Caballero, Engel and Haltiwanger (1997), Rota (2004) report large employment changes at the plant level whose could be undoubtedly depicted by a model of adjustment which includes non-convexities and non-differentiability in the adjustment costs function, or simply a fixed cost component. Hamermesh (1989) depicts a model of labor dynamics where firms decide either to not change the employment level or to adjust it completely to the static level implied by derived by the profit optimization firm problem in the presence of fixed adjustment costs. Thus the overall literature of factor adjustments costs in favour of the importance of fixed component in the adjustment cost

[2] See Ricardo Caballero (1999) for an overview of this topic.
[3] See also Goolsbee and Gross (1997), Barnet and Sakellaris (1998) and Abel and Eberly (1999) for further evidences on the importance of lumpiness and irreversibility in capital adjustments process.
[4] See Dixit and Pyndick (1994).
[5] See also Hamermesh and Pfann (1989, 1992, 1995), Bentolila and Saint-Paul (1994), Abowd and Kramarz (2003), Cambell and Fisher (2000a,b).

function as a considerable reason of the lumpy behaviour of these factor demands, consent to use a "spike" definition to capture large adjustment episodes of capital and labor.

The above empirical works have been performed based on models with a single quasi fixed input factor (either investment or employment). It seems that all investment (labor) studies have been done at expense of labor (investment). So, in one-factor adjustment models, the other factor is considered as fully flexible (either there are no labor costs or the stock of capital is exogenous). However, intuition suggests that the adjustment process of one factor should be dependent on the other's process. The cross-dependence of investment and employment is known in the economic literature as interrelation. Nadiri and Rosen (1969, 1973) constructed the first model of interrelation where the firm controls the investment, labor and utilization rates of both inputs. Each variable is assumed to be endogenous and all variables are directly or indirectly interrelated through the production function. They find significant cross-dependence among employment and investment. Recently Abel and Eberly (1998) show that when employment decision depends on capital stock, employment may perform in the same lumpy way as investment.[6] Sakellaris (2004) using a sample of US firms, found that firms tend to hire more employees before an investment spike and at the time the spike is generated. Letterie, Pfann and Polder (2001, 2004) found that in periods of major capital adjustments and immediately after or just before such episodes, firms increase their labor force.

Based on the empirical literature of interrelated factor demand, this paper aims to: a) provide some descriptive statistics of the capital and employment interrelationship by giving attention to patterns of observations with large adjustments using a sample of 1710 Italian firms during the period 1977-1997, b) to extend the augmented adjustment-cost functions for employment (capital) by incorporating the fixed component of adjustments costs of capital (employment) in the adjustment costs function of labor (capital) and consequently express the inaction range of capital in terms of inaction range of labor, c) to express the inaction range interrelationship through threshold constructions and capture any link between hiring, firing and investment spikes decisions by employing a discrete choice model such as fixed-effect logit, and finally d) finally, as there is a large literature stressing the importance of heterogeneity among plants in their factor adjusting behaviour, to control for such heterogeneity (under different firms classification) through the inclusion of a fixed

[6] The fact that labour hoarding can arise without direct costs of adjusting employment casts doubts on any attempt to measure the costs of employment adjustment simply by focusing on the behaviour of employment without looking at other factors of production.

effect. Accordingly, the behaviour of multinationals, R&D firms and old firms with respect to the interrelationships between factor demand adjustment episodes will be described more in details.

A fixed effect logit will be used to perform the above estimations where large hiring episodes act as dependent variables. These episodes will be depicted by a dummy variable which take value one for employment growth rates observations exceeding a certain threshold. Equivalent dummy variables which capture large investments episodes (located in three subsequent periods) will be used as control variables

This paper is organized as follows. Section II will shed light on the descriptive statistics of employment adjustment and investment spikes. Section III tries to extend the augmented adjustment-cost function taking into account the interrelationship between factors. Section IV deals with a fixed-effect logit modeling and comments on estimation results. Section V concludes accordingly.

II. Descriptive Statistics

The data set used in this study is extracted from a large dataset (PANEL97) of Italian firms constructed by CERIS-CNR using data published by Mediobanca, a large investment bank (annual directory "Le Principali Societa"). This panel is composed of 1710 firms over the period 1977-1997. It provides firm-level information with respect to firms' primary industry, ultimate ownership, group affiliation, location, foundation year, Istat group, and business activity and sectoral data for the firm's primary industry (e.g. production and price indexes, turnover etc.).[7] Also it sheds light on the main firm's activity variables as employment, labor costs, sales, value added, fixed investment, stock of capital at replacement cost.[8], [9], [10] To get a better idea about the distribution of firms across age groups and locations I show some descriptive tables.[11], [12] These data are provided on an annual basis and therefore probably this time aggregation could disguise

[7] For a better data description see working paper N.5/2001, Benfratello, Margon, Rondi, Sembenelli, Vannoni, Zelli and Zittino.
[8] Labour costs are calculated as the sum of nominal wages and firing costs and consequently I cannot spell out them separately.
[9] Appendix 1 shows how missing values of stock of capital and investment are constructed.
[10] This variable has been computed using perpetual inventory technique.
[11] For some summary statistics on firm distribution see tables 8-14
[12] I have removed all observations with employment growth and investment rates bigger than 100% and those which are considered as outliers.

other forms of employment and capital adjustment which could be frequent for quarterly data. All variables are deflated by producer price.

To establish whether firms perform large investment during a certain year, I make use of several definitions nevertheless few empirical results have demonstrated that the interrelation behaviour does not change on the spike definition. These spike definitions are: the absolute, relative and combined spikes. Power (1998) used the definition of relative investment spike to denote the investment rate observations which exceed 1.75 times the median of investment rates. Following Cooper, Haltiwanger and Power (1999) an observation is called an absolute investment spike if the investment rate exceeds 20 percent.[13] On the other hand, to check for employment spikes, Sakellaris (2001) define an observation as a positive employment spike if the current adjustment rate of employment exceeds 10 percent and the past rate does not exceed 10 percent, and as negative employment spike if it is less –10 percent at the current period and more than –10 percent at the precedent period.[14] [15] Power (1998) employs another definition to make a robust estimation of spikes: the combined investment spike which occurs when the investment rate behaves either as absolute or as relative spike.[16] Therefore I intend to use some of these definitions mentioned above, and then opt for estimated coefficients which get significant for no less than 3 spike definitions.[17]

Fig 1, 2

Figures 1 and 2 show the density functions of employment growth and investment rates. It is obvious that the employment growth rates are more normally distributed than the investment rates around zero. Moreover, the distribution of investment rates exhibits a considerable kurtosis, being peaked in the center and with fat tails. Also it exhibits some skewness which is justifiable by the relative small number of observations of disinvestments. With respect to the employment growth rates, the kurtosis is still crucial (many observations with very low employment changes) but the skewness is less

[13] See Cooper, Haltiwanger and Power (1999).
[14] Letterie and Pfann (2001) use a switching regime to estimate the probabilities that an observation belongs to a high or low regime. When it is higher than 0.5, they say that, firms have done a switching investment spike.
[15] A positive employment spike corresponds to the hiring process. A negative employment spike corresponds to the firing process.
[16] See Laura Power (1998).
[17] See Section IV to understand this selection criterion.

pronounced than for investment rates. However, the employment growth rates density exhibits some skewness towards the negative side as there are much more values of negative rates.

Table 1

Table 1 shows the number of observations of large investments episodes (denoted as Spike), large positive employment adjustment episodes (denoted as Poseg) and large negative employment adjustment episodes (denoted as Noseg) for 4 different ways of spike definitions. In the first type, an observation is called investment (employment) spike when it is bigger than 1.75 times the median of the investment (employment growth) rates for any firm. In the second type, an observation is called spike if it exceeds 1.75 times the median of investment (employment growth) rates.[18] The absolute investment spike denotes observations of investment rates bigger than 0.2 while the absolute employment spike denotes observations of employment growth rates bigger than 0.09 in absolute value. The last type of definition is a combination between the first method and the absolute method defining as a spike those observations which are either bigger than the absolute threshold or bigger than the first type threshold.

Fig 3

Figure 3 and Table 1 (see Appendix 2) suggests, there are 22 and 17 percent of observations with investment spikes in the case of the combined spike definition and the absolute spike definition respectively (for the US data used by Cooper and Haltiwanger (2003), there are almost 18 percent of observations denoting investment rates higher than 0.2). There are 9 percent of the observations generated as positive employment spikes using the combined threshold in spite of 6 percent ones generated by the absolute type. With respect to the negative employment spikes, the picture does not change a lot with spikes definitions; there are 14 percent negative employment spikes generated by the combined thresholds in spite of 10 percent generated with absolute threshold. Thus, the combined type definition (using either relative or absolute spikes) makes the large discrepancies between the relative spikes and absolute spikes smoother.

[18] The 1.75 criterion could be changed for the firing case, but I don't see any reason to discriminate the firing spikes.

The absolute spikes generated with thresholds values suggested by Cooper, Haltiwanger and Power (1999), Power (1998), Sakellaris (2001) and others allow for fewer cases of capital adjustments. This could be explained partially by the large dissimilarities existing between the Italian data and US data with respect to the investment and employment growth rates. What about these dissimilarities? The Italian rigid labor market during this period, is characterized by the highest unemployment rate in Europe, the lowest level of employment level in the EU, 60% of the workforce (the EU average is 69%), total unemployment is 9% (in the south it reaches 20%). Olivier Blanchard (1998) goes through the juxtaposition of striking discrepancies between US economy and Continental European economy: the steady increase in unemployment since the early 1970s in Continental Europe (France, Germany and Italy) and the increase in capital share since the mid-1980s in spite of a very opposed macroeconomic picture in USA.[19] Then, he concludes that the initial increase in unemployment was due to a powerlessness of wages to adjust to the slowdown in factor productivity growth. Initially, capital shares and profit rates decreased and latter on, firms reacted by reducing capital accumulation and substitute labor with capital. Besides wage differentials, labor market rigidity stimulated Italian firms to replace labor with capital. Italy is considered as a country with a very stringent employment protection legislation (EPL). A study by Lazear (1990) for the period 1956-84 and a study by Bertola (1990) for the late 1980's rank Italy as the strictest country in terms of EPL.

Fig 4, 5, 6, 7

Graphs 4-7 show the persistence of employment and investment spikes over 4 periods. The number 1, 2, 3, 4 and 5 in the X-Axes signify respectively the percentage of subsequent spikes in five, four, three, two and one periods (point 5 shows 100% of investments spikes in 1 year, point 4 shows that 40% of investments spikes are performed in 2 subsequent years, point 3 shows that 20% of investment spikes are performed in 3 subsequent years, point 2 shows that 10% of investments spikes are performed in 4 subsequent years, point 1 shows that nothing is performed in 5 subsequent years). It is obvious that investment spike graph is much smoother than poseg and noseg graphs implying that a huge investment process takes place in more than one period, while a huge employment adjustment process is more lumpy. This implies that convex components besides fixed component are

Blanchard found out an elasticity of substitution between production factors in Europe higher than 1.

encompassed in the adjustment cost of capital. Also it shows that it is costly to adjust capital within one year. On the other hand this implication is a little imprudent as spikes occurring in several consecutive years would stand for a multi-year spike. With respect to employment spikes, negative employment adjustment (employment reduction) occurs in a smoother way than positive employment adjustment (employment expansion). This loosely implies that firing process takes more time than hiring process.

Table 2, 3

Table 2 shows some summary statistics of investments and disinvestment rates for the sample in use. There are very few (2.2%) observations with negative investment rates and this is in line with the irreversible feature of investment. In addition, this disinvestment rates are very small in absolute value. Table 2 shows in average, investment rate amount to 0.12 (with a 0.11 standard deviation) and positively skewed. It increases up to 0.22 in case of hiring and decreases down to 0.09 percent in case of firing. The average investment rate in case of current investment spikes is much higher that the overall average, reaching about 0.32. Table 3 shows some summary statistics of employment reduction and expansion rates. There are almost the same percentage of observations showing employment reduction and expansion. In average, employment growth rate amounts to 0.04 (with a 0.06 standard deviation), it increases up to 0.13 in case of hiring and decreases down to –0.14 percent in case of firing. The average employment growth rate in case of current investment spikes is 0.014.

Table 4, 5
Fig 8-15

Tables 4 and 5 (Appendix 2) and figures 8-11 and 12-15 display some descriptive statistics with respect to the investment and employment patterns before, during and after employment and capital adjustment spikes. Considering the combined spike definition, the average employment growth rate is about 0.02 before a hiring spike, it raises to 0.13 during it and then it decreases to 0.13 after. Before a firing spike, the average employment growth rate is –0.003, it decreases to –0.13 during it and then it increases to –0.14 after. Before an investment spike, the average employment growth rate is 0.01, then it slightly increases 0.014 and decreases after to –0.002. Considering the same spike definition, the average

investment rate is 0.17 during a hiring spike, it increases to 0.22 during it and decreases after it at 0.19. Before a firing spike, the average investment rate is 0.11, it decreases to 0.09 during it and it increases to 0.12 after. Before the investment spike, the average investment rate is 0.18, it reaches 0.32 during it and it decreases to 0.18 after it. These tables show that investment and employment growth rates share the same trend before, during and after huge factor demand adjustments. Looking at the figures 8-15, it is obvious that employment growth rates and investments rates tend to follow similar trends along hiring and investments spikes paths. On the other hand, it is apparent that employment and investment rates share the same trend along firing paths which, in turn, seem to be quite distinct from hiring and investment spikes paths.

Table 6 here

Table 6 shows the frequencies of observations of some possible combination between the past, current and future investment spikes and the positive and negative employment spikes when all type of thresholds are employed. With respect to the simultaneous combinations, it is obvious that the observations with neither investment nor positive employment spikes are most frequent (73.55%). The observations with only investment spikes (no positive or employment spikes) come next (17.32%) followed by the observations with only positive employment spikes (5.34). The observations with both investment and positive employment spikes are less observed (3.79%). The same hierarchy of frequencies can be noticed when the frequencies of the employment spikes with the past and future investment spikes are taken into consideration, with a slight decrease of the highest frequencies and a slight increase of the second ranked frequencies. The other spike definitions show the same picture.

As it is noticeable from the table, there are more observations when the firms adjust only one factor than when it adjust both factors. It seems that these summary statistics are at odds with the conclusion of a theoretical study performed by Dixit (1997) on firms level. He considers a model with separate linear cost of adjustment and concludes that episodes where firms adjust the less flexible factor will be much rarer than those where they change the two factors together. On the other hand, the observations of factor adjustment in my study are based on the assumption that the fixed cost component is a driving component in the composition of the adjustment costs. The assumption of linear adjustment costs allows Dixit to pass the homogeneity, concavity and supermodularity features from the production

function F(A,K,L) on the Bellman function V(A,K,L) and therefore to derive the slopes of the inaction range of factor demands. Nevertheless, these nice features do not hold when the fixed component of adjustment costs (as such is my case) is taken into consideration rendering impossible accordingly the Dixit conclusions. On the other hand, he says: "But we can make some general inferences. An increase in the costs of increasing or decreasing one factor, other things equal, will contribute to making that factor the less flexible one. If the crucial dividing line is crossed, then the qualitative nature of the firms' policies changes. From a policy where labor is adjusted only at 2 isolated points, the optimal policy becomes the other way round." Thus, the summary statistics of factor demands spikes derived in this paper, actually are not at odds with Dixit conclusion. They can simply justify a shift in the flexibility status whenever that government reforms make easier to hire or fire workers or to facilitate the investment procedures.

To conclude, all these statistics show that, if the "spikes" definitions fit quite well the adjustment in factor demands, then there is a certain relationship (not random at all) between the adjustment episodes in employment and capital demands. Moreover, these simple statistics illustrate that this relationship between factor demand spikes would hold even when these spikes are not contemporaneous. This implies that the past and the future decisions of the firms with respect to the labor and capital adjustment are highly correlated with the current decisions.

III. Theoretical model

In this part, I will try to build some theoretical basis for the empirical model I will employ in the next section. For that reason I will make use of the augmented adjustment-cost function for investment developed by Abel and Eberly (1994, 1998). They show that the interrelation between factor demands is "one-way" such that the employment adjustment decisions are determined by the investment decisions but not vice-versa. According to their investment model, investment is irreversible and subject to a fixed cost, so that the capital stock is a quasi-fixed factor that is adjusted infrequently and by discrete amounts. This quasi-fixity of capital can give rise to labor hoarding, even when labor is considered as a purely flexible factor.

Taking into consideration all the empirical studies done so far with respect to the adjustment processes in the capital and labor market, firms face significant fixed costs

either when they adjust employment or they adjust capital. If I describe in a similar way the total cost of employment and capital adjustment, the linear, convex and fixed cost should be all considered. Assuming that adjustment cost function can be represented by a linear, convex and constant relationship with respect to the factor demands, the augmented adjustment-cost function for labor and capital adjustment is given as:

$$(1) \qquad C(\Delta E, E) = \frac{(\Delta E)^2}{2\alpha_E E} + p_E \mid \Delta E \mid + F_E$$

$$(2) \qquad C(I, K) = \frac{I^2}{2\alpha_K K} + p_K \mid I \mid + F_K$$

where $C(\Delta E, E)$ and $C(I, K)$ denote adjustments costs functions of Employment and Capital respectively; E , ΔE , K, I denote employment, employment change, capital stock and investment flow respectively. The coefficients α_E , α_K , p_E , p_K , F_K F_E measure the role of convexity, linearity and lumpiness in the adjustments costs function of labor and capital respectively.

There is an economic meaning behind these cost components. So, labor adjustment costs are composed of:

1. linear labor costs are linear with respect to employment change and measure the wage and salvage payments; higher value of linear parameters delay the inaction periods in response to shocks.
2. convex part which is related to the rate employment is adjusted (immeasurable costs); in case of asymmetric convex costs marginal cost of hiring are not the same with marginal costs of firing.
3. the fixed costs which are related to advertising, screening and training activities and are up to a point independent of the number of people hired. The best example of fixed costs is mentioned by Hamermesh and Pfann (1996), referring to the clerical costs of handling the deluge of applications and assembling potential hiring pools incurred in case of advertisements placed in the Job Opening for Economist regardless of the number of people to be hired.

Likewise, capital adjustment costs are composed of: [20]

1. linear costs which vary linearly with the quantity of change in capital stock but not on time such as the prices paid for the capital goods purchased or firing costs for workers associated with machines being retired or site restoration costs when mines are shut down. They are (piecewise) linear in investment and possibly "kinked" at zero investment if the acquisition costs of capital differ from those associated with capital sales- for example- if the purchase price of capital exceeds its resale price
2. convex costs as in traditional q-theory which depend on the rate at which capital is being change. These costs depend on the time period such that smaller the time unit higher cost are accrued.
3. lump-sum cost that does not depend on the level of investment, though it may depend on the sign of investment. It includes stock fixed costs (managerial decision costs, fixed costs of placing orders) and flow fixed costs (costs that accrues as a given rate of flow over the period adjustment action is taken)

The literature of adjustments costs highly acknowledge the asymmetric feature of these costs (piecewise linear costs and asymmetric convex costs) as there are no reasons why hiring and firing workers or increasing and decreasing capital stock cost the same. However, as the intention of this chapter is to provide theoretical basis to the estimation method used in the next chapter, I skip the comments on different parameters for positive and negative labor adjustments.

Economic theories are based on the strong assertion that firms follow a profit maximizing behaviour when they adjust either employment or capital. If the marginal value of one unit of extra employment and capital is denoted respectively by q_E and q_K then, firms would follow the following inequalities to perform their factor demands adjustments:

$$(3) \qquad \begin{aligned} q_E &\geq \frac{C(E)}{\Delta E} \Rightarrow \Delta E > 0 \\ q_E &\leq \frac{C(E)}{\Delta E} \Rightarrow \Delta E < 0 \end{aligned}$$

[20] See Dixit and Pindyck,1994

$$(4) \qquad q_K \geq \frac{C(K)}{I} \Rightarrow I > 0$$ [21]

The inequalities (3) denote the constraint the firms are subject to, in case of hiring and firing respectively, while the inequality (4) denotes investment constraint. They both imply that firms would adjust their factor demands when profits exceed costs. In case of hiring and investments, the inequalities (3) and (4), can be extended to yield:

$$(5) \qquad \begin{aligned} q_E &\geq p_E + \frac{\Delta E}{2\alpha_E E} + \frac{F_E}{\Delta E} \\ q_K &\geq p_K + \frac{I}{2\alpha_K K} + \frac{F_K}{I} \end{aligned}$$

Also, the optimal adjustment level of employment and capital can be specified as:

$$(6) \qquad \begin{aligned} \left(\frac{\Delta E}{E}\right)^* &= \alpha_E (q_E - p_E) \\ \left(\frac{I}{K}\right)^* &= \alpha_K (q_k - p_k) \end{aligned}$$

and therefore considering the optimal values of adjusted employment and investment, the inequalities (3) and (4) can be transformed as: [22]

$$(7) \qquad \begin{aligned} q_E &\geq p_E + \sqrt{\frac{2F_E}{\alpha_E E}} = IA_E \\ q_K &\geq p_K + \sqrt{\frac{2F_K}{\alpha_K K}} = IA_K \end{aligned}$$

where IA_E and IA_K stand for the upper inaction frontiers of the factors adjustments.

These expressions show that fixed and linear costs affect the inaction frontiers. The higher they are, less possible it is for the firms to adjust. Also the convex costs affect the inaction

[21] The case when investment is negative will not be considered because it is very rare in our data in line with the irreversible way the investment process takes place.

[22] The inequalities (7) are derived by replacing employment and capital with its optimal values in inequalities (5).

frontier through the parameter α (the smaller it is, the higher inaction introduced). In a word, according to these expressions, the inaction range is totally due to the fixed, linear and convex costs.

The model developed so far is extracted by Abel and Eberly (1998), and is well known in the literature of adjustment costs. In order to express interrelationships between adjustments processes in labor and capital markets through a discrete choice modelling, I incorporate the fixed component of adjustments costs of capital (labor) in the adjustment costs function of labor (capital) and consequently express the inaction range of capital in terms of inaction range of labor. This interrelationship between inaction ranges of factor demands through fixed components of adjustments costs would justify the purpose of fixed effect logit in the next section.

Thus the set of adjustments costs for capital and labor are expressed as:

$$(8) \qquad C(\Delta E, E)^N = \frac{(\Delta E)^2}{2\alpha_E E} + p_E \mid \Delta E \mid + F_E + \beta_E F_K$$

$$(9) \qquad C(I, K)^N = \frac{I^2}{2\alpha_K K} + p_K \mid I \mid + F_K + \beta_K F_E$$

where $C(\Delta E, E)^N$ and $C(I, K)^N$ denote the new functions of adjustments costs of labor and capital respectively and the inclusion of fixed component of labor (capital) adjustments costs requires a economic justification. When the firm intend to set up a new establishment, they consider also the option of hiring new people. In case the new hired require high training and the overall situation is insecure (in stagnation), the firm's managers will feel reluctant to make this capital adjustment. How much? The parameter β_E is supposed to capture this effect. The same logics is worth in the case of the inclusion of fixed capital adjustment costs component in the adjustments costs function of labor. In case the firm intends to hire new workers, as the market demand increases, the costs of new machineries to be purchased should be considered as well.

$$(10) \qquad \begin{aligned} q_E &\geq p_E + \frac{\Delta E}{2\alpha_E E} + \frac{F_E + \beta_E F_K}{\Delta E} \\ q_K &\geq p_K + \frac{I}{2\alpha_K K} + \frac{F_K + \beta_K F_E}{I} \end{aligned}$$

$$\alpha_E(q_E - p_E) \geq \sqrt{\frac{\alpha_E(2F_E + 2\beta_E F_K)}{E}} = \sqrt{IR_E}$$
$$\alpha_K(q_K - p_K) \geq \sqrt{\frac{\alpha_K(2F_K + 2\beta_K F_{E)}}{K}} = \sqrt{IR_K} \quad (11)$$

$$IR_K = \frac{2\alpha_K F_K}{K}(1 - \beta_E\beta_K) + \beta_K IR_E(\frac{\alpha_K E}{\alpha_E K})$$
$$IR_E = \frac{2\alpha_E F_E}{E}(1 - \beta_K\beta_E) + \beta_E IR_K(\frac{\alpha_E K}{\alpha_K E}) \quad (12)$$

where IR_E and IR_K denote the new inaction frontiers for employment and capital adjustment in terms of fixed component terms of other factor demand respectively.

The coefficients β_E and β_K take value in the unit interval and measure the sensitivity of the employment (capital) adjustment towards capital (employment) adjustment. If β_E and β_K get closer to zero, employment and capital do not affect each other' adjustment at all. On the other hand, if β_E and β_K get closer to one, inactions ranges of factor demands get closer to each other as well. Two factors are said to be p-complements if the slow adjustment in the demand for one triggers slow adjustment in the demand for the other. They are dynamic p-substitutes if slow demand for one is accompanied by a fast adjustment in the demand for the other[23]. According to this definition, a positive value of these coefficients signifies that the factors are dynamic p-complements, while a negative value would signify that they are dynamic p-substitutes. In case β_E is positive and close to 1 and β_K is positive close to zero, a large inaction range of capital triggers a large inaction range in labor while the opposite does not hold.[24] In case β_E is negative and close to –1 and β_K is negative and close to zero, a large inaction range of capital triggers a small inaction range in labor while the opposite doesn't hold.[25]

Abel and Eberly (1998) have modelled a two-factor interrelated adjustment process where labor is fully flexible (no cost of adjustment) and capital is adjusted infrequently.

[23] See Hamermesh and Pfann (1996).
[24] Thus, there is no relation between inactions ranges.
[25] It takes place when firms hire low-skill workers without making large investments.

Their theoretical deduction is that the lumpy adjustment of capital will trigger considerable increases in employment level. They don't predict the same behavior in the opposite direction. Using the expressions (8), their model's estimation could be characterized by a β_K close to zero and β_E positive and close to 1 as they advocate that the employment adjustment behavior mimic the investment behavior.

Following all the empirical works done so far, in cases of large hiring or firing processes, firms are sensitive to the lag and lead values of investment spike. It is found that the firms increase their labor force either in periods just before or immediately after an investment spike occurs. To take into account these dynamic interrelationships, I extend the "inaction frontiers" of labor (capital) including the lag and lead values of inactions range of capital (labor) as follows.

$$IR_K^{-1} = \frac{2\alpha_K (F_K + \beta_K^{-1} F_E^{-1})}{K}(1 - \beta_E \beta_K) + \beta_K IR_E (\frac{\alpha_K E}{\alpha_E K}) \tag{9}$$

$$IR_E^{-1} = \frac{2\alpha_E (F_E + \beta_E^{-1} F_K^{-1})}{E}(1 - \beta_E \beta_K) + \beta_E IR_K (\frac{\alpha_E K}{\alpha_K E}) \tag{10}$$

where β_E^{-1} and β_K^{-1} coefficients take value in the unit interval and measure the sensitivity of the employment (capital) adjustment towards capital (employment) adjustment before the investment (employment) spikes take place.

These equalities show that factors affect each other through the components $\beta_K^{-1} F_E^{-1}$ and $\beta_E^{-1} F_K^{-1}$ in addition to the direct effect through the inaction range component. Their effect get larger when both coefficients β_E and β_K are far from 1 or -1. In the next section, a supposed estimate of these parameters will show which of them is more significant.

IV. Fixed-effects Logit Estimation

The summary statistics demonstrates that firms do not adjust randomly their factor demand. They behave under a set of strategies which include several combinations in the employment and capital adjustment. In this section I intend to estimate the probabilities

of the most plausible combinations of employment and capital adjustment over time, making use of discrete choice modeling. The motivation of using fixed-effect logit model comes from the facts that :1) adjustment process of factor demands are based on discrete choices and discrete variables, 2) panels could accommodate random or fixed effects.

Dummy variables Poseg and Spike are constructed to denote hiring and investment spikes respectively considering 4 different thresholds. The attempt in the previous section to express the inactions range of capital in terms of inaction range of labor was meant for interrelating factor demand through these theoretical structures (inaction ranges). Different thresholds can be used to proxy these inaction ranges and construe a link between constructed hiring and investment spikes. This could validate the use of a discrete choice model though it is not common to motivate factor adjustment in terms of utilities, but rather in terms of some latent profit variable.

To obtain an estimable representation of the assumed interrelationship between investment and hiring spikes (investment decisions and positive employment adjustment decisions), I parameterize a discrete choice model as follows:

$$(11)\quad Poseg_j = \begin{cases} 1 \Rightarrow \alpha_E (q_E - p_E) \geq \sqrt{IR_E} \Rightarrow U_{1it} = \beta_1 x_{it} + v_i + \alpha_1 u_t + \varepsilon_{1it} \\ 0 \Rightarrow \alpha_E (q_E - p_E) < \sqrt{IR_E} \Rightarrow U_{0it} = \beta_0 x_{it} + v_i + \alpha_0 u_t + \varepsilon_{0it} \end{cases}$$

where j is the index of employment adjustment strategy being chosen by the firm i, x_{it} is a vector of variables that characterize the investment, hiring and firing spikes, and the other continuous variables, β_j is a vector of coefficients associated with the observed vector of variables x_{it}, U_{jit} represents the utility of the choice j, v_i is a firm specific random or fixed effect that is unobserved directly to the econometrician, u_t is a variable that captures year effect (unemployment rate) and ε_{jit} is an error term.

Moreover, variable x_{it} is constructed to measure the effect of investments spikes on the employment spikes considering mainly firm heterogeneity. As such, it is simply a product of a dummy for investments spikes $Spike_j$ at any period and a dummy for any firm category along with product homogeneity (firms which invest in products of high R&D, high Advertising, high R&D and Advertising and low R&D), industry sector,

ownership type (public, small, medium, big national group, multinationals (MNEs) and independent), firm size, firm location and firm age. Thus, these new control variables don't affect each other at all.

Thus, the variable X_{it} is constructed such as to capture firm heterogeneity:

$$X_{it} = Spike_{it} * D_P$$
$$X_{it} = Spike_{it} * D_{IT}$$
$$X_{it} = Spike_{it} * D_G$$
$$X_{it} = Spike_{it} * D_L$$
$$X_{it} = Spike_{it} * D_A$$
$$X_{it} = Spike_{it} * D_S$$

where $D_P, D_{IT}, D_G, D_L, D_A$ and D_S are dummy variables representing any firm category along with product homogeneity, industry sector, ownership type, firm size and firm age. Additionally, to measure the effect of investments spikes before and after these hiring spikes, the same fixed effect logit regressions will be performed using x_{it-1} and x_{it+1} instead of x_{it} as independent variables. To control for aggregate trends in the variables, I include in the model also variables that don't vary across firms, such as yearly unemployment rate (u_t).

Assuming further that the disturbance elements in the model are logistically distributed and that the firm *i* chooses the alternative *j* with the highest utility, then the probability that the firm *i* will choose the employment adjustment strategy *j* is given as:

$$\Pr(Poseg_1) = \Pr(U_{1it} > U_{0it}) = \frac{\exp(x_{it}\beta_1 + \alpha_1 u_t + v_i)}{\sum_{k=0}^{1} \exp(x_{it}\beta_k + \alpha_k u_t + v_i)}$$

(12)
$$\Pr(Poseg_0) = 1 - \Pr(Poseg_1)$$
$$i = 1,2,...,33$$
$$t = 1,2,...,21$$

Defining further an index variable I_{ij} such that $I_{ij} = 1$ if firm *i* choose the option *j* and $I_{ij} = 0$ otherwise, then the joint probability that all firms select the observed options set is given as:

$$(13) \qquad \prod_{i=1}^{33} \prod_{j=0}^{1} P(z_j)^{I_{ij}}$$

and the log likelihood function for the above multinomial choice equation as:

$$(14) \qquad \log L = \sum_{i=1}^{33} \sum_{j=0}^{1} I_{ij} \log P(z_j)$$

A pooled logit regression disregards firm heterogeneity problem whose existence is purportedly captured by the component v_i. Thus, this component represents an individual specific, time-invariant effect which is unobserved. The two main approaches to deal with it are fixed-effects and random effects. While in the random effects approach we assume independence of the unobserved components and the observed covariates, in the fixed-effects approach we relax this assumption. The relax of the independence assumption renders fixed-effects logit approach more attractable. On the other hand, as long as the errors included in the utility function are assumed to be logistically distributed, the insertion of a random distributed term (as random effect presumes) would bring to a composed variable without any known distribution.[26] Moreover, the construction of spike control variable as explained above validate the use of fixed effect logit rather than random effect logit. To dispose of this confusing estimation approach I simply presume that there is fixed effect dominating in the logit regressions. [27]

[26] In the preliminary copy of this paper, I tried to check for the dominance of fixed effect or random effect using the Hausman test. In a fixed-effect model, the Hausman test is a test of H0: that random effect would be consistent and efficient, versus H1: that random effect would be inconsistent. (Note that fixed-effects would certainly be consistent.) The result of the test is a vector of dimension k dim(b)) which will be distributed chi-square(k). So if the Hausman test statistic is large, one must use FE. If the statistic is small, one may use RE.

[27] Xtlogit with the fe option is used to estimate Chamberlain's fixed effect logit model.

With respect to the goodness of fit, I use the McFadden R2 which is given as follows:

$$R2 = 1 - \frac{LogL}{NLog(J)} \quad (15)$$

Where J denotes the number of strategies firms would employ (J = 2)

V. Estimation Results

The main target of this paper is to study non-parametrically the interrelationship between labor and capital adjustments decisions. Firstly, Tables 14-20[28] show the estimated coefficients attached to the current, past and future investment spikes (running fixed-effects logit regressions) following the different methods of spike generation (relative, absolute and combined). Secondly, I make clear again the criterion used to opt for the most significant coefficients: estimated coefficient is considered sufficiently robust when no less than three types of thresholds generate significant coefficients.

Tables 7 show that, considering all firms, the coefficients attached to the current and future investments spikes are positive and significant according to the aforementioned criterion. In this way, firms hire a substantial number of employees during and before an investment spike occurs in order to complement or anticipate these spikes. Thus, there is a considerable relationship between investment spikes and employment adjustment and this is in line with the empirical studies. [29]

The positive simultaneous interrelationship is not significant only for the firms operating in metal sector, data processing machines and leather sector. The last industry sectors have a very low share in this dataset and this could be the reason of the non-significance, while the metal sector firms anticipate the investment spikes as I will explain below. With respect to the hiring episodes after an investment spike occurs, only for firms operating in printing and publishing and those located in center, I find evidence of interrelationship.

With respect to the episodes of employment expansion occurring in advance of the investment adjustment, this interrelationship is significant only for some firm

[28] These tables are provided at readers' request.
[29] Sakellaris (2001), Letterie and Pfann (2001) demonstrate the same relationship.

groupings. Thus, only firms investing in R&D products, those operating in chemical sector, metal products, mechanic materials and machineries, electric materials, transportation sector equipment and precision instruments, small national groups, MNEs and independent firms, those located in north and those older than 25 years prefer to hire hugely one year prior to an investment episode in addition of hiring simultaneously. What about these firms? Running the same logit estimations for firms which are multinationals and in the same time invest in R&D and Advertising, I find out that pharmaceuticals and pharmacosmetics firms such as L'Oreal, Schering, Roche, Palmolive-Colgate, Procter&Gamble, Vichy, Fiat Group, Instituto de Angeli etc incur massive hiring episodes before and during investment spikes. Some simple graphs of employment and investment rates are shown in the next page.

Examples of interrelationships between Factors Demand adjustments decisions

Fig. 7 shows four cases of simultaneous interrelationship. Considering first Procter and Gamble, employment growth and investments rates shares a similar trend where episodes of investment spikes coincide with episode of hiring spikes. In 1985, this firm has incurred simultaneously an investment and hiring spike while the same adjustment simultaneity exists even in 1990. Colgate Company experienced simultaneous spikes in 1978, 1982, 1984 and 1988. Looking at Fiat group, again a similar trend is obvious for employment and investment rates. There are simultaneous spikes in 1978, 1982, 1986 and 1995 while in the investment spike in 1996 was anticipated by a hiring spike in 1995. As regards the firm Recordati Industria Chimica e Farmaceuticha, fig. 7 shows that there are simultaneous hiring and investment spikes in 1978, 1982, 1986, 1991 and 1996.

Fig. 8 shows two examples of hiring spikes anticipating investment spikes. As regards the pharmaceutical firm "Instituto delle vitamine", this firm has anticipated the investment spikes by hiring in advance in 1980, 1983, 1988, 1992 and 1995 while the other firm Sandvik (operating in the mechanic sector) experienced hiring spikes in 1981, 1985, 1989 and 1993 anticipating the investments spikes in the next years.

One of the results of these estimations was that firms operating in printing and publishing prefer to hire also after the investment spike (which can be seen at fig. 9). Considering, for example, the publishing firm, SELEZIONE DAL READER'S DIGEST, it is obvious that there is an investment spike in 1984 which is succeeded by a hiring spike

in 1985. There is also an investment spike in 1988, 1992 and 1995 succeeded by hiring spikes in 1989, 1993 and 1996 as the estimated results claim for. Finally, considering Auguri Mondadori firm, there are investments spikes in 1980, 1983 and 1988 succeeded by hiring spikes in 1981, 1984 and 1989.

Fig. 7, 8, 9

Why firms investing in R&D, MNEs and firms older than 25 years enjoy such a interrelationship? These firms hire high skilled and low skilled workers. While, high skilled workers need to be trained (and therefore hired in advance), low-skilled workers do not need much training. The presence of these low-skill workers could be a justification for the significant simultaneous relationship between investment and hiring spikes while the presence of high-skill workers would justify the significant relationship between hiring episodes in advance of the investment spike episodes.

According to human capital theory, employers and employees may find advantageous to invest in the development of plant specific human capital because higher skilled labor provides profits either to the employee through a higher wage or to the employer through a higher labor productivity.[30] Therefore, it is less probable that employees and employers incur quits and fires for high-skilled workers than for low-skilled workers. Thus, jobs get more persistent for high skill workers than for low-skilled workers. Consecutively, this reasoning would affect directly the multinationals behaviour since they possess a plant-specific asset that allows them to use a higher technology level than the local firms.[31] The estimation results show that, MNEs will tend to smooth their hiring episodes in more than one year (actually two years) with respect to the investment episodes. Thus, employment decisions in MNES are taken (and made) under a longer time horizon than in local firms. Hymer (1976) says that MNEs in general are at disadvantage compared to the local firms when they set abroad. These advantages may induce MNEs affiliates to be more cautious in planning carefully their investment decisions and hiring (expansion) strategies over a longer time period. Also it may

[30] See Parsons (1986)
[31] See Caves (1996)

indicate that as MNEs own superior management expertise, they are capable to predict market fluctuations and to plan the expansion and investment strategies in advance. [32]

Business Cycle

The time period analyzed in this study is rather long to not account for the business cycle trends. One of the indicators representing it is the unemployment rate. As table 13 shows the unemployment rate increased notably during this period starting from a value of 7.2% in 1977 and reaching 12.2 % in 1997. Further, the data is divided into three subsamples: 1977-1981, 1982-1989 and 1990-1997 and the same fixed effect logit regressions are run for each subsample. Table 20 shows the estimated coefficients of the interrelationship between labor and capital adjustment processes over these different time periods. The simultaneous relationship holds over the whole time span and it gets stronger in the first two periods than in the third period, which is characterized by the highest unemployment rate. This implies that the business cycle trend is correlated with the dynamics of factor demands such as it gets stronger in upturns and weaker in downturns. This correlation is reasonable since in recessions, investments and employment expansions are not so frequent as in boom.

The anticipation of investment spikes by hiring spikes holds for the three periods but it gets significant only during 1990-1997. What is surprising is the fact that these estimations reveal as significant the anticipation of employment adjustments by capital adjustments. Thus, during 1977-1989, firms hired hugely new workers even after they invested, while during 1990-1997 they shed labor after having adjusted their capital. Why? The last decade of the previous century recognized a deep recession in most European countries (and in Italy as well). The real costs of labor per unit of output decreased together with the real wages. This deterioration of the overall situation, (which didn't hold significant during the disaggregated estimations) made that many investment projects be misguidedly started and generate consequently bad returns. Hence, firms were obliged to fire many of its workers. Thus, the sign of the interrelationship in this period (1990-1997) is compatible with the perplexed decisions taking of investors.

[32] Gorg and Strobl (2003) collude in the same predictive and planning behaviour of MNEs as regards to their investment and expansion strategies.

These results show that firms either anticipate the investments spikes by employing workers before or proceed with such employment policies in the same time they invest substantially. Anyway, there is a noteworthy evidence of the interrelationship between employment and capital adjustment processes. Also, cases where firms adjust employment in the same year they adjust capital should not be interpreted as simultaneous decisions. Probably these decisions are taken with a certain distance in time. As these data are taken on a yearly basis, nothing else can be performed under this data set to switch the decision timing on a quarterly or a monthly basis.

What does this noticeable relationship implies? It implies that any policy affecting labour adjustments directly would affect the performance of capital indirectly. For example, if capital costs are lowered, firms will be encouraged to make excessive capital investment whose contribution reflects in output expansion. If labor productivity is unchanged, normally extra workers would be hired to satisfy the new capacity. Employment adjustment would be associated with capital adjustment asserting the interrelationship phenomena in these markets. From a macro standpoint, any government policy that makes capital costly induce a labor market rigidity and the opposite also holds as long as employment will mimic capital adjustment patterns. Form a micro standpoint, a firm's strategy of hiring would make the other firms deduce that in a near future will hire also capital while when a firm sheds capital, it would make the others think that it will shed labor sooner. Thus, employment strategies of a firm would convey some information on its investment strategies to the other firms and vice-versa.

VI. Conclusion

This paper intended to study non-parametrically the interrelationship between large hiring and investments spikes decisions. The main conclusion is that investment spikes are highly interrelated with hiring spikes. Whereas some firms prefer to hire substantially in the same time the investments spike occurs, the others find profitable to anticipate them as well.

The other conclusions are as follows:

Investment process occurs more smoothly than employment adjustment process, while hiring process is less smooth that firing process. Convex components seem to be important in the adjustment process of capital.

Firms investing in R&D products, MNEs and those older than 25 years prefer to hire in the same time the investment spike occurs in addition to anticipate them one year. These firms possess a plant-specific asset that allow them to use a higher technology level than the other firms. In turn, this higher technology level will require more skilled labor and therefore it is worthwhile to provide training for workers in order to develop their human capital and use it efficiently in their organizational structure. Therefore, these firms will take employment decisions under a longer time horizon and will be inclined to plan carefully their investment decisions and hiring (expansion) strategies on a long term period. Also it may indicate that MNEs, firms investing in R&D and old firms have superior management expertise that allows them to predict market fluctuations and plans the expansion and investment strategies in advance.

Business cycle trend is correlated with the dynamics of factor demands such as it gets stronger in upturns and weaker in downturns. This correlation is reasonable as in recessions, investments as well as employment expansions are not as frequent as in booms. During the period 1990-1007, which was characterized by the highest unemployment rate, hiring spikes are succeeded by investment spikes which in turn are succeeded by firing spikes and such perplexed decisions are compatible with the overall economic deterioration.

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Appendix 1

Description of the variables

Labor costs: They are calculated as the sum of firing cost and wages. Therefore I can not measure the separate effect of each component on the probability to adjust employment and capital.

Investment: It denotes Gross Investments. Up to 1994 they are computed based on the formula:

$IL_t = (ITL_t – ITL_{t-1}) + FC_t – (RIV_t – RIV_{t-1})$

Where ITL: gross technical fixed assets; RIV: revaluation fund Visentini bis
FC = FA + Q – FA
Where FA: amortization fund; Q = Quota of Amortization
From 1995 and on, Investment is calculated as:
$IL_t = (ITN_t – ITN_{t-1}) + Q_t$
Where $ITN_t = ITL_t – FA_t$

Stock of Capital Net of Sunk Costs: Stock of Capital net of Sunk Costs is defined as:
For the years after a given benchmark BM:
$ITNEW_{t+1} = ITNEW_t (1-\delta) (p_{t+1} / p_t) + IL_{t+1}$

For the years after a given benchmark BM:
$ITNEW_{t-1} = [(ITNEW_t – IL_t)/(1-\delta)] (p_{t-1} / p_t)$

Employment Growth Rate: The Employment Growth Rate is defined as the difference between the log value of employment at time t and the log value of employment at time t-1

Investment Rate: Investment rate is defined by the ratio of fixed investment in year by the stock of capital net of sunk cost at the end of the year t-1.

Firms' Age: The age variable is generated as the deviation of the firm's foundation year variable from year 1977 which is the initial year of our data.

All these variables have been deflated by the Producer Price Index.

Appendix 2

Fig.1
Employment Growth Rate Density

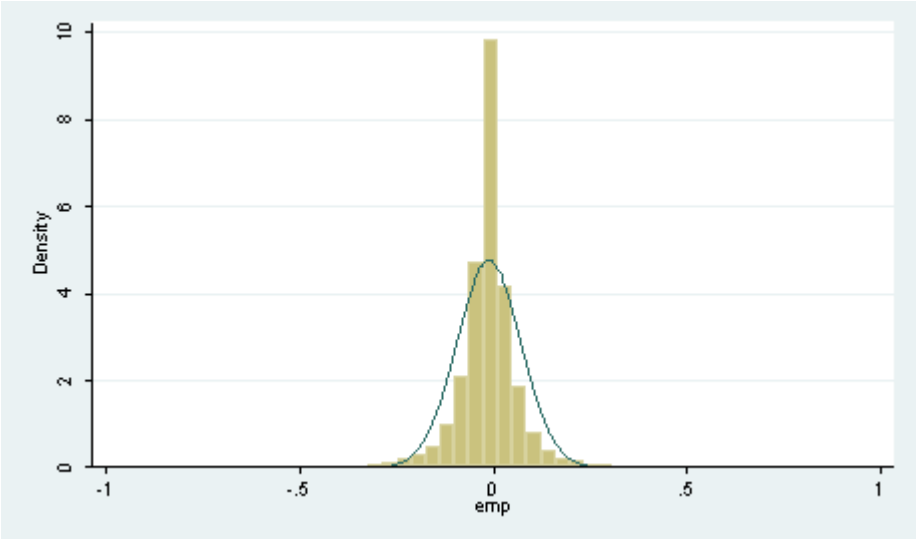


Fig.2
Investment Rates Density

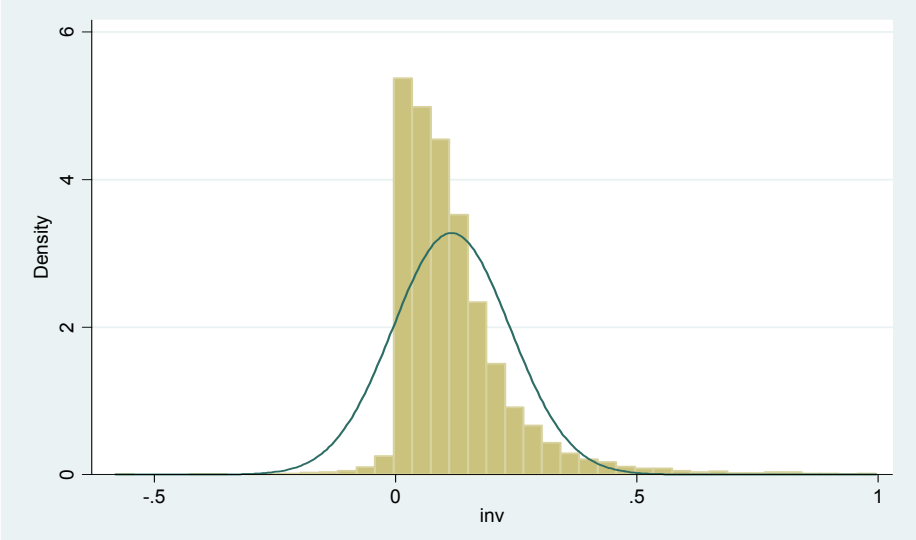


Fig.3
Poseg, Noseg and Spike Percentage for 4 thresholds

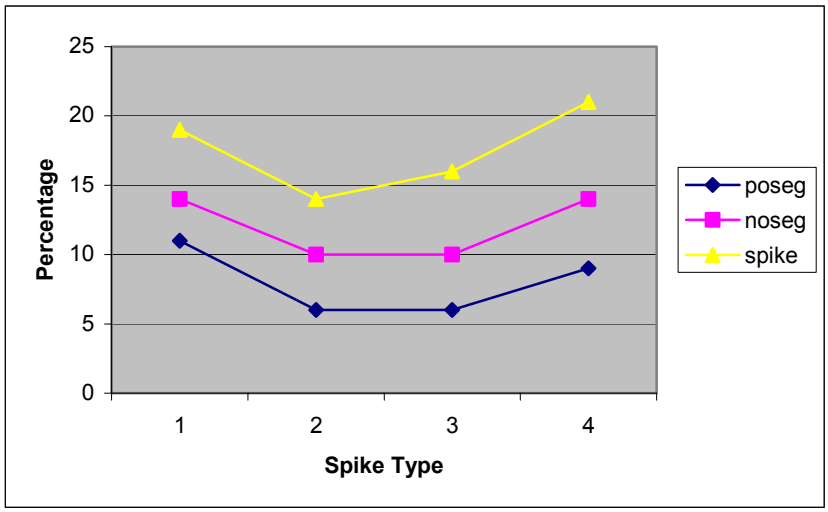
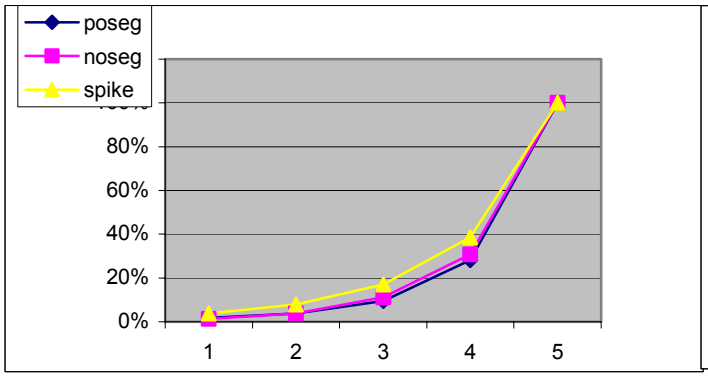
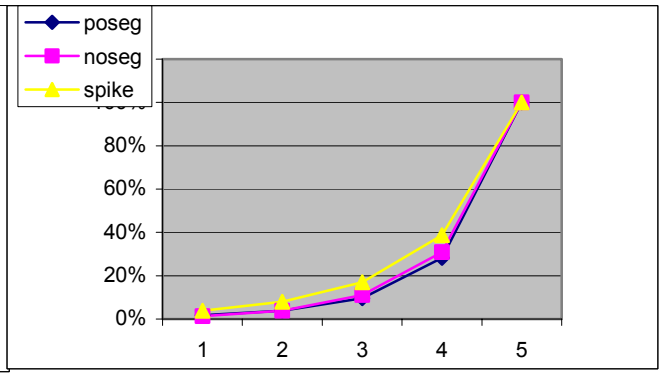


Fig.4
Investment and Employment Spike Persistence over 4 periods (using 4 threshold types)

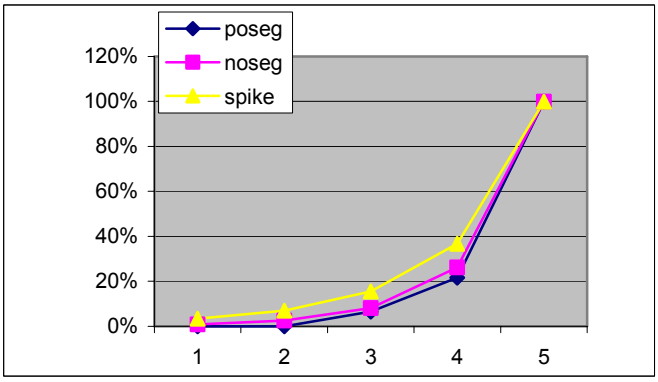
1st type



2nd type



absolute type



Combined type

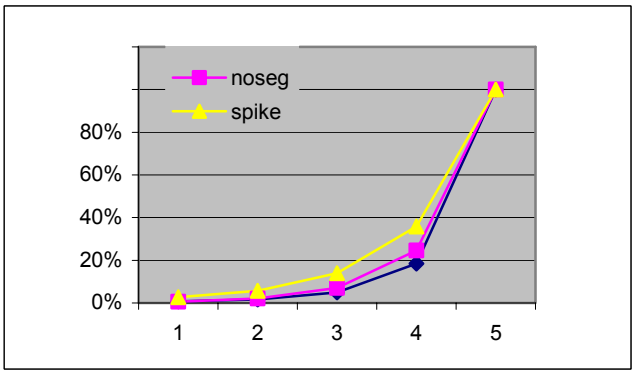
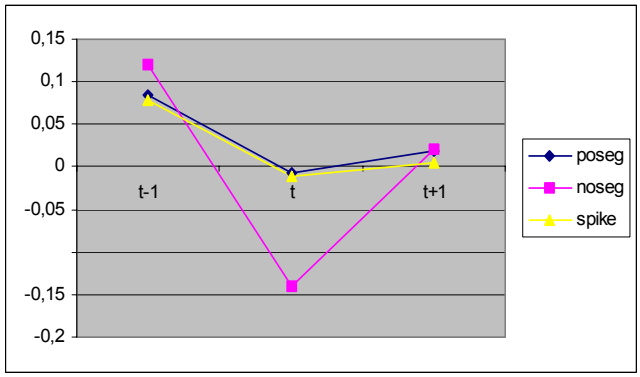


Fig 5
Employment growth rate evolution before, during and after employment and capital spikes (using four thresholds)

1st type



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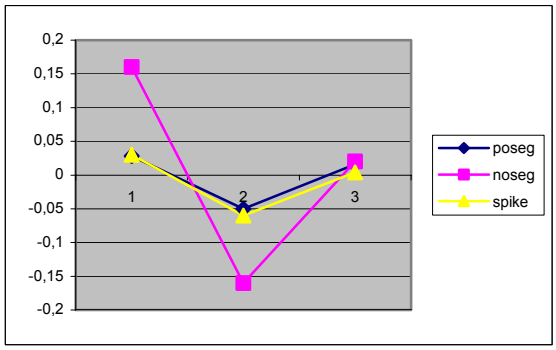
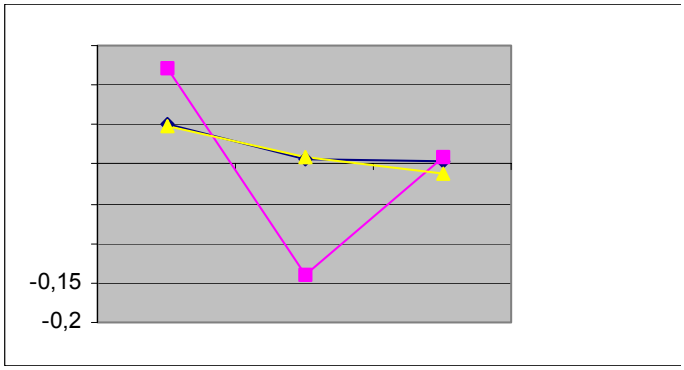


absolute type



Combined type

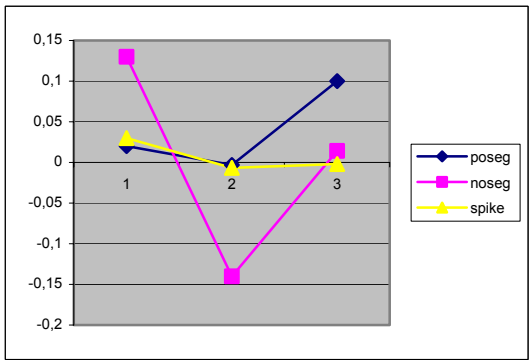
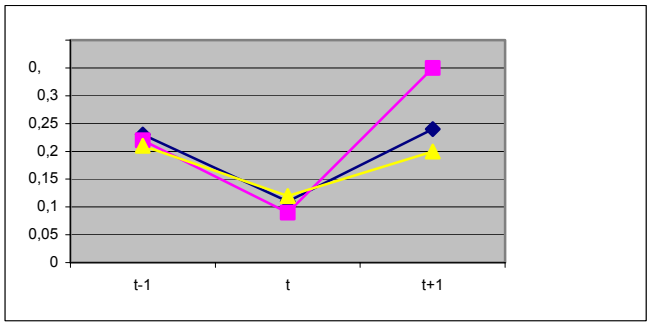
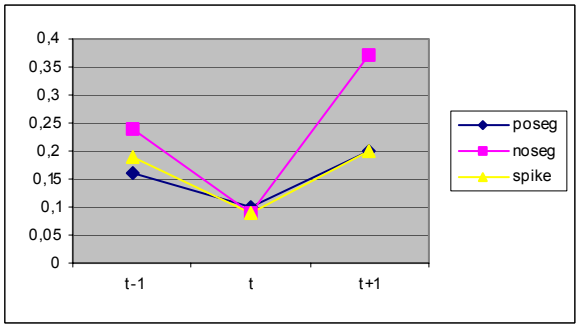


Fig 6
Investments rate evolution before, during and after employment and capital spikes (using four thresholds)

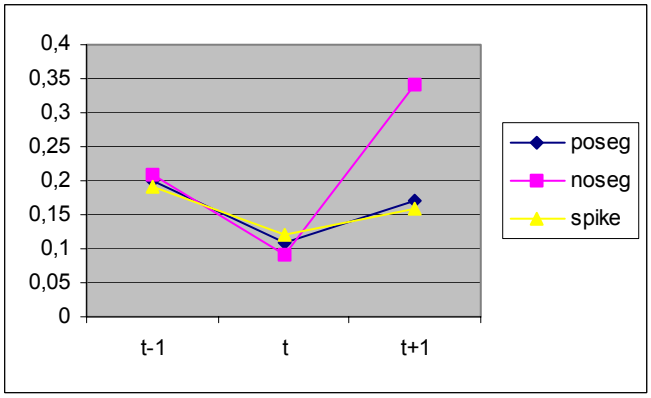
1st type



2nd type



absolute type



Combined type

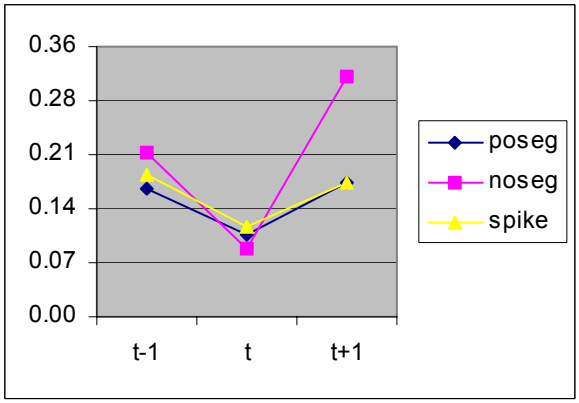
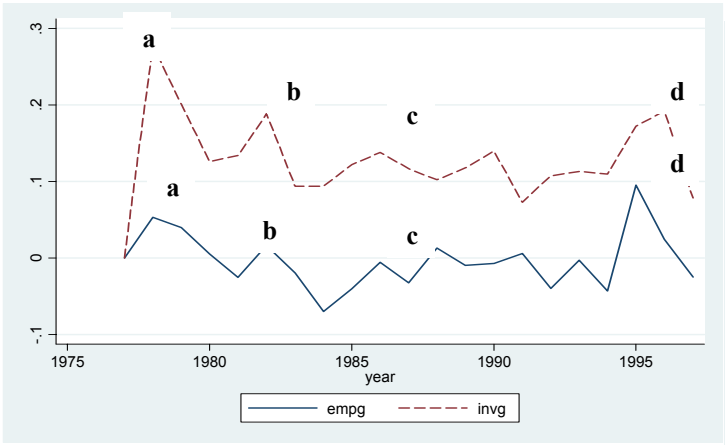
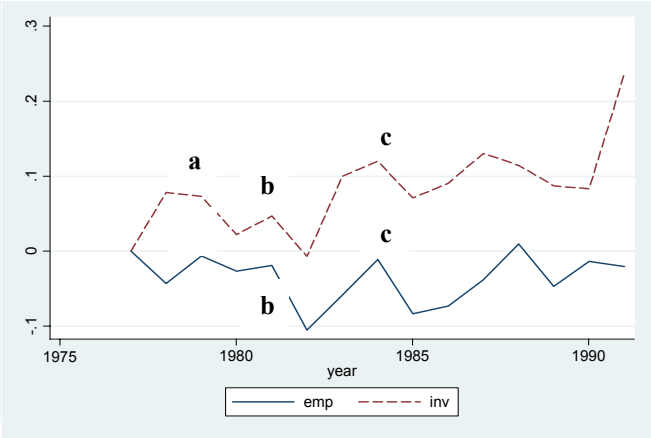


Fig. 7
Simultaneous interrelationships cases

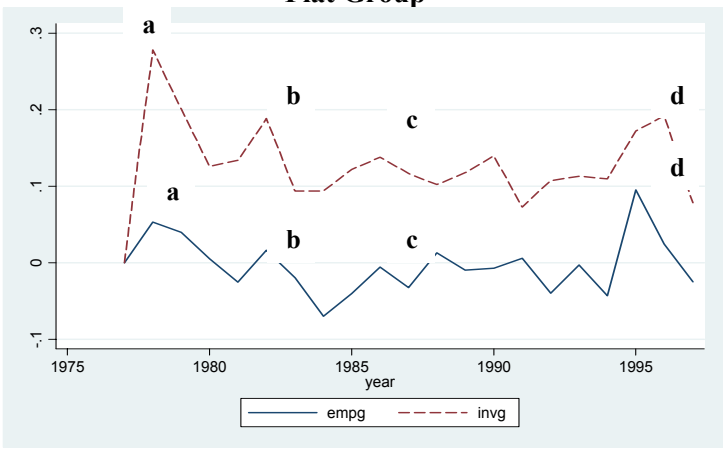
Procter&Gamble



Colgate



Fiat Group



Recordati Industria Chimica e Farmaceuticha

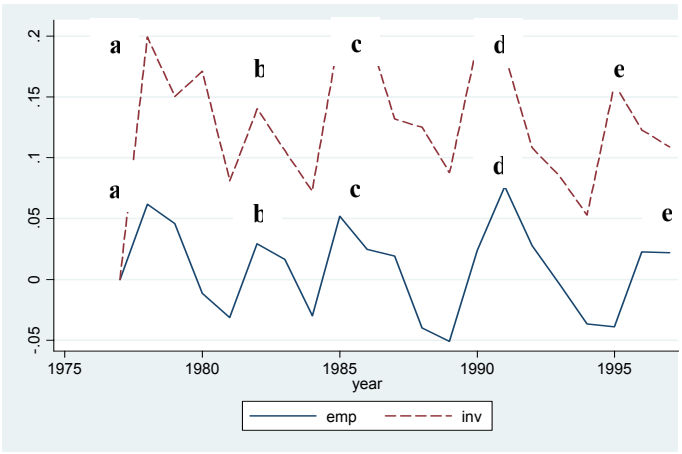
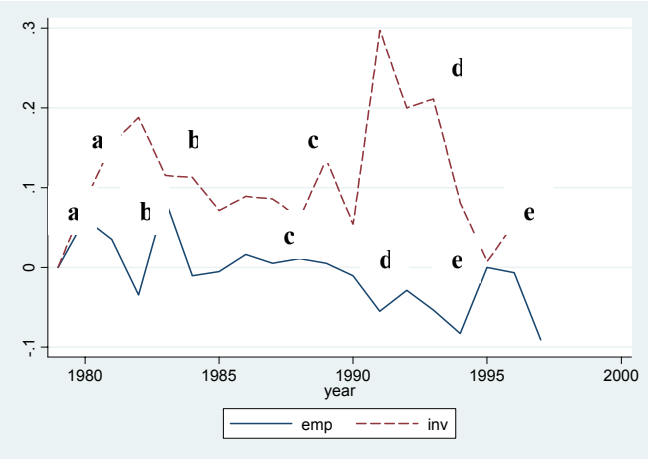


Fig 8
Cases with Hiring spike in advance of investment spike

ISTITUTO DELLE VITAMINE



SANDVIK ITALIA

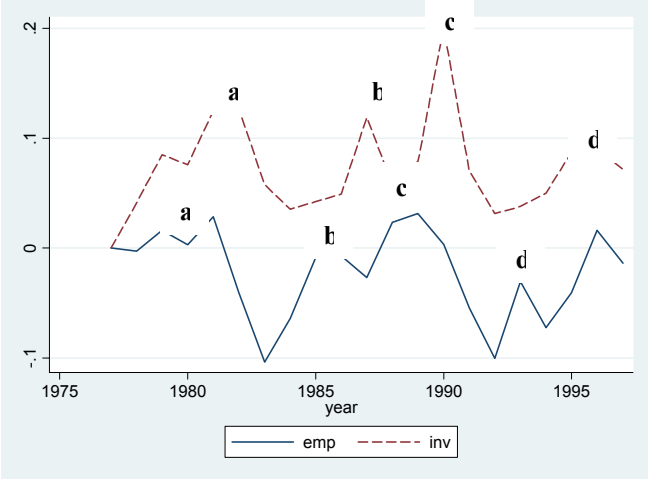
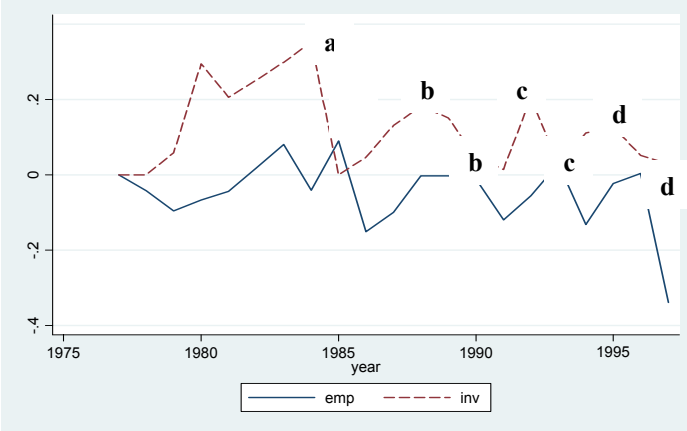


Fig 9
Cases with Investment spike in advance of hiring spike

SELEZIONE DAL READER'S DIGEST



Mondadori

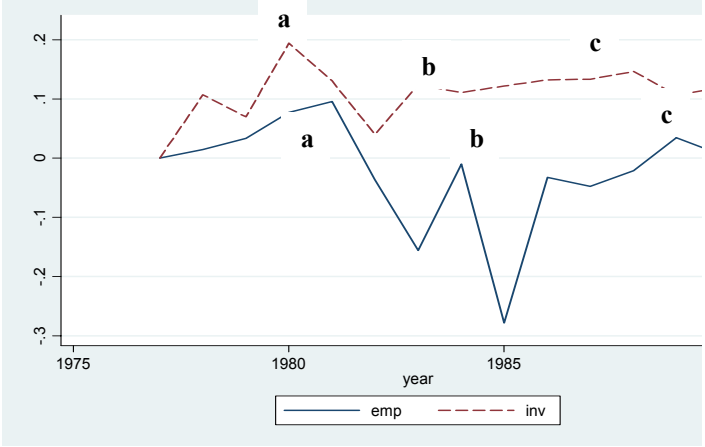


Table 1
Observations of Investments, Hiring and Firing Spikes

Notes: Spike, Poseg and Noseg denote investments, hiring and firing spikes respectively.

Variables	Observations			
	1st type Relative spikes (for each firm)	**2nd type Relative spikes (for all firms)**	**Absolute Spikes**	**Combined spikes (2nd type&absolute)**
Spike	2903 (19%)	2171 (14%)	2504 (16%)	3261 (21%)
Poseg	1634 (11%)	923 (6%)	968 (6%)	1410 (9%)
Noseg	2140 (14%)	1503 (10%)	1598 (10%)	2136 (14%)

Table 2
Investment and Disinvestment Statistics

Variable	Observations (percentage)	Mean	Std. Dev.	Min	Max
Disinvestments	330 (2.2%)	-.062	.077	-.58	-.000016
Investments	15120 (97.8%)	.12	.11	0	0.99

Note: Disinvestments denotes the negative investment rates; Investments denote the positive investment rates.

Table 3
Employment Reduction and Expansion Statistics

Variable	Observations (percentage)	Mean	Std. Dev.	Min	Max
Firing	7819 (51%)	-.062	.077	-.807	-.0003
Hiring	7631 (49%)	.04	.06	0	.71

Note: Firing denotes the negative employment growth rates; Hiring denote the positive employment growth rates.

Table 4
Employment Growth Pattern Before, During and After Employment and Capital Adjustment Processes

Employment Growth Rate	Poseg At time t	Noseg At time t	Spike At time t
At time t-1	0.084 (0.082) 918 0.05 (0.05) 511 0.028 (0.10) 969 0.02 (0.09) 1216	-0.007 (0.08) 4515 0.007 (0.075) 4069 -0.05 (0.10) 1599 -0.003 (0.08) 4492	0.018 (0.08) 2412 0.003 (0.08) 1814 0.016 (0.08) 2585 0.10 (0.08) 3223
At time t	0.12 (0.08) 1634 0.12 (0.10) 923 0.16 (0.09) 9690 0.13 (0.09) 1411	-0.14 (0.08) 2140 -0.14 (0.10) 1503 -0.16 (0.09) 1598 -0.14 (0.09) 2136	0.02 (0.09) 2943 0.008 (0.98) 2234 0.02 (0.09) 2586 0.014 (0.098) 3337
At time t+1	0.078 (0.072) 932 0.047 (0.05) 545 0.03 (0.11) 866 0.03 (0.10) 1125	-0.012 (0.10) 3308 0.009 (0.08) 2877 -0.06 (0.10) 1298 -0.0065 (0.98) 3276	0.004 (0.08) 2647 -0.0107 (0.08) 1981 0.004 (0.08) 2364 -0.002 (0.88) 3007

Table 5
Investment Pattern Before, During and After Employment and Capital Adjustment Processes

Investment Rate	Poseg At time t	Noseg At time t	Spike At time t
At time t-1	0.23 (0.29) 918 0.20 (0.24) 511 0.16 (0.22) 969 0.17 (0.22) 1216	0.11 (0.27) 4515 0.11 (0.27) 4069 0.10 (0.15) 1599 0.11 (0.26) 4492	0.24 (0.41) 2412 0.17 (0.19) 1814 0.20 (0.41) 2585 0.18 (0.37) 3223
At time t	0.22 (0.43) 1634 0.21 (0.22) 923 0.24 (0.51) 969 0.22 (0.44) 1411	0.09 (0.15) 2140 0.09 (0.11) 1503 0.09 (0.16) 1598 0.09 (0.15) 2136	0.35 (0.41) 2943 0.34 (0.47) 2234 0.37 (0.43) 2586 0.32 (0.39) 3337

At time t+1	0.21 (0.19) 932 0.19 (0.17) 545 0.19 (0.18) 865 0.19 (0.17) 1125	0.12 (0.17) 3308 0.12 (0.18) 2877 0.09 (0.20) 1298 0.12 (0.17) 3276	0.20 (01.7) 2647 0.16 (0.17) 1981 0.20 (0.18) 2364 0.18 (0.17) 3007

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Table 6
Percentage of Investment and Employment using 4 thresholds definitions

		Spike		**Spikes**		**Spike1**		**Spike3**	
		0	**1**	**0**	**0**	**1**	**1**	**0**	**1**
Poseg	**0**	74.99 81.56 80.03 73.55	14.43 12.47 13.70 17.32	88.78 93.90 93.61 90.67	0.65 0.12 0.13 0.21	75.35 82.23 80.18 73.98	14.08 11.80 13.55 16.89	77.27 83.40 78.98 72.97	12.16 10.63 14.76 17.90
	1	6.22 4.39 3.76 5.34	4.36 1.59 2.50 3.79	10.50 5.96 6.25 9.09	0.07 0.01 0.01 0.03	7.42 4.94 4.52 6.53	3.16 1.03 1.75 2.60	7.17 4.93 4.29 6.15	3.41 1.04 1.97 2.98
Noseg	**0**	69.04 77.30 74.47 67.23	17.11 12.97 15.18 18.94	85.75 90.17 89.97 86.02	0.40 0.10 0.08 0.16	71.00 78.87 75.67 69.43	15.15 11.40 13.99 16.74	71.88 79.40 73.72 66.98	14.27 10.87 15.94 19.20
	1	12.17 8.65 9.32 11.66	1.68 1.08 1.02 2.16	13.53 9.69 10.28 13.74	0.32 0.04 0.06 0.08	11.77 8.30 9.03 11.08	2.08 1.43 1.31 2.74	12.56 8.93 9.55 12.14	1.29 0.80 0.79 1.68

Table 7
Estimated Coefficients of Interrelationships between Labor and Capital Adjustments Processes

Employment and investment spikes	**Investment Spike (time t-1)**	**Investment Spike (time t)**	**Investment Spike (time t+1)**
Probability of hiring (time t)	(+) - R&D - chemical[33] - metal[34] - mechanic and machineries [35]	(+) Significant for all firms except[36] - metal sector - data processing machines	(+) - printing and publishing[37]

[33] Instituto delle vitamine, L'oreal
[34] Euroallumina

	- Electric - Transportation vehicles - Precision instruments - Small national group - MNEs - Older than 25 years	- leather	

Appendix 3

Tables of firms statistics

Table 8
(Location)

L n	*Firm numb*
N	*8*
So	*6.7*
Ce	*6.5*

Table 9
Firms' Age[38]

Less than 10 years (firms)	*From 11 to 25*	*From 25 to50*	*More than 50 y*
22	*28.2*	*28.8*	*21*

[35] Such as firms Sandvik Italia
[36] As Recordati Industria Chimica e Farmaceuticha, Procter&Gamble, Colgate, Fiat Group etc
[37] As Selezione Dal Reader's Digest, Mondadori etc.
[38] The age variable is generated as the deviation of the foundation year variable from year 1977 which is the initial year of our data.

Table 10
(Industry group)

"Istat" gro	*Firm percentage*
(Metals)	*6*
Ist (Non- Me)	*7*
(Chem	*12*
(Artificial Fibres)	*1*
Ist31 (Metal products)	*6*
Ist32 (Mechanic machineries and materials)	*11*
Ist33 Data Processing machineries	*0.4*
Ist34 (Electric machinery and apparatus)	*12*
Ist35 (Auto vehicles)	
Ist36 (Other transport equip	*3*
Ist37 (Precision instrum	*1*
Ist41 (Food)	*8*
Ist42 (Other food and beverage)	*6*
Ist43 (Textiles)	*7*
Ist44 (Leather and leather products)	*0.6*
Ist45 (Clot	*5*
Ist46	*1*
Ist47	*6*
Ist48 (Plastics & Rubber)	*3*
Ist49 (Miscellaneous)	*1*

Table 11
(Ownership type)

Ownership type	*Firms num (in %)*
Public	*9.1*
ational group	*8.*
Member of "medium" national group	*4.6*
of "small" national group	*17*
Filial of foreign multinational	*26.1*
nt	*34.2*

Table 12
Product Homogeneity

	Firms numbe
R&D	*33*
Advertising	*13*
No R&D	*39*
R&D & Advertising	*13.4*

Table 13
Firm Size

Less th	*From 500 to 1000*	*From 1000 to 1500*	*More than 1500*
60.8	*22.7*	*7.6*	*8.9*

Table 14
Unemployment rates in Italy during the period 1977-1997

Year	*Unemployment ra (in percent)*
197	*7.2*
	7.2
1	*7.7*
	7.6
1981	*8.4*
	8.
1983	*9.*
1984	*10*
1985	*10*
198	*11.1*
1987	*12*
1988	*12*
1989	*12*
1990	*11*
1991	*10.9*
1992	*11.5*
1993	*10.2*
1994	*11.3*
1995	
1	*12*
199	*12.2*

Source: COMPARATIVE CIVILIAN LABOR FORCE STATISTICS (U.S Department of Labor, Bureau of Labor Statistics