Interrelationships Between Labor and Capital Adjustment Decisions

Edlira Narazani

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Abstract

This paper intends to provide empirical evidence on the interrelationship between employment and capital adjustment. I employ a dynamic logit model to estimate this interrelationship using a data set of huge Italian firms. I find that these firms tend to hire a substantial number of employees during an investment spike episode. But when I consider the firms across industry sectors, ownership type and other groupings, I find that there are some firms eager to hire workers only during an investment spike and others eager to hire employees only after the investment spike. Also I try to extend the "augmented adjustment-cost function" for employment and capital and allow the inaction range of employment (capital) adjustment to capture the effect of capital (employment) in a linear way. Another aim of this paper is to investigate the trend of productivity growth rates in the presence of huge labor and capital adjustments. I, then, find that firms are more eager to hire a substantial number of employees in the same time that the productivity growth rates decrease. With respect to the firing spikes, decreasing labor productivity is followed by higher probabilities of substantial firing in the next period. With respect to investment, significant positive correlations exist between the probabilities of current investment spikes and the productivity growth rates at the next period. Finally, I find that old firms seem less inclined to hire substantially employees and more inclined to have investment spikes.

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Introduction

The economic literature on adjustment processes of the most important determinant of production function fully 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[2] due to uncertainty and irreversibility conditions. Their reluctance lasts until the underlying deviations of the actual capital stock from the optimal one reaches a certain threshold, which is imposed by the demand and the degree of irreversibility and uncertainty.

The literature of labor markets[3] recognizes the sluggish behavior of adjustment process also, and the traditional justification is that the employment fluctuation is accompanied by adjustment costs. For that reason, firms do not choose the optimal employment level, but instead, they hire or fire as much as the previous optimal and real level of employment in addition to the present ones could indicate. This results in a nonlinear pattern of employment fluctuation in contrast with the earlier model of linear adjustment based on standard quadratic adjustment costs.

These 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

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[2] See Ricardo Caballero (1999) for an overview of this topic.

[3] See Hamermesh and Pfann (1996) have prepared an essay about the adjustment cost in factor demand introducing all the forms the adjustment costs would theoretically take and drawing the conclusion that employment adjustment at firm level is slow and not characterized by symmetric quadratic costs. This could provide a good reason to give up using the quadratic adjustment cost for studying the behavior of employment fluctuation. But on the other side, this renouncement could make difficult the aggregation process across firms in opposition to the smooth quadratic adjustment cost could be able to do. See also Caballero and Engel (1993), Caballero, Engel and Haltiwanger (1997), Cooper, Haltiwanger and Power (1999), Nilsen and Schiantarelli (2001) and Letterie and Pfann (2000) and Hamermesh (1989,1992), Rota (1995), Abowd and Kramarz (1997), Cambell and Fisher (2000) and Goux, Maurin and Paucet (2001).

investment and employment is known in the economic literature as interrelation. Nadiri and Rosen (1969, 1973) constructed the first model on 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[4] (1998) show that when employment decision depends on capital stock, employment may perform in the same lumpy way as investment. Sakellaris (2001) 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)[5] 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 huge adjustments, b) to extend the "augmented adjustment-cost functions" for employment (capital) by incorporating the effect of inaction range of capital (employment), c) to capture any link between hiring, firing and investment spikes decisions by employing a discrete choice model such as dynamic logit, and finally d) to check how growth rates of labor productivity will affect these adjustment decisions at capital and employment level.

This paper is organized as follows. Section II will shed light on the descriptive statistics of employment adjustment and investment spikes. Section III will try to extend the well known "augmented adjustment-cost function" taking into account the interrelationship between factors. Section IV will deal with a dynamic logit modeling and comments on estimation results. Section V will conclude.

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[4] 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.

[5] See Letterie, Pfann and Polder (2001), "Investment Spikes and Labor Demand"

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"). All firms with missing observations are excluded from this data set to render the panel balanced. Thus, the remaining panel is actually composed of 33 firms over the period 1977-1997. It is very probable that because of this "cleaning" process the remaining data set is biased towards big and successful firms. This data set provides firm-level information with respect to firms' primary industry, ultimate ownership, group affiliation, location, foundation year, Istat group, and business activity[6] and sectoral data for the firm's primary industry (e.g. production and price indexes, turnover etc.). Also it sheds light on the main firm's activity variables as employment, labor costs[7], sales, value added, fixed investment[8], stock of capital at replacement cost[9]. To get a better idea about the distribution of firms across age groups and locations I show some descriptive tables[10]. These data are provided on an annual basis and therefore probably this time aggregation could disguise 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 huge investment during a certain year, I make use of several definitions nevertheless the overall 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

[6] For a better data description see working paper N.5/2001 "Il Nuovo Panel Ceris su Dati di Impresa 1977-1997", Benfratello, Margon, Rondi, Sembenelli, Vannoni, Zelli and Zittino.

[7] Labour costs are calculated as the sum of nominal wages and firing costs and consequently I cannot spell out them separately.

[8] The Appendix 1 shows how missing values of stock of capital and investment are constructed.

[9] This variable has been computed using perpetual inventory technique.

[10] Also a table with some main statistics of employment, capital, investment, employment growth rate and investment rate is shown at the Appendix 3 taking into account the overall, within and between effect.

times the median of investment rates. Following Cooper, Haltiwanger and Power (1999)[11] an observation is called an absolute investment spike if the investment rate exceeds 20 percent. On the other hand, to check for employment spikes[12], Sakellaris (2001) define an observation as a positive[13] employment spike if the current adjustment rate of employment exceeds 10 percent and the past rate does not exceed 10 percent, and as negative[14] employment spike if it is less –10 percent at the current period and more than –10 percent at the precedent period. Power[15] 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. Therefore I intend to use some of these definitions mentioned above and, then opt for estimated coefficients which get significant[16] for no less than 3 spike definitions.

The figures 1 and 2 show the plots of the cumulative distribution function 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 very few 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 much less pronounced than for the investment rates. However, the graph of employment growth rates density exhibits some skewness towards the negative side as there are much more values of negative rates.

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[11] See Cooper, Haltiwanger and Power (1999), “Machine Replacement and the business cycle: lumps and bumps,”

[12] Letterie and Pfann 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.

[13] A positive employment spike corresponds to the hiring process.

[14] A negative employment spike corresponds to the firing process.

[15] See Laura Power (1998), “The missing link: technology, investment and productivity”.

[16] See Section IV to understand this selection criterion.

Fig.1

Investment Rates Density

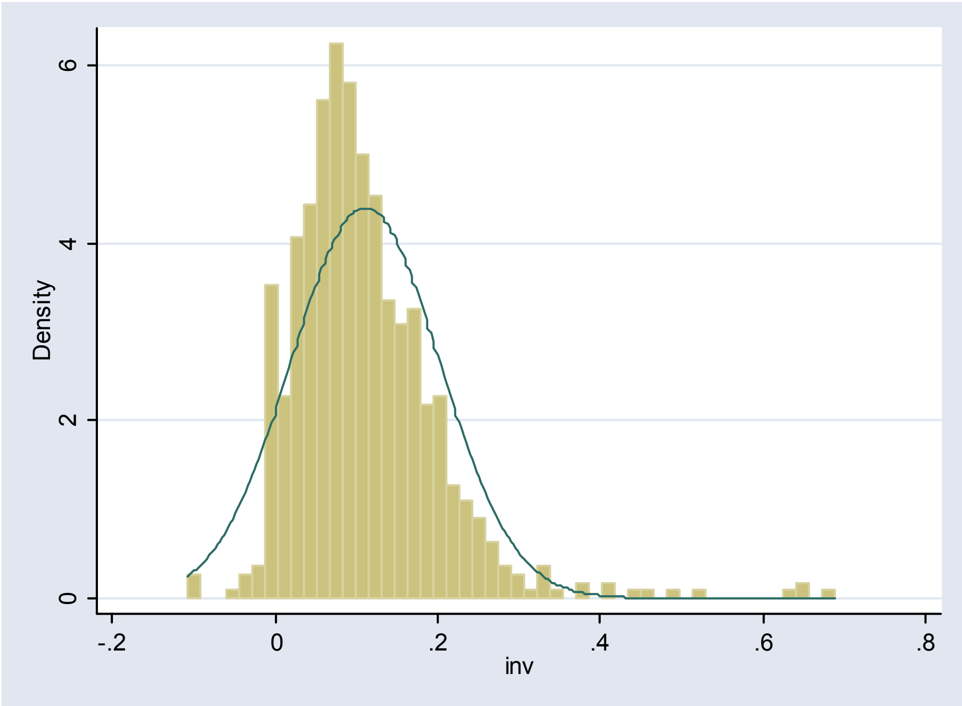
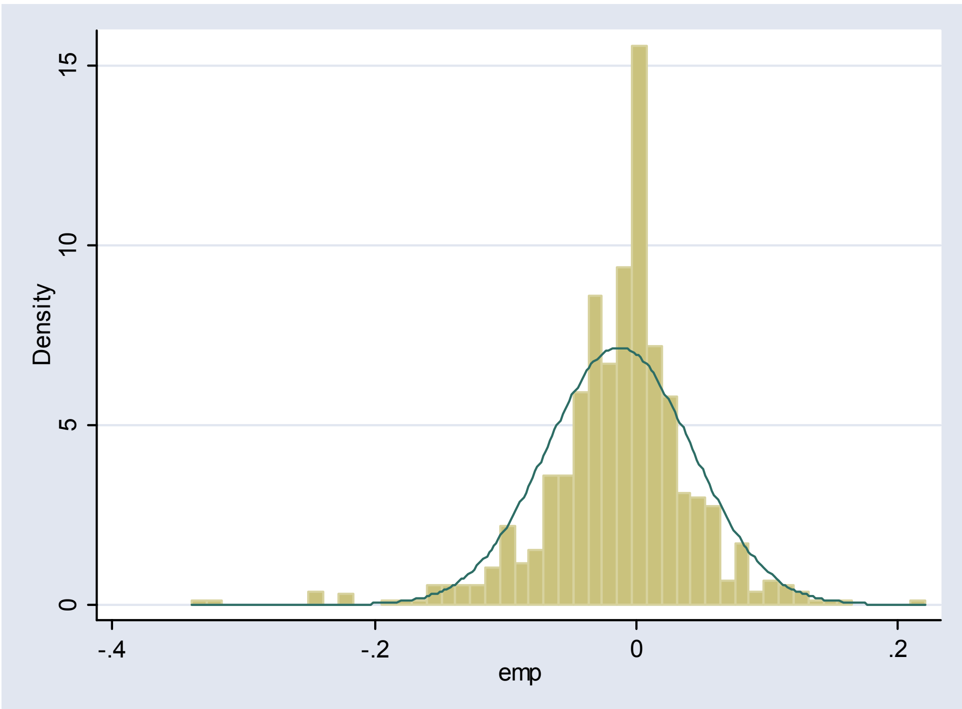


Fig.2

Employment Growth Rates Density



The following table shows the number of observations of huge investments episodes (denoted as Spike), huge positive employment adjustment episodes (denoted as poseg) and huge negative employment adjustment episodes (denoted as noseg) for 4 different ways of spike definition. In the 1st type, an observation is called investment (employment) spike when it is bigger than 1.75 times the median of the investment (employment growth) rates. In the 2nd type, an observation is called spike if it exceeds 1.75[17] times the median of investment (employment growth) rates in overall. The absolute investment spike denotes the observations which have an investment rate bigger than 0.2 and the absolute employment spike denotes the observations with employment growth rate 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 or the 1st type threshold.

As the Table 1 suggests, there are 19.48 percent of observations with investment spikes in case of the combined spike definition and only 12 percent of observations in case of the absolute definition (for the US data[18] used by Cooper and Haltiwanger (2003), there are almost 18 percent of observations denoting investment rates higher than 0.2). A higher discrepancy is noticed with respect to the substantial hiring episodes. So, there are 9.81 percent of the observations generated as positive employment spikes in case of the combined type, in spite of 2.6 percent ones in case of the absolute type. With respect to the negative employment spikes, the picture does not change a lot with spikes definitions; there are 12.69 percent negative employment spikes generated by the combined thresholds, in spite of 7.5 percent ones generated with absolute threshold. It seems that the combined type of spikes (using either relative or absolute spikes) makes the huge differences between the relative spikes and absolute spikes smoother. The absolute spikes generated with thresholds suggested by Haltiwanger, Power, Sakellaris and others allow for very few cases of employment and capital adjustments. This could be explained partially by the huge dissimilarities existing between the Italian data and US data with respect to the investment and employment growth rates.

[17] The 1.75 criterion could be changed for the firing case, but I don’t see any reason to discriminate the firing spikes.
[18] See Cooper and Haltiwanger (2003), “On the nature of capital adjustment cost”

Table 1
Observations of spikes, poseg and noseg using different thresholds

Variables	Observations			
	1st type Relative spikes (for each firm)	**2nd type Relative spikes (for all firms)**	**Absolute Spikes**	**Combined spikes (1st type& absolute)**
Spike	110 (15.87%)	111 (16.01%)	83 (12%)	135 (19.48%)
Poseg	63 (9.09%)	84 (12.12%)	18 (2.6%)	68 (9.81%)
Noseg	83 (12%)	103 (14.86%)	52 (7.5%)	88 (12.69%)

Tables 2, 3 and 4 display some descriptive statistics with respect to the investment and employment growth rates. The average employment growth rate is about –1.27 percent, with a small negative skewness (median –0.607 percent). In case that the absolute spike definitions are employed, when firms invest substantially, the average employment growth rate becomes strictly positive at about 1.77 percent and positively skewed (median 1.257 percent). In case of hiring, the employment growth rate is 12.17 percent on average and decreases with almost 1.5 percent in case of current investment spikes, but increases with 0.10 percent in case of future investment spikes. In case of firing, the average employment growth rate is about –13.9 percent and there are no observations in case of investment spikes and negative employment spikes. In case that the combined spike definitions are used, the employment growth rates get smaller (in absolute value) on average, compared to the case of absolute definition because there are more observations contributing in this average.

Table 2
Descriptive Statistics for Employment Growth rates using absolute spikes

Employment Growth Rate	Total mean (median)	Spike = 0 Mean (median)	Spike = 1 Mean (median)	Spike1 = 1 Mean (median)	Spike3 = 1 Mean (median)
$(\Delta E/E)_t$	-.0127695 (-.006079)	-.0169215 (-.007691)	.0177452 (.0125788)	.0003281 (.0071814)	.0126451 (.0079823)
$(\Delta E/E)_t$	.1217059	.1307571	.1074826	.1032522	.1227976

(in case of Poseg)	(.1140994)	(.1224934)	(.1056537)	(.1035923)	(.123556)
$(\Delta E/E)_t$ (in case of Noseg)	-.1390777 (-.1162949)	-.1390777 (-.1162949)	*[19]	-.1365269 (-.1509231)	-.1104545 (-.1059814)

Abbreviations: $(\Delta E/E)_t$ denotes the employment growth rate at time t; Poseg denotes the positive employment spike at time t; Noseg denotes the negative employment spike at time t; Spike means absolute investment spike at time t; Spike1 means investment spike at time t-1; Spike3 means investment spike at time t+1.

Table 3

Descriptive Statistics for Employment Growth rates using combined spikes

Employment Growth Rate	Total mean (median)	Spike = 0 Mean	Spike = 1 Mean	Spike1 = 1 Mean	Spike3 = 1 Mean
$(\Delta E/E)_t$	-.0127695 (-.006079)	-.0177236 (-.007722)	.0071549 (.0020587)	-.0035509 (-.0038352)	.0050226 (0)
Poseg	.0709 (.058127)	.063121 (.0547467)	.0842799 (.0800427)	.0849206 (.0791678)	.0768794 (.0646932)
Noseg	-.1056773 (-.097886)	-.1076984 (-.0983223)	-.0899123 (-.0706302)	-.0815837 (-.0751206)	-.0781265 (-.0877056)

Abbreviations: $(\Delta E/E)_t$ denotes the employment growth rate at time t; Poseg denotes the positive employment spike at time t; Noseg denotes the negative employment spike at time t; Spike means absolute investment spike at time t; Spike1 means investment spike at time t-1; Spike3 means investment spike at time t+1.

Table 4 shows some summary statistics of investments and disinvestment rates for the sample in use. There are very few (2.16%) observations with negative investment rates and this is in line with the irreversible feature of investment. In addition, this disinvestment rates are very tiny in absolute value. Table 5 shows that, using the absolute spike definitions, the average investment rate is around 11.07 percent (with a 9.5 percent median implying a positive skewness). It increases up to 20.11 percent in case of hiring and decreases down to 6.7 percent in case of firing. The average investment rate in case of current investment spikes is much higher that the overall average, reaching about 28.25 percent, and, when positive employment spikes are contemporaneously occurring, it reaches 33.39 percent.

[19] There are no observations in case of negative employment spikes and investment spikes.

Table 4

Investment and disinvestment statistics

Variable	Observations (percentage)	Mean	Std. Dev.	Min	Max
Disinvestments	15 (2.16%)	-.0375429	.0361455	-.1069872	-.0005448
Investments	678 (97.84%)	.1139994	0887059	0	.6882712

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

Table 5

Descriptive Statistics for Investment Rate using absolute definitions

Investment Rate	Total mean (median)	Poseg = 0	Poseg = 1	Noseg = 0	Noseg =1
$(I/K)_t$	.1107193 (.0953775)	.1083074 (.093971)	.201164 (.1729119)	.1142578 (.0980839)	.0670998 (.0654786)
$(I/K)_t$ in case of Spike	.2825266 (.2430497)	.2777892 (.2426637)	.3339613 (.2657385)	.2825266 (.2430497)	*[20]
$(I/K)_t$ in case of Spike1	.1739408 (.1644962)	.1640235 (.161767)	.3698088 (.3687675)	.1796684 (.1682121)	.0845901 (.0703045)
$(I/K)_t$ in case of Spike3	.1620268 (.1493438)	.1605222 (.1479144)	.1917438 (.1764033)	.1666409 (.1582948)	.0900474 (.0758583)

Abbreviations: $(I/K)_t$ denotes the investment rate at time t.

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 absolute spikes definitions are employed. With respect to the simultaneous combinations, it is obvious that the periods with neither investment nor positive employment spikes are most frequent (86.4 percent) and, the periods with

[20] There are no observations in case of negative employment spikes and investment spikes.

investment spikes and no positive employment spikes come next (10.96 percent). The periods with both investment and positive employment spikes are less observed (1.01 percent). 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. Table 7 shows the same distribution of frequencies in case of using the combined type of spikes instead of the absolute type. It is obvious that the high discrepancies of the investment and employment spikes frequencies observed in the Table 6, get smoothed in the Table 7. This is due to the inclusion of much more employment and capital adjustment episodes in the later case.

Table 6
Frequencies of investment and employment absolute spikes (standard errors in brackets)

		Spike		Spike1		Spike3	
		0	**1**	**0**	**1**	**0**	**1**
Poseg	**0**	.8643579 (.3426555)	.1096681 (.3127013)	.8585859 (.3486999)	.1139971 (.3180373)	.8585859 (.3486999)	.1139971 (.3180373)
	1	.015873 (.1250745)	.010101 (.1000671)	.020202 (.1407924)	.005772 (.0758089)	.020202 (.1407924)	.005772 (.0758089)
Noseg	**0**	.8051948 (.3963367)	.1197691 (.3249259)	.8109668 (.3918178)	.1125541 (.3162752)	.8109668 (.3918178)	.1125541 (.3162752)
	1	.0750361 (.2636398)	0 (0)	.0678211 (.2516202)	.007215 (.0846953)	.0678211 (.2516202)	.007215 (.0846953)

Abbreviations: Noseg denotes the negative employment spike at time t; Spike means absolute investment spike at time t; Spike1 means investment spike at time t-1; Spike3 means investment spike at time t+1.

Table 7
Frequencies of investment and employment combined spikes (standard errors in brackets)

		Spike		Spike1		Spike3	
		0	1	0	1	0	1
Poseg	**0**	.7431457 (.4372139)	.1587302 .3656882	.7287157 .4449436	.1717172 .3774068	.7388167 .4395969	.1616162 .3683642
	1	.0620491 .2414189	.036075 .1866116	.0750361 .2636398	.023088 .1502916	.0649351 .2465892	.033189 .1792593
Noseg	**0**	.6926407 .4617328	.1803752 .3847774	.7012987 .4580192	.1702742 .376145	.6984127 .4592785	.1731602 .378659
	1	.1125541 .3162752	.01443 .1193413	.1024531 .3034623	.024531 .1548026	.1053391 .3072116	.021645 .1456266

Abbreviations: Noseg denotes the negative employment spike at time t; Spike means absolute investment spike at time t; Spike1 means investment spike at time t-1; Spike3 means investment spike at time t+1.

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 in the employment and in capital. 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 put forward 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. They show that this quasi-fixity of capital can give rise to labor hoarding, even when labor is considered as a purely flexible factor[21].

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[22] and capital[23] adjustment, the linear, convex and fixed cost should be all considered. Assuming that the linear, convex and fixed part of the 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 can be given as:

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

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

where	$C(E)$ and $C(K)$ denote	:	Adjustment cost of Employment & Capital
	E	:	Employment,
	ΔE	:	Employment adjustment
	K	:	Capital
	I	:	Investment

[21] See Abel A and Eberly. J. (1998) "The Mix and Scale of Factors with Irreversibility and Fixed Costs of Investment".

[22] Total costs of adjusted employment are assumed to be compound of 3 elements: the linear part which is linear with respect to the employment change and measures the wage and salvage payments; the convex part which is related to the immeasurable costs; and the fixed costs which are related to the search and training activities.

[23] Total costs of investment are assumed as composed of three parts: the linear costs, which are proportional to the investment such as the price of capital itself. 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. The second element is the convex part as in traditional q-theory. The third component may be fixed cost of investing that does not depend on the level of investment, though it may depend on the sign of investment. (See Abel, A.B. and J.C. Eberly (2002), "Investment and q with fixed costs: An empirical analysis").

Coefficients α_E and α_K measure : Convex costs

Coefficients p_E and p_K capture : Asymmetric nature of the costs

Coefficients F_E and F_K measure : Fixed costs

Economic theories are based on the strong assertion that firms follow a profit maximizing behavior 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:

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

$$4) \qquad q_K \geq \frac{C(K)}{I} \Rightarrow I > 0$$ [24]

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[25] of employment and capital can be specified as:

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[24] 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.

[25] The optimal level of adjustment is taken considering the equality part of inequalities conditions and under zero fixed costs.

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

and therefore considering the optimal values of adjusted employment and investment, the inequalities (3) and (4) can be transformed[26] as[27] :

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

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 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 cost.

The model developed so far is well-known in the literature of adjustment costs. As this paper aims to study the relationship between the investment and labor adjustments, I assume that employment is present in the costs function of capital adjustment and vice versa as follows:

$$
(8) \qquad IR_E = IA_E + \beta_E IR_K
$$
$$
IR_K = IA_K + \beta_K IR_E
$$

where IR_E and IR_K denote the new inaction frontiers for employment and capital adjustment including the effect of other factor demand respectively. The coefficients β_E

[26] The same transformations can be performed in case of firing.

[27] The inequalities (7) are derived by replacing the employment and capital variables with its optimal values at the inequalities (5).

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 are zero, then employment and capital do not affect each other' adjustment. On the other side, if β_E and β_K equal one, the factors affect fully each other's adjustment process. Two factors are said to be p-complements if the slow adjustment in the demand for one trigger 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[28]. 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 that a huge inaction range of capital would be associated with a huge inaction range in labor, β_E is positive and close to 1. In case of huge inaction range of capital and tiny inaction range in labor[29] the coefficient β_E is negative and close to -1. In cases that both capital and labor are adjusted, the coefficient β_E is close to zero, rendering smaller the inaction range of labor.

Abel and Eberly (1998) have modeled a two-factor interrelated adjustment process where labor is fully flexible[30] and capital is adjusted infrequently. Their theoretical guess 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 guesses could be characterized by a $\beta_K = 0$. With respect to the β_E, it should take positive value as they advocate that the employment adjustment behavior mimic the investment behavior.

Following all the empirical works done so far, in cases of huge 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

[28] See Hamermesh and Pfann (1996).

[29] It takes place when firms hire low-skill workers without making huge investments.

[30] There are no costs in adjusting employment.

extend the "inaction frontiers" of labor (capital) including the lag and lead values of inactions range of capital (labor) as follows.

$$
(9) \qquad \begin{aligned} IR_E^t &= IA_E^t + \beta_E IR_K^t + \beta_E^{-1} IR_K^{t-1} + \beta_E^{+1} IR_K^{t+1} \\ IR_K^t &= IA_K^t + \beta_K IR_E^t + \beta_K^{-1} IR_E^{t-1} + \beta_K^{+1} IR_E^{t+1} \end{aligned}
$$

where β_E^{-1}, β_E^{+1} and β_K^{-1}, β_K^{+1} coefficients take value in the unit interval and measure the sensitivity of the employment (capital) adjustment towards capital (employment) adjustment before and after the investment spikes take place. The same logics as for β_E and β_K should work even for these new coefficients with respect to their values taking place in the unit interval. These models can be extended in several ways. One of these ways could be performed by allowing the fixed component of employment adjustment cost to capture inaction range of investment or by allowing a nonlinear function of inaction range.

IV

Dynamic 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 dynamic 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.

Here I employ all the defined discrete variables already used in the previous summary statistics. Further, I follow Power (1999) and construct dummy variables to keep track of the investment spikes in periods before and after such spikes. To obtain an estimable representation of the employment adjustment decision, I construct a dummy variable $Poseg_j$ which takes value 1 in case of positive employment spikes and 0 otherwise and parameterize the model as follows

$$(1)\quad Poseg_j = \begin{cases} 1 \Rightarrow q_E \geq IR_E \Rightarrow U_{1it} = \beta_1 x_{it} + v_{it} + \varepsilon_{1it} \\ 0 \Rightarrow q_E < IR_E \Rightarrow U_{0it} = \beta_0 x_{it} + v_{it} + \varepsilon_{0it} \end{cases}$$

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_{it} is a firm specific random or fixed effect that is unobserved directly to the econometrician, and ε_{jit} is an error term. All the studied performed so far have disregarded the other observable variables as labor costs or investment. But cost of hiring or firing workers may depend on the level these other variables are utilized. This reasoning motivates the inclusion of these variables in the model.[31]

If I assume 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:

$$(2)\quad \begin{aligned} &\Pr(Poseg_1) = \Pr(U_{1it} > U_{0it}) = \frac{\exp(x_{it}\beta_1 + v_{it})}{\sum_{k=0}^{1}\exp(x_{it}\beta_k + v_{it})} \\ &\Pr(Poseg_0) = 1 - \Pr(Poseg_1) \\ &i = 1,2,...,33 \\ &t = 1,2,...,21 \end{aligned}$$

where x_{it} is a vector of explanatory variables for the firm i, β_j is a vector of parameters specific to the strategy j. If I define further an index variable I_{ij} such that $I_{ij} = 1$ if firm

[31] Also I get a better goodness of fit when these other variables are considered.

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:

$$(3) \qquad \prod_{i=1}^{33}\prod_{j=0}^{1} P(z_j)^{I_{ij}}$$

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

$$(4) \qquad \log L = \sum_{i=1}^{33}\sum_{j=0}^{1} I_{ij} \log P(z_j)$$

To run a logit regression for panel data I should check for fixed or random effect the data would accommodate. Hausman test[32] is in support of a model which strongly accommodates random effects in case of using the absolute definitions while in the case of employing other definitions I cannot conclude absolutely on the type of effects the panel accommodate. Table 10 at the Appendix 2 displays the results for the random effect logit model for cross-sectional time-series.[33] The same logit[34] model is also valid either when the investment spike or negative employment spikes are used as independent variable.

At the end of the table 10, it is shown the likelihood ratio test for the unit heterogeneity. In all regressions employing the four types of spike definitions, LR tests show that random effect is statistically significant. With respect to the goodness of fit, I use the McFadden R2 which is given as follows:

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

[32] In a fixed-effects kind of case, 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 get away with RE.

[33] The random effect logit model for cross-section time series data have be estimated by Stata 8 command xtlogit with the option re.

[34] $$Spike_j = \begin{cases} 1 \Rightarrow q_K \geq IR_K \Rightarrow U_{1it} = \beta_1 x_{it} + v_{it} + \varepsilon_{1it} \\ 0 \Rightarrow q_K < IR_K \Rightarrow U_{0it} = \beta_0 x_{it} + v_{it} + \varepsilon_{0it} \end{cases}$$

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

The calculations demonstrate a high McFadden R2 implying therefore that the model describes very well the data. In the logit model, with random effects, there are two random terms: v_{it}, the firm specific random effect and ε_{jit}, the error term. The random effect term is distributed as i.i.d. variable with expected value 0 and variance σ_u^2. Under the assumption that the error term is independent of the random term, correlation between the total random terms (the within cross-section correlation is the same across time periods) is given as:

$$\rho = \frac{\sigma_u^2}{\sigma_u^2 + 1}$$

The coefficient ρ can be interpreted as the share of the random term variance in the whole variance[35]. When ρ is close to zero, there is no any difference between pooled logit and random effect logit.

In the logit model with discrete effect, v_{it} denotes the firm specific effect – fixed[36] parameters. The fixed effect term are simply fixed parameters to be estimated and assumed to be correlated with explanatory variables.

Estimation results

A. Interrelationship coefficients between labor and capital adjustments choices

The main target of this paper was to study the interrelationship between the labor and capital adjustment. Firstly, I scheme a table with the coefficients attached to the current, past and future investment spikes following the different methods of spike generation (relative, absolute and combined). Secondly, I make clear again the criterion I use to opt

[35] The values of ρ and σ_u^2 are presented at the regression table 6.

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

for the most significant coefficients: I identify estimation as sufficiently robust when no less than three spike methods generate significant coefficients. Table 8 shows that, considering all firms, the coefficient attached to the current investments spikes is positive and significant according to the aforementioned criterion. This means that firms hire a substantial number of employees rather during the investment spike than after or before it. This shows that there is a considerable relationship between investment spikes and employment adjustment and this is in line with the empirical studies[37].

But if I study firms across the industry sector, product heterogeneity, ownership and location, different estimates of these coefficients are found. Table 8 shows that firms working in the machinery sector, prefer rather to anticipate the investment spikes one year before by hiring a substantial number of employees than to employ them during the investment spike occurs. For example, if firms invest in new machineries they should invest as well on training courses for the new workers before the machineries are installed. Therefore, in this case, the positive employment spike would anticipate the investment spike. The same investment spikes seem to be more significant even for the firms which are local, for those which invest on products where high research and advertising are needed.

When I consider firms which are filial of multinational, the most significant investment spike coefficient is the one corresponding to the current investment spike. This could imply that these firms find more profitable to adjust employment in the same time with the investment than to do it in advance or lag it behind. The same investment spike turns out to be significant for the firms which belong to “low wage sector”. Also the firms located in the north follow the same timing of interrelationship. They prefer to not anticipate the investment spikes.

These results show that firms either anticipate the investments spikes by employing workers before or proceed with such employment politics in the same time they invest substantially. Anyway, there is a noteworthy evidence of the interrelationship between employment and capital adjustment processes. What does this noticeable relationship implies? It naively implies that any policy affecting the labour

[37] Sakellaris (2001), Letterie and Pfann (2001) demonstrate the same relationship.

adjustment directly would affect the performance of the capital indirectly. For instance, an increase of firing tax imposed by the government authorities would restrain the firms to fire their workers and this implies a worse performance of employment adjustment; if this employment stickiness would be associated with capital stickiness (as the interrelationship facts claim), then the firms should hardly invest substantially as well.

Table 8

Estimated coefficients of adjusted employment across different groupings (t-values in parenthesis)

Probability of the event ($Poseg_t$ =1)	Relative, Absolute & Combined Spikes	Spike (t)	Spike1 (t-1)	Spike3 (t+1)
Machinery sector	Relative 1st	0.82 (1.25)	-0.105 (-0.17)	0.54 (0.97)
	Relative 2nd	0.63 (1.17)	-0.13 (-0.26)	1.22 (2.6)
	Absolute	1.01 (0.72)	0.85 (0.7)	1.98 (1.89)
	Combined	0.33 (0.57)	-0.12 (-0.22)	1.21 (2.53)
Local firms	Relative 1st	0.05 (0.09)	0.07 (0.14)	0.58 (1.24)
	Relative 2nd	0.91 (2.18)	0.19 (0.46)	0.64 (1.68)
	Absolute	1.09 (1.24)	0.32 (0.3)	0.72 (0.81)
	Combined	0.41 (0.89)	-0.23 (-0.51)	0.55 (1.39)
Filial of multinationals	Relative 1st Type	1.5 (2.67)	0.26 (0.45)	0.55 (0.97)
	Relative 2nd Type	1.33 (2.25)	0.21 (0.36)	0.82 (1.49)
	Absolute Type	1.93 (1.43)	1.46 (1.18)	-0.26 (-0.19)
	Combined Type	1.31 (2.59)	0.34 (0.66)	0.805 (1.6)
Independent firms	Relative 1st Type	-0.46 (-0.50)	-0.43 (-0.59)	0.46 (0.76)
	Relative 2nd Type	0.78 (-1.19)	-0.45 (-0.84)	0.55 (1.18)
	Absolute Type	-1.6 (-1.01)	0.34 (0.24)	1.36 (1.17)
	Combined Type	-1.04 (-1.35)	-0.93 (-1.33)	0.61 (1.15)
Research &advertising	Relative 1st Type	1.00 (1.69)	0.66 (1.17)	0.94 (1.66)
	Relative 2nd Type	1.09 (2.44)	-0.27 (-0.58)	1.6 (3.68)
	Absolute Type	0.95 (1.06)	0.47 (0.45)	1.23 (1.37)

	Combined Type	0.86 (1.86)	-0.09 (-0.19)	1.11 (2.62)
"low wage sectors"	**Relative 1st Type**	0.68 (1.73)	-0.17 (-0.41)	0.302 (0.78)
	Relative 2nd Type	1.04 (3.08)	0.29 (0.85)	0.80 (2.45)
	Absolute Type	1.6 (2.56)	1.08 (1.44)	0.57 (0.81)
	Combined Type	0.72 (2.12)	-0.04 (-0.12)	0.61 (1.85)
Located in North	**Relative 1st Type**	1.03 (2.53)	0.18 (0.44)	0.39 (0.97)
	Relative 2nd Type	1.17 (3.16)	0.16 (0.44)	0.728 (2.11)
	Absolute Type	1.43 (2.25)	0.8 (1.02)	-0.34 (-0.40)
	Combined Type	1.15 (3.2)	1.14 (0.38)	0.52 (1.51)
All firms	**Relative 1st Type**	0.649 (1.71)	-0.139 (-0.35)	0.304 (0.83)
	Relative 2nd Type	1.07 (3.32)	0.17 (0.52)	0.67 (2.14)
	Absolute Type	1.45 (2.42)	0.89 (1.27)	0.47 (0.7)
	Combined Type	0.78 (2.39)	-0.08 (-0.24)	0.56 (1.78)

Table 10 at the Appendix 2 shows that the results of the random logit in both cases when Poseg and Spike are considered as dependent variables. Does size matter[38]? The estimation results neglect fully the importance of firms' size. Does age matter[39]? Yes, it matters a lot. Old firms seem less inclined to have huge hiring and more inclined to have investment spikes. The reluctance of old firms to hire, may probably come from the stronger presence of their labor union. When the absolute definitions are employed, I find that to labor costs affect negatively (significantly) the probability of hiring jumps and investment spikes, while the investment are related positively with these probabilities. It is obvious that in this case, the labor costs have the right sign as hiring process is accompanied by higher wage payments. On the other side, when the other definitions are employed, I don't find any significant relationship between labor costs and investments, and probabilities of huge hiring and investments episodes.

[38] See Figure 3 at Appendix 4 to get the picture of the firms size density. The majority of firms have less than 5000 employees but none of them has less than 46 employees. Therefore, the threshold of 15 employees, settled on by the Articolo 18, is wholly surpassed.

[39] Fig 4 at Appendix 4 describes the density of firms age. It is obvious that most of the firms are younger than 50 years, and almost founded after the 2nd World War.

B. Trend of productivity growth rates respecting employment and investment spikes

Another aim of this paper is to study the trend of productivity growth rates with respect to the employment and investment spikes. Table 9 shows the coefficients linking the productivity growth rates at the previous, current and next period with the employment and investment spikes at the current period. To choose the most significant coefficients I will use the same criterion as previously opting for the cases with no less than 3 significant spike types.

With respect to the hiring spikes, Table 9 suggests that decreasing productivity growth rates are simultaneously attached to higher probabilities of a substantial number of hiring. One explanation for the negative relationship between hiring spikes and productivity growth rate could be the fact that these new hired employees are less efficient than the old ones. No significant relationships are found between the probability of substantial hiring (Poseg) at time *t* and the productivity growth rates at time *t-1* and *t+1*.

With respect to the firing, Table 9 shows that decreasing labor productivity will be followed by higher probabilities of firing a substantial number of people in the next period. In front of a negative demand shock, firms do not fire immediately their employees even if they are not efficient (actually, no significant contemporaneous relationships exist between the productivity growth rates and the firing spikes). There is a huge set of institutional[40] restrictions that justify this prudent behavior especially in the big firms (as such is my case). This could be one of the reasons of the increasing probabilities of firing after decreasing productivity growth rate. The sign of my

[40] According to Italian employment protection legislation, individual and collective dismissals of workers are only permitted on a just cause basis. Accordingly, workers can be dismissed because of misconduct or when firms downsize its activities. Workers can appeal to the court against dismissal. In case of unfair dismissals, workers are entitled to compensation which varies significantly upon to firm size. Firms with more than 15 employees, to which Article 18 of the "Statuto dei lavoratori" applies, have to compensate workers for the forgone wages in the time elapsing between the dismissal and the sentence with no upper limits. In 1991, a special procedure was introduced for collective dismissals in firms with more than 15 workers. When such firms want to fire 5 or more workers within 120 days to downsize or reorganize their production, they have to ask the trade union representatives and the public administration to reach an agreement on dismissals; if no agreement is reached, firms still can dismiss their worker upon specific criteria.

coefficient is in line with the Sakellaris[41] findings in this case. No significant relationships are found between the probability of substantial firing (Noseg) at time *t* and the productivity growth rates at time *t* and *t+1*.

With respect to investment spikes, I was eagerly awaiting any significance between the investment spikes and productivity growth rates at different times. However, I find that higher probabilities of occurrences of investment spikes at time *t* are significantly associated with increasing productivity growth rates at time *t + 1* (and this is the only significant coefficient in this case). This timing of variables with the dependant variable situated one period before the independent variable renders the result somehow hardly explainable. Nevertheless, it could be interpreted as a motivation of firms to anticipate the predicted increasing productivity growth rates by investing more (through a new machinery or a training course).

I don't find a significant relationship between investment spikes and the labor productivity before and during the spikes, and this is in line with Narazani (2004) and Power (1998). On the other side, Sakellaris (2001) says that total factor productivity drops immediately after the introduction of an investment spike with a gradual recovery after. He tries to explain the drop of TFP after an investment spike as due to the phenomena of "Embodied technology & learning effect" arguing that in the early stage of the installation of the new equipment, this new technology may operate inefficiently because new skills are needed to deal with. However, my results consider the labor productivity values and not the total factor productivity.

[41] Sakellaris (2001) found that before and during an employment reduction episode, labour productivity shows a pronounced positive co-movement whereas afterwards this is not the case. The simple pattern of pro-cyclical productivity is not observed at the plant level data. He attributes this productivity behaviour to labour hoarding and variable effort, and the costly adjustment of organization capital. .

Table 9
Productivity growth rates and the employment and investment spikes
(t-values in parenthesis)

		Productivity growth rate (at time t)	Productivity growth rate (at time t-1)	Productivity growth rate (at time t +1)
Probability of the event ($Poseg_t$ =1)	Relative 1st Type	-1.5 (-1.94)	0.71 (0.84)	0.50 (0.65)
	Relative 2nd Type	-1.31 (-1.86)	0.68 (0.89)	0.09 (0.13)
	Absolute Type	-3.3 (-2.67)	0.86 (0.60)	1.69 (1.33)
	Combined Type	-1.5 (-1.94)	0.71 (0.84)	0.67 (0.85)
Probability of the event ($Noseg_t$ =1)	Relative 1st Type	0.99 (1.36)	-1.46 (-1.93)	0.23 (0.35)
	Relative 2nd Type	1.6 (2.25)	-1.6 (-2.22)	0.58 (0.87)
	Absolute Type	1.33 (1.46)	-2.7 (-2.96)	0.66 (0.75)
	Combined Type	0.99 (1.36)	-1.46 (-1.93)	0.33 (0.46)
Probability of the event ($Spike_t$ =1)	Relative 1st Type	-0.38 (-0.56)	0.25 (0.35)	1.58 (2.24)
	Relative 2nd Type	0.3 (0.37)	0.72 (0.88)	1.37 (1.79)
	Absolute Type	0.75 (0.89)	0.85 (0.96)	1.71 (2.08)
	Combined Type	-0.28 (-0.41)	0.25 (0.35)	1.8 (2.66)

Abbreviation: Poseg, Noseg and Spike denote respectively the positive employment, negative employment and investment spikes at time t.

Conclusion

This paper intended to study the interrelationship between employment and capital adjustments episodes which were called as Poseg, Noseg and Spikes characterizing huge hiring, firing and investment process respectively. The main conclusion is that investment spikes are highly interrelated with either positive or negative employment spikes. But for some firms, I find that they hire substantially before the adjustment occurs and for some others during this process.

The other conclusions are as follows:

With respect to the hiring spikes, firms are more eager to hire a substantial number of employees in the same time that the productivity growth rates decrease.

With respect to the firing, decreasing labor productivity will be followed by higher probabilities of substantial firing in the next period and this result is consistent with Sakellaris findings.

With respect to investment spikes, I find that higher probabilities of occurrences of investment spikes in the current period are significantly associated with increasing productivity growth rates at the next period. No significant relationship is found between current investment spikes and either current or preceding labor productivity growth rates.

The estimation results neglect fully the importance of firms size while with respect to the firms' age, old firms seem less inclined to face huge hiring and more inclined to face investment spikes.

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Appendix 1
Description of the variables

Total Factor Productivity: The labor productivity is constructed as the ratio between the value added and total employment. Sargent and Rodrigues (2000) argue that in the mid run, labor productivity could be a good proxy for total factor productivity as well. As my observations are taken on an annual basis, I could consider the labour productivity variable as a substitute of Total Factor Productivity.

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
Tables of firms statistics

The following tables demonstrate the distribution of firms across sectors, ownership type, location and age.

Table 10 shows the distribution of firms in the country. Obviously, most of the firms are located in the northern part of the country and there only 3 firms located in the south.

Table 10
(Location)

Location	***Firms number***
Nord	***29(87.9%)***
South	***3(9.1%)***
Center	***1(3%)***

Table 11 shows the distribution of firms with respects their age. Most of the firms (12 exactly) are "old" (older than 50 years). The second-rank group includes 10 firms aged from 11 to 25 years old. The firms founded after the Second World War (from 25 to 30 years) are exactly 5.

Table 11
Firms' Age[42]

Less than 10 years (firms)	*From 11 to 25 years*	*From 25 to 30 years*	*From 30 to 50 years*	*More than 50 years*
1	***10***	***5***	***5***	***12***

Table 12 shows the distribution of firms with respects their industry group. Most of the firms (16 exactly) belong to "machinery sector". The rest are distributed with low weights at the other sectors.

Table 12
(Industry group)

"Istat" group	***Firms number***
Ist1 (machinery sector)	***16(48.5%)***
Ist2 (alimentary sector)	***7(21.2%)***
Ist3 (Dressing sector)	***1(3.03%)***
Ist4 (editorial)	***6(18.2%)***
Ist5 (others)	***3(9.1%)***

Table 13 shows the distribution of firms with respects their ownership type. Most of the firms (13 exactly) are filial of foreign multinationals. The second rank group (10 firms) include independent firms. The rest are distributed with "low weights" at the other sectors.

[42] 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 13

(Ownership type)

Ownership type	*Firms number*
Public	***3(9.1%)***
Member of "big" national group	***1(3.03%)***
Member of "medium" national group	***1(3.03%)***
Member of "small" national group	***5(15.15%)***
Filial of foreign multinational	***13(39.4%)***
Independent	***10(30.3)***

Table 14

Summary Statistics

Variable		Mean	Std. Dev.	Min	Max	Observations	
Employment	Overall	1130.381	2105.506	46	15088	N =	693
	Between		2065.115	67.7619	10872.86	n =	33
	Within		540.1071	-3037.476	5345.524	T =	21
Investment	Overall	51.59314	141.0864	-112.0034	2971.652	N =	693
	Between		81.241	4.351061	384.9308	n =	33
	Within		116.1724	-333.3377	2638.314	T =	21
Capital	Overall	513.4353	949.0268	7.180686	5959.482	N =	693
	Between		896.9524	50.33083	4677.006	n =	33
	Within		345.5146	-1137.934	2673.224	T =	21
EGR[43]	Overall	-.0127695	.0556917	-.3395071	.2213292	N =	693
	Between		.0229231	-.0606004	.0268454	n =	33
	Within		.0509047	-.3043823	.2015657	T =	21
InvR	Overall	.1107193	.090618	-.1069872	.6882712	N =	693
	Between		.0331142	.0347198	.1895365	n =	33
	Within		.0845386	-.1160764	.628989	T =	21

[43] EGR and InvR denote investment and employment growth rate respectively.

Appendix 3

Graphs of main variables trend

The following figures show the density of firms observations with respect to firm size and age.

Fig 3
Density of Firm size

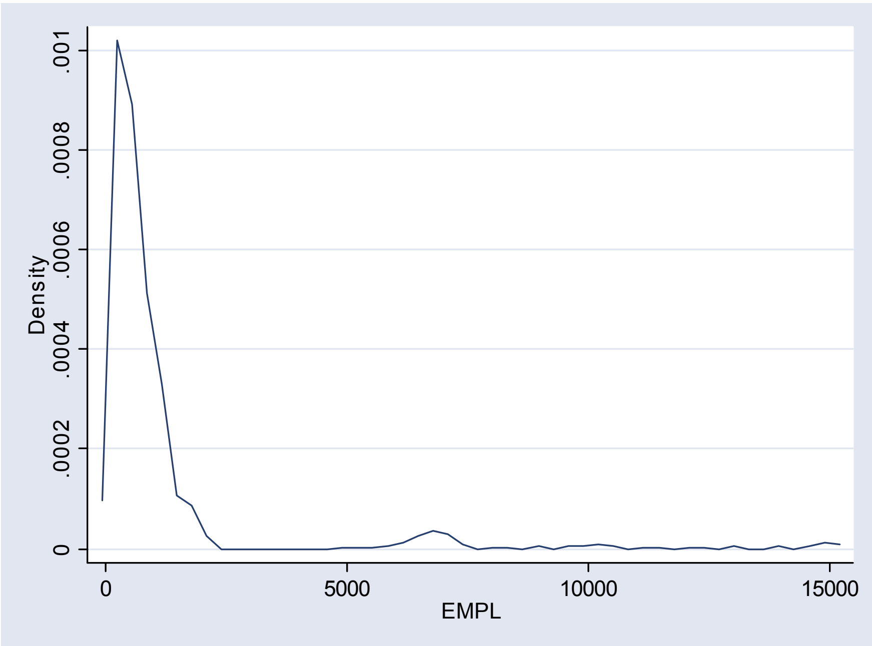
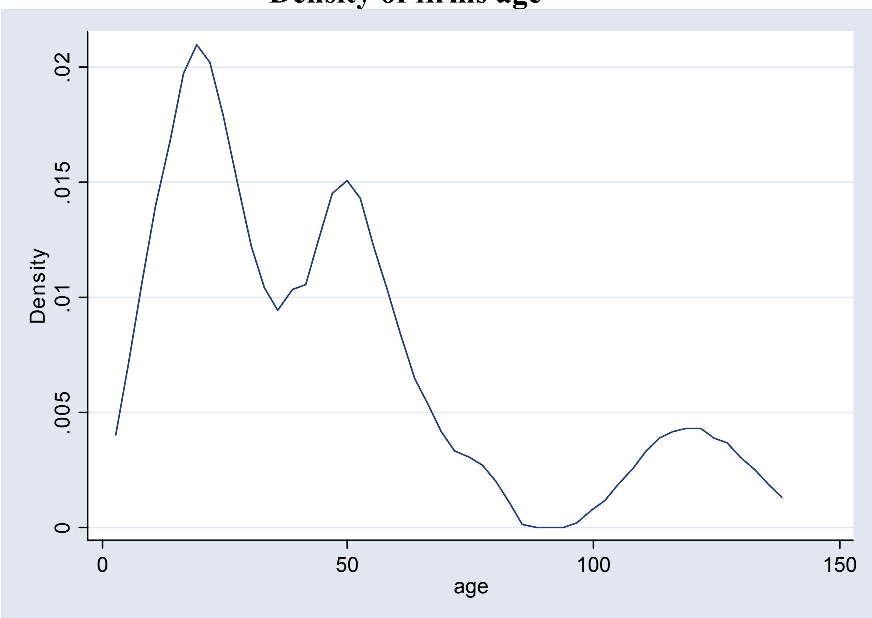
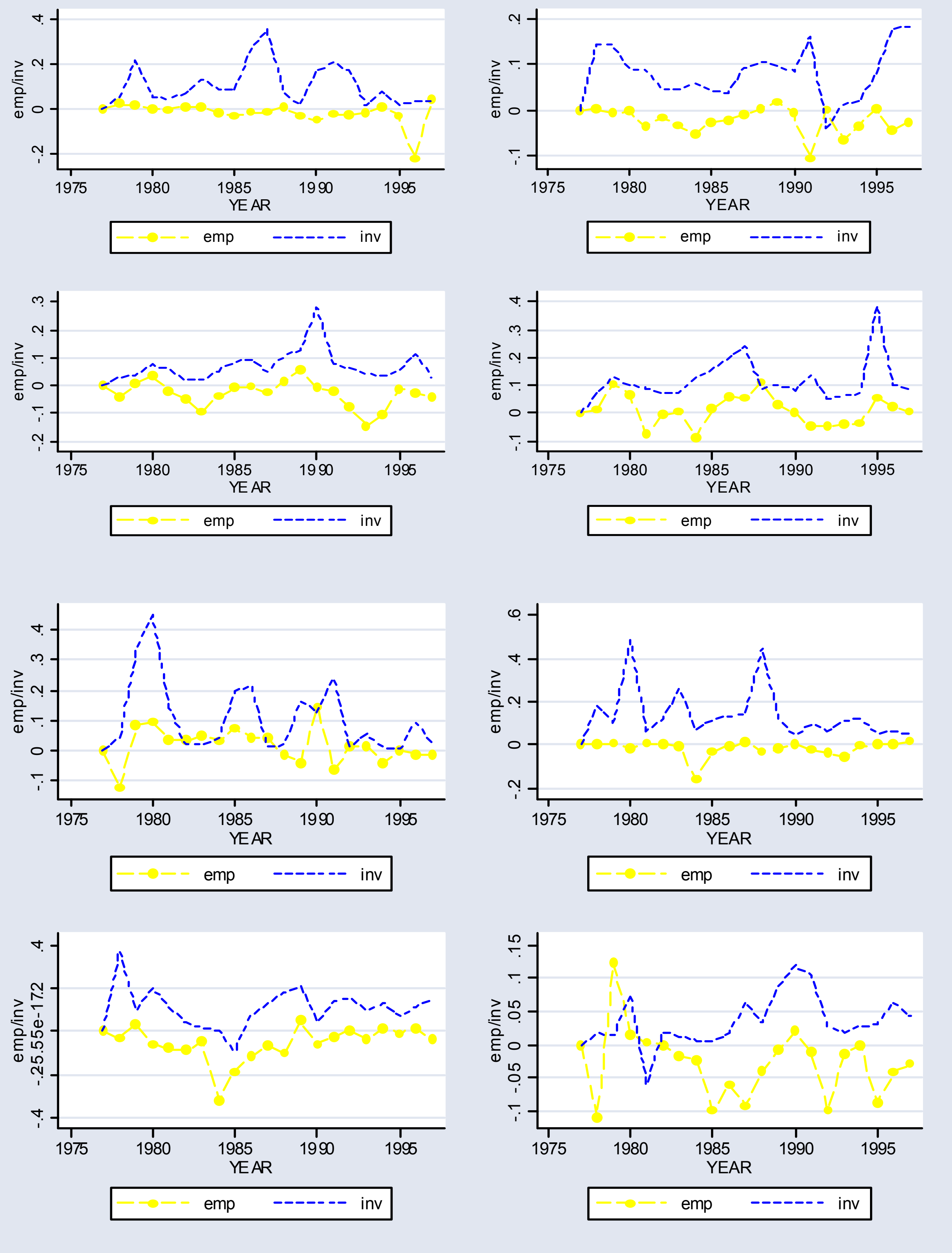
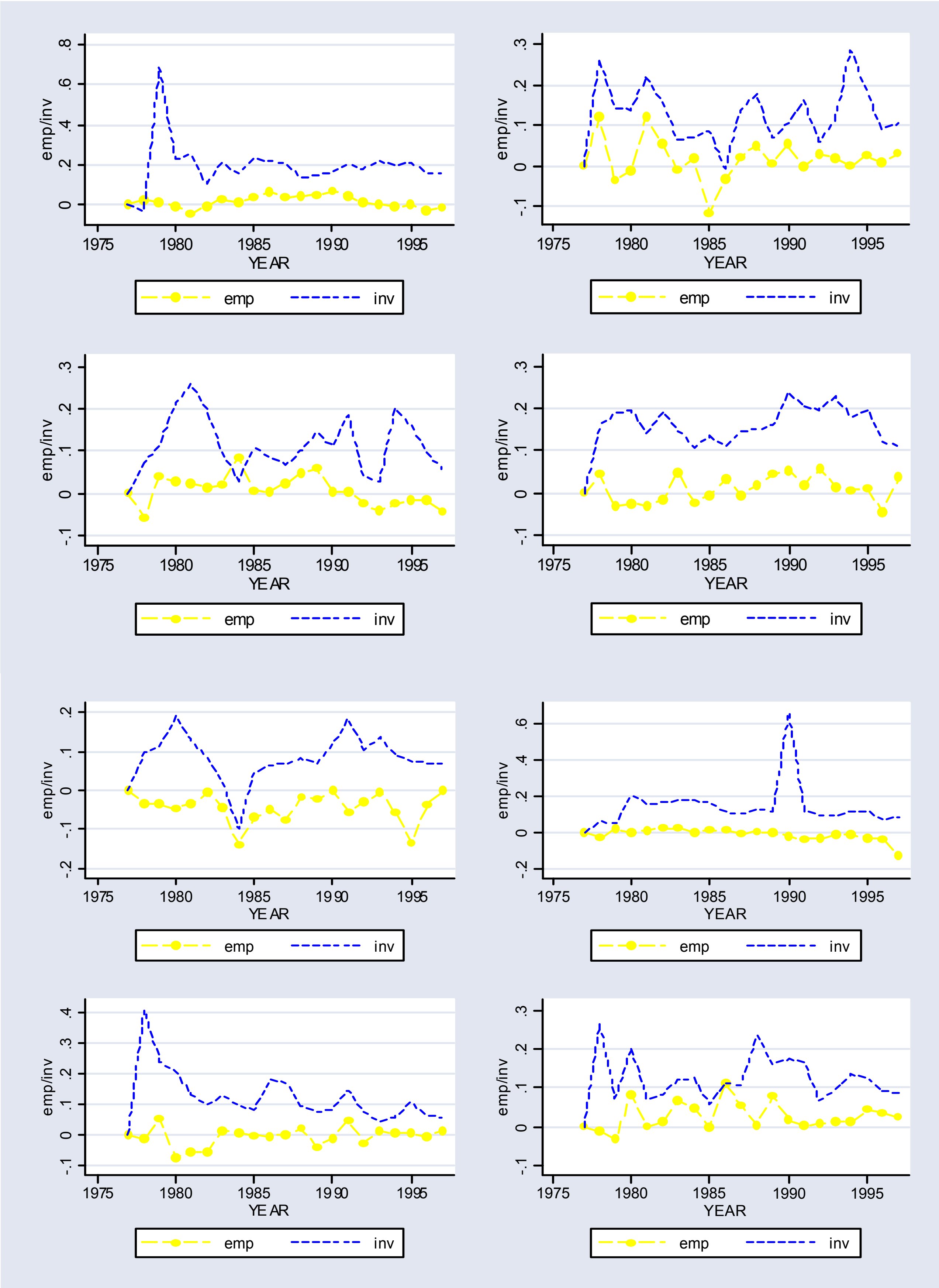


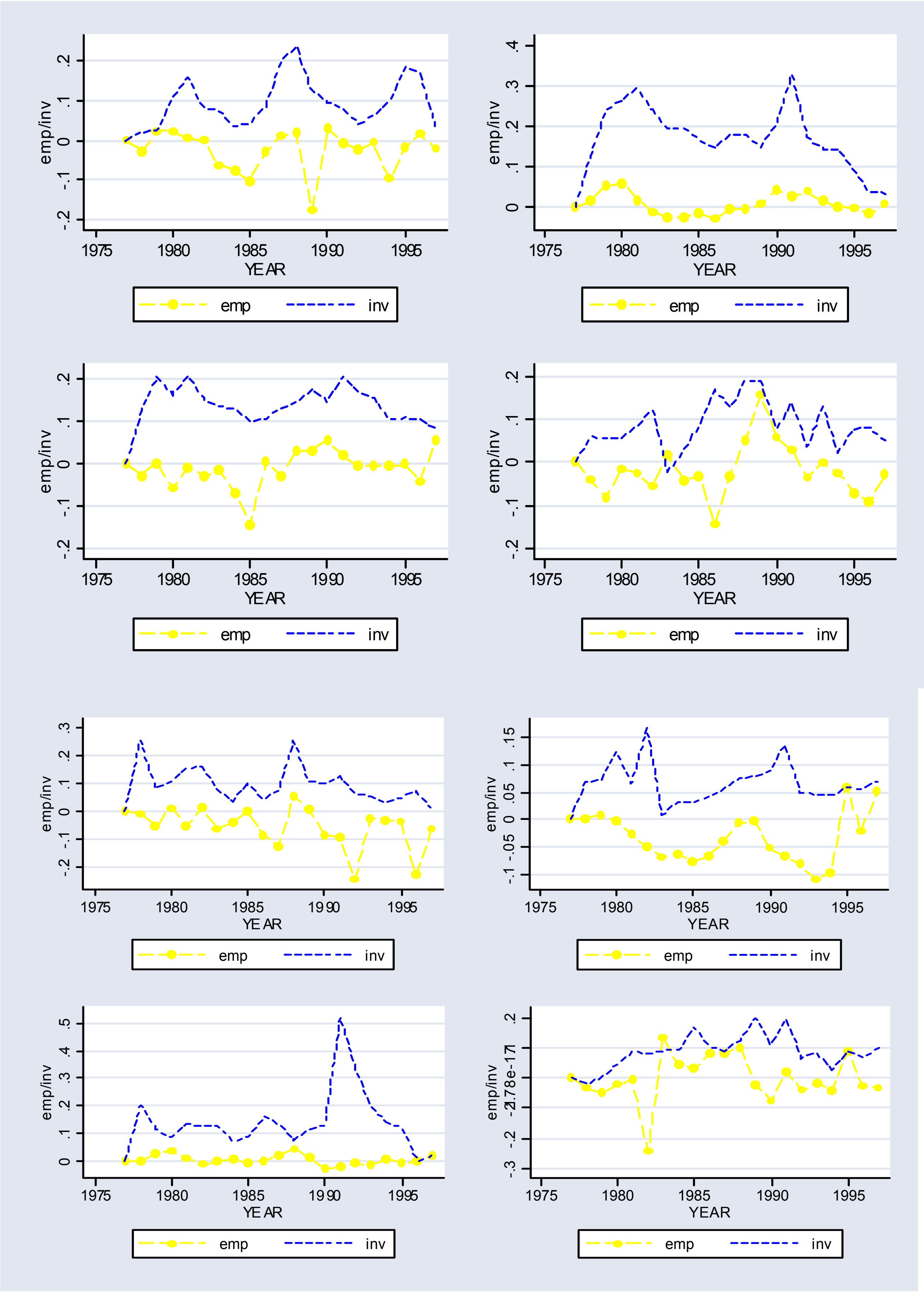
Fig 4
Density of firms age

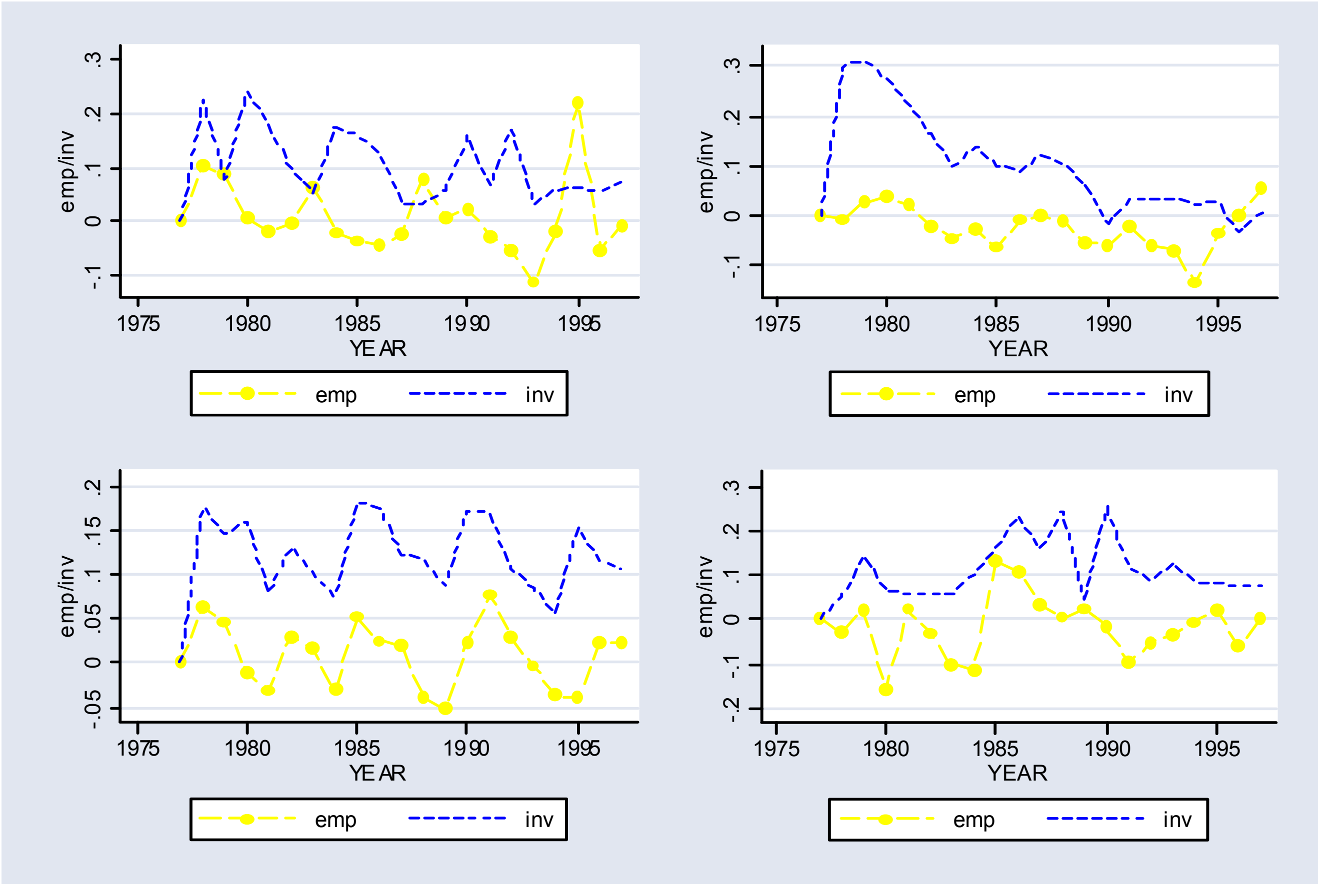


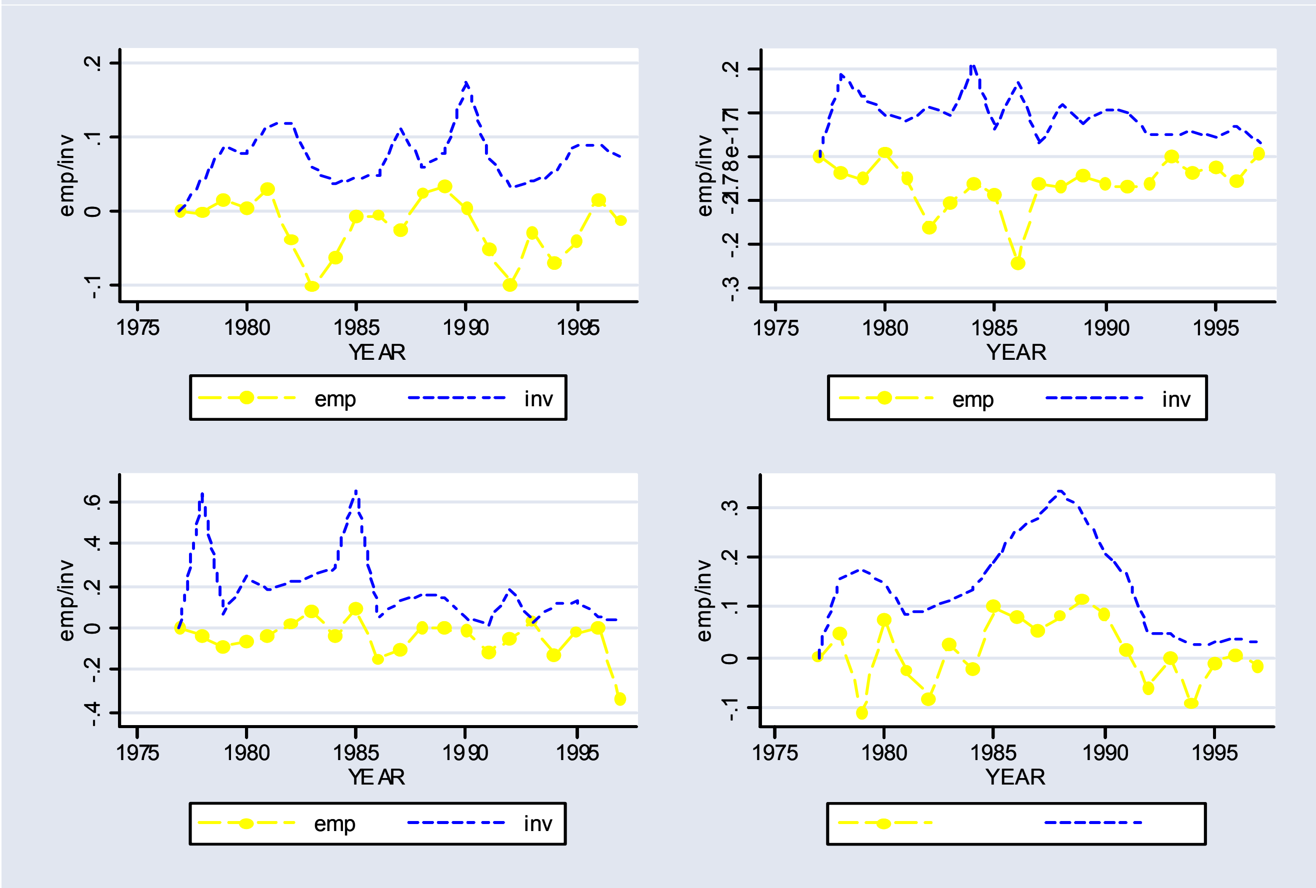
INVESTMENT & EMPLOYMENT GROWTH RATES




emp/inv
YEAR
1975
1980
1985
1990
1995
emp
inv


emp/inv
YEAR
1975 1980 1985 1990 1995
emp
inv


emp/inv
YEAR
emp
inv


emp/inv
YEAR
emp
inv