Fabrizio Alboni, Furio Camillo e Giorgio
Tassinari

A Data Mining approach for the monitoring
of active labour market policies

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Dipartimento di Scienze Statistiche "Paolo Fortunati"

1. Introduction: labour market information (LMI) systems as a monitoring tool and the Italian data-framework

A recent report of the Upjohn Institute on a framework for an optimal labour market information (hereafter LMI) system said that "government must play a major role to ensure there is a public LMI system, which produce reliable and relevant information, and that LMI is disseminated in user friendly ways to increase the likelihood of improving the efficiency of markets. In addition to assembling relevant data, public agencies have a key role in transforming facts about economic activity into useful labour market" (Woods and O'Leary, 2006).

The study offers some important criteria for the optimization of an LMI system, and also uses standard and innovative data mining techniques as final instruments in public and private monitoring process of labour market.

Our work is based upon micro-data generated by the administrative and operative database systems of certain specific, more advanced Italian sub-areas.

The paper offers selected results from the first version of an analytical process of data-mining applied to the labour market within the province of Bologna, in Italy.

A data set included in an LMI system can be organized in several ways; however, starting from a general database, an optimal data-mining process will be characterized by demand data (labour, skill sets, etc), occupational characteristics, information about the education and permanent training of each worker, information about the crosswalks of the workers with no stable employment trough different status at different times in the worker's life-cycle.

In particular, causal inference methods shall be applied to semi-automatic Data Mining approaches, in order to create a system for evaluating the performance of the Provincial Job Centres, whereby the success of policies designed to guarantee equal employment opportunities can be duly monitored. Our variable target is represented by the number of people hired on full-time contracts.

The results obtained give a closer insight into the working of the Italian labour market after the introduction of Law 30/2004 (the "Biagi Law"), which provided for substantial reductions in employment protection.

2. The dual nature of the labour market

The employment crisis that dogged the European Community throughout the 1990s has led to a

growth in forms of employment which cannot be compared with full time, life-time work; these include part-time employment, temporary employment, jobs created by the public authorities; and work experience schemes for young people, as well as jobs based on unusual schemes (OECD 2007).

Italian labour market reforms implemented from 1995 onwards, have led to a substantial increase in the number of temporary workers and, more generally, of jobs with non-standard working schedules. At the same time, Italy has witnessed a substantial fall in unemployment rates, and a rise in employment rates, although labour productivity has grown at a very slow pace compared with other European countries.

There is also strong evidence, according to the OECD, that a partial reform which weakens regulations on temporary employment, but fails to modify the nature of permanent employment contracts, may well produce negative effects in the long term. In fact, when the regulation of full-time employment remains stringent, firms tend to hire temporary workers, and are very reluctant to transform their temporary contracts into permanent contracts. Temporary labour is often used by firms as a mechanism with which to render employment more flexible in relation to the fluctuations in the economic cycle (Blanchard and Landier, 2001). This gives rise to an increased concentration of turn-over among specific groups within the labour force that are over-represented in the temporary employment sector. This, in turn, implies both high levels of employment and income insecurity for the said workers, and underinvestment in human capital, which leads to a worsening of the latter's productivity potential, and of levels of occupational safety (Guell and Petrangolo, 2000; Booth et al. 2002, Guadalupe, 2003). The dualistic nature of the Italian labour market, and the process of "segregation" of "atypical" workers, is further confirmed if we examine those matrices drawn up by the CNEL (2007) regarding changes in the professional status of workers. If we take 100 to be the number of temporary workers in 2005, what we see is that after one year, only 29% of the said workers has managed to secure a permanent employment contract, while 65% continue to be employed in temporary jobs, and the remaining 5% results as being unemployed. In order to interpret these figures correctly, we need to bear in mind that approximately 88% of those workers with a temporary employment contract declare that "the temporary nature of their job is not of their own choosing", compared with a figure of 55% for the EU countries as a whole (Biggeri 2006). With regard to those workers employed on "semi-subordinate", employer-coordinated freelance contracts, there is not that much likelihood of their being offered permanent employment contracts (only about 12% do, in fact, move on to permanent contracts), and this may be due in part to the

fact that a certain percentage of them do not aspire to, or look for, dependent employment[1]. The timescales of transition from temporary employment or employment on a "semi-subordinate" basis, to permanent employment, thus constitute one of the most important points in the present labour market situation both in Italy and the rest of Europe.

The present study consists of two specific lines of investigation, which are part of a wider monitoring system that, in a multi-year work in progress, covers the province of Bologna and the centralised administrative data from the Job Centres. The first line taken involves the measurement of the probability of transition from the status of temporary worker to that of permanent worker, with a special focus being placed on young workers; the second line, on the other hand, regards the effects of those active employment policies[2] that the Italian government has begin to implement in an attempt to improve the employability of the country's workforce, with a special focus on the more disadvantaged segments of the population (young people, immigrants, women and early school leavers). It is generally acknowledged that it is difficult to evaluate the effectiveness of active job programs because of the selectivity bias that affects inflows into such programs. A direct comparison of unemployed people who attend these programs with those that do not, may lead to spurious conclusions about the effectiveness of the programs themselves. Econometric methods have been proposed to overcome this problem (Rosenbaum and Rubin, 1983 and 1984; Bondonio and Greenbaum, 2007), and there are also a number of case studies that adopt an experimental approach (see e.g. Graversen and van Ours, 2008; Black et al. 2003). The present study proposes a different approach, one that is based on Data Mining methods; this enables us to use observational data collected by administrative sources *(Centri Per l'Impiego*, Job Centres), that may provide useful information about the specific program best suited to each job seeker.

The province of Bologna is one of the most highly-developed regions in Italy. It has about 950.000 inhabitants, and its pro-capita GDP in 2007 ranked third out of all Italian provinces; the presence of manufacturing is also strong (34.8% of all workers are employed in manufacturing industry). As far as the labour market is concerned, the labour force participation rate is one of the highest in Italy, while employment rates (for both men and women) are also very high (even higher than the Lisbon parameters – see **Table 1**).

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[1] The Ministry of Labour, in its document entitled *Occupazione e forme di lavoro precario* (Employment and precarious forms of working) (Rome, 13th November 2007), has also divulged estimates regarding the process of transition from one form of employment to another, using both ISTAT figures gathered during the Labour Force survey, and INPS data built on the basis of the Longitudinal Employed Persons and Pensioners Database. The results taken from the two sources contrast somewhat, in that in the case of the ISTAT figures for 2005-2006, with 100 taken as the number of temporary workers in 2005, 71% were still temporarily employed at the end of 2006; according to the INPS figures, on the other hand, the probability of remaining in temporary employment after one year resulted as being 40%.

[2] The OECD (1993) subdivides active policies into five different categories: the temporary creation of work, professional training, actual services for job seekers, employment allowances for those in regular work, and the funding of new business enterprises.

Table 1 – The Lisbon parameters and the province of Bologna

Group	Rate of employment	Rate of female employment	Rate of employment among those aged 55-64 *
2010 Targets	70.0	60.0	50.0
Bologna	71.1	63.4	31.5

According to official statistics, the unemployment rate in 2007 was very low. However, the number of people registered with Job Centres (*Centri Per l'Impiego*) is more than double the official unemployment figure.

Before expounding the results of the analyses conducted using the Kaplan-Meier filter, we would like to examine the composition, in terms of age and contract type, of job placements in the province of Bologna during the first half of 2007, in order to highlight any links between the stage in the life cycles of those persons involved in the said job placements, and the type of employment contract they were offered.

The job-placement-by-age analysis, based upon figures for the first half of 2007 (**Table 2** below), may be summed up as follows: the average worker comes into the labour market at a very young age, usually either as an apprentice or on a temporary contract, although fairly often as a coordinated and continuous collaborator, then works in a series of temporary jobs, before being offered a permanent employment contract (at the age of 35 or over). This is, of course, a picture of the "average worker", and does not reflect the heterogeneous nature of the work experiences of different individuals (this question shall be dealt with in more detail in the following section).

An examination of the figures we have for job placements clearly reveals the dual nature of the labour market in the province of Bologna: while the majority of workers are employed on permanent contracts, there are nevertheless a substantial number of "flexible/precarious" workers. The interesting thing is that job placements, and the termination of employment contracts, tend to involve the latter of these two categories (almost to the exclusion of the former): this category is characterised by the "intermittent" nature of the work in question, by the constant rotation of those being hired, by the limited duration of the employment relationship, and finally, by the limited likelihood of temporary employment contracts being transformed into permanent ones.

Table 2 Job placements according to contract type and age group during the first half of 2007

	15-24	25-34	35-44	45-54	55-64	65 and above	Total
			Age group				Total
Temporary employed work	34.6	32.9	41.5	43.4	26.5	59.1	21,449
Permanent employed work	11.0	28.2	36.5	37.0	43.1	12.2	14,854
Apprenticeship	29.1	4.5	0.0	0.0	0.0	0.0	3,829
Agency-based work	11.4	11.8	10.2	5.1	5.6	0.1	5,560
Member of a cooperative	2.3	3.1	3.7	1.5	1.5	0.1	1,564
Coordinated and continuous collaboration	0.8	1.6	1.3	4.2	4.2	10.6	823
Temporary work on specific projects	3.4	5.7	4.4	15.0	15.0	14.8	2,823
Others	7.4	4.8	2.4	4.1	4.6	3.3	2,397
Total	9,973	20,504	13,170	6618	2,395	639	53,299

Does the type of contract affect the duration of employment in a given job, that is, the time between "placement" and "termination"? The answer is, of course, yes, given that permanent job placements usually come to an end for objective, financial reasons, whereas flexible/precarious job placements, by their very nature, are of a temporary nature. Nevertheless, it is important to try to measure just how long any employment contract lasts, and to distinguish the two types of contract. The shorter a temporary contract, the greater the uncertainty the worker in question will have about his/her future, and this will have repercussions on the accumulation of human capital, on labour productivity, and on occupational health and safety.

3. How long does temporary work last ?

Measuring the "duration" of job placements is not a simple task, however, since the likelihood of placement and termination depends on the passing of time, and varies according to the temporal distance from the start of the phenomenon in question. In such cases, the variable in question is constituted by the duration of the state in question (in this case, the state of being employed), which

within a given observation period may arise more than once. Thus we need to analyse data expressing the time between an originating event (in our case, a job placement) and a terminal event (the end of employment) marking an individual's exit from a given state (that of being employed). Such data may be interpreted and elaborated according to a specific statistical approach known as duration data analysis, or survival analysis (Cox and Oates, 1984), which has also been utilised by Booth (2001 and 2002), Alboni at al.(2008) and Evangelista and Rinaldi (2008).

One of the fundamental features of such analyses is the evaluation of the contribution made estimation of the survival of those persons who never experience the terminal event (termination of employment) during the observation period: these are the so-called censured observations.

Usually we think that the average (or median) duration of the observed job placements constitutes an indicator of the likelihood of an employment contract being terminated: this would only be correct, however, if all the individuals in question had been given the same time from the start of their job placement, which is clearly not the case. In fact, scholars generally accept that in such cases, an estimate is required of a survival function representing the probability, over time, that an individual is still going to be in his/her job, at least up until the end of the observation period. Thus we took the SILER database for the period 2004-2006, and used it to estimate the survival functions for job placements, subdivided according to the type of employment contract in question. In order to elaborate the survival curves, we adopted the following classification:

- permanent employed labour contracts (including those of cooperative members);
- temporary employed labour contracts;
- apprenticeship contracts;
- agency-work contracts and other contracts (mainly contracts for continuous and coordinated collaboration).

The resulting survival curves are shown in Figure 1 below.

Figure 1 – Survival curves, according to contract type, for the province of Bologna (2004-2006)
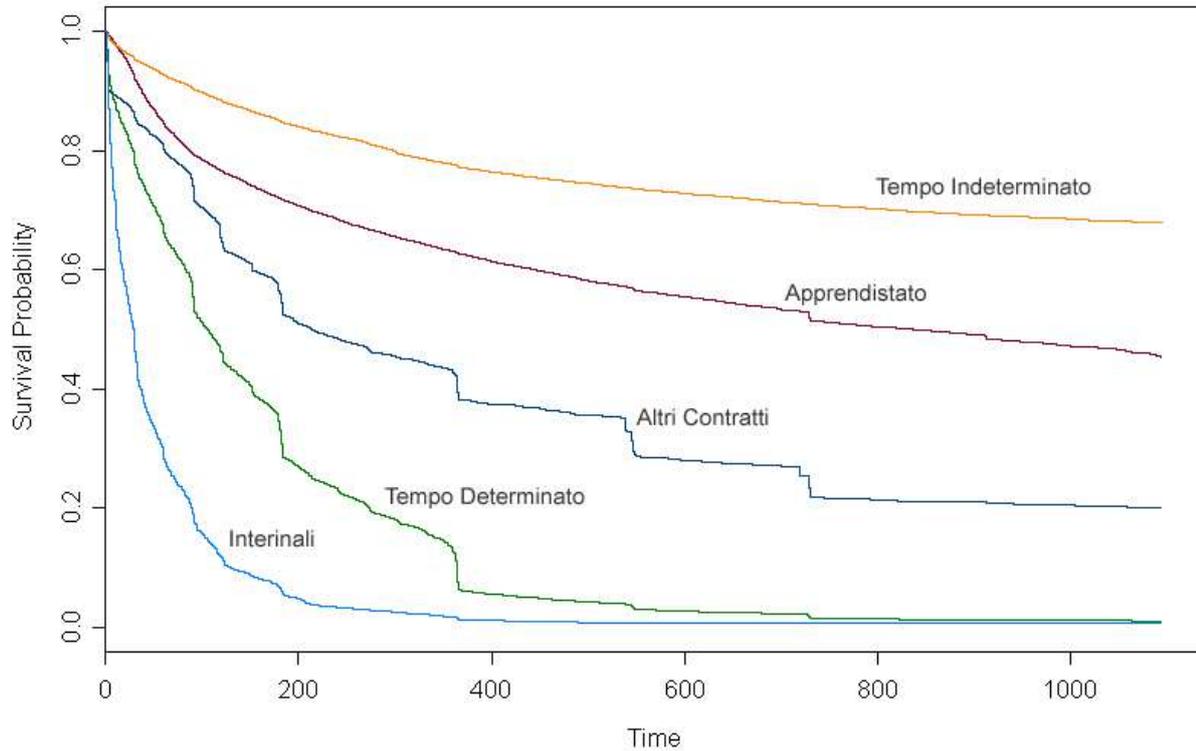
Source: Elaboration of SILER data – Province of Bologna

The above graph is crystal clear: given a certain type of job placement, you can trace the probability of an individual still being employed under that contract after a certain number of days. Of course, by separating the various types of employment contract, the resulting probabilities diverge considerably. As far as regards permanent employment contracts (fig.2), with reference to job placements during the period 2004-2006 once again, the probability that a job placement lasts more than 1,000 days is slightly more than 80% (which in practice corresponds to the length of the period subject to analysis). The duration of apprentices' job placements is also rather lengthy, the probability of such contracts lasting more than 836 days being greater than 50%. As far as regards temporary employment contracts, the median duration of such contracts is much lower, ranging from 29 days in the case of temporary contracts through job placement agencies, to 105 days in the case of temporary job placements, and to 213 days in the case of job placements on "other contracts" (mainly contracts for continuous and coordinated collaboration, as we have already

seen). The summarised picture shown in Table 3 below also highlights the considerable precision of the estimates, given the low standard error for the estimate of median duration.

This situation could be seen, in a certain sense, as "innate" to the type of contract in question: nevertheless, there are also certain aspects of precarity and insecurity associated with the extremely short "expected duration" of the contracts, in terms of both the insecurity of the job and of the previously-mentioned strictly economic repercussions.

Table 3 below reveals the extremely high number of job placements registered during the three-year period (around 382,000), compared with the average number of employed persons which varies between 420,000 and 450,000 during that same period. There is thus a substantial process of job creation and destruction, in that the considerable number of movements (an average of around 130,000 a year) contrasts with the increase of only 20,000 or so in the number of persons in work during the period 2004-2006: hence the figures for the province of Bologna would seem to indicate that the majority of firms create new jobs in the form of both temporary and permanent posts. When the said temporary contracts come to an end, the majority are renewed for a further temporary period, whereas only a very limited number get transformed into permanent contracts (Cahuc and Postel-Vinay, 2002).

Table 3 – Summarised survival curve figures

| Type of contract	No. placements	Average duration	S.E. average duration	Median duration
Temp. Contracts through agencies	31,031	59	0,656	29
Temp. contracts	161,023	161	0,498	105
Other contracts	6,694	412	6,123	213
Apprentices	29,633	658	3,003	836
Permanent contracts	154,247	836	1,127	N.A.

Source: Elaboration of SILER data – Province of Bologna

It is interesting to see whether the duration of the temporary job placements depends in some way on demographic factors. To this end, and without going beyond job placements on temporary contracts (that is, excluding apprenticeship contracts and permanent contracts), we have estimated the survival curves according to gender (Fig. 2) and to age group (Fig. 3). The age-group classification fails to reveal any difference worthy of note: the median duration of job placements is

98 days for women and 120 days for men, which comes down to 98 days for the age groups 25-34 and 35-44, whereas the median duration for the over-45s age group is 92 days. It would thus seem that for younger people, the "precarity" of temporary job placements is no less pronounced than it is for older people (and in particular, for those over 45), for whom one may presume the existence of a negative signal effect related to the fact that they are looking for work at a mature age, a signal that contributes towards "confining them" to short-term (temporary) jobs. The situation is very different for young people (under 25 years), whose survival curve is significantly removed from, and constantly higher than, the others. It is very likely that this pattern is due to the fact that people under 25 usually get jobs as apprentices, under an employment contract that although of a temporary kind, is usually of considerable duration, as Figure 1 shows and Tassinari et al. (2007) confirm.
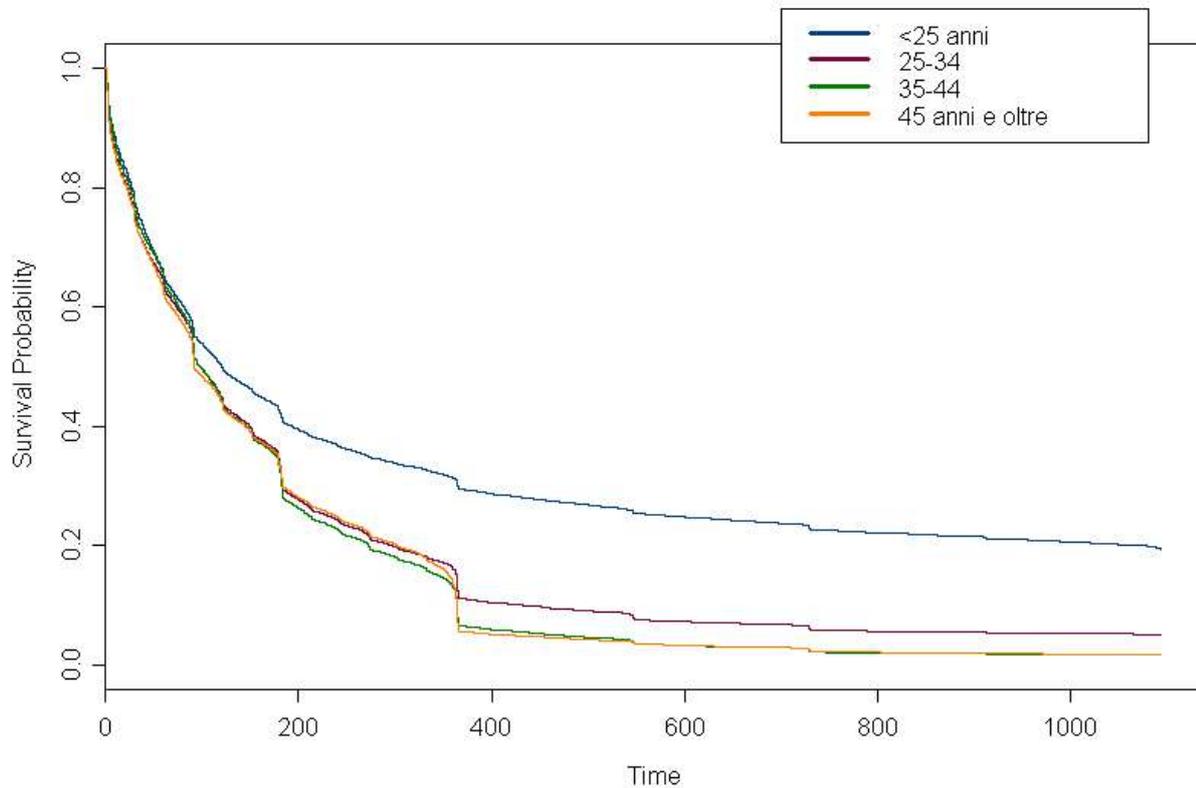
As far as concerns gender, it would seem that there is little or no difference between women and men.

Figure 2 – Survival curves for job placements on temporary contracts, according to gender (2004-2006)
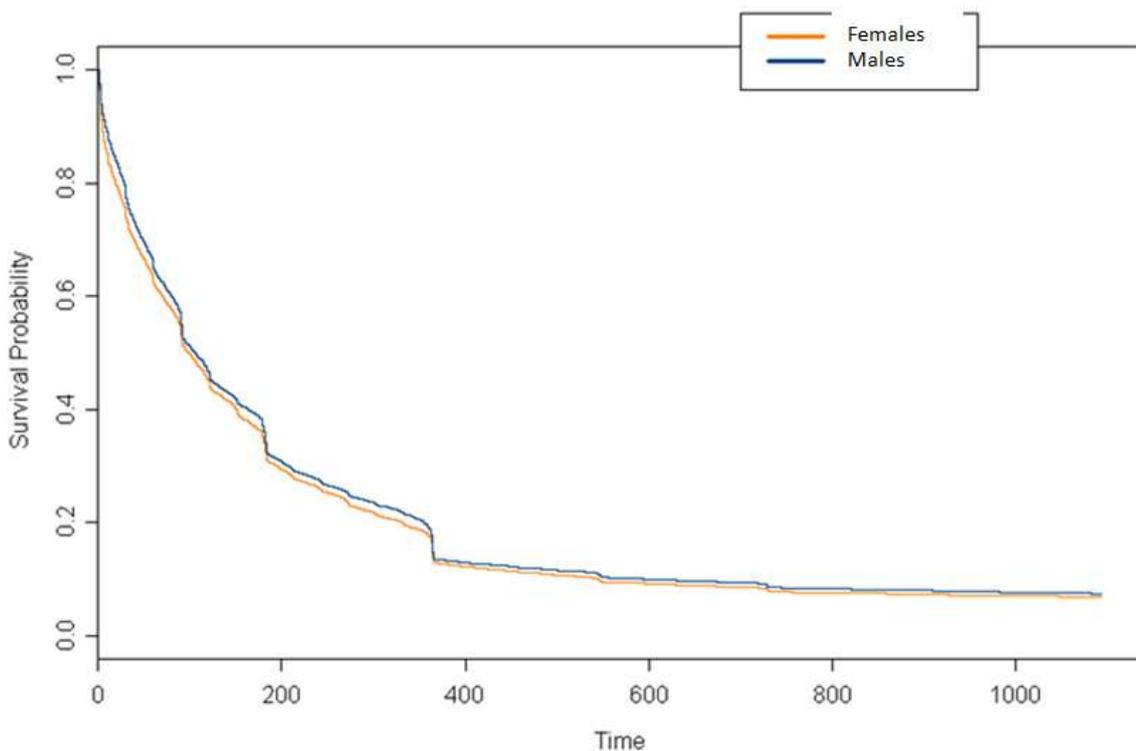
Source: Elaboration of SILER data – Province of Bologna

Figure 3 - Survival curves for job placements on temporary contracts, according to age (2004-2006)

Source: Elaboration of SILER data – Province of Bologna

4. The effectiveness of the CPI's Workfare Action

One of the principal aims of the work of the CPIs (Job Centres) is, as has already been mentioned, that of reinforcing the level of equality in a strongly differentiated workforce, by trying to compensate for the disadvantaged status of the "weaker" segments of the workforce in terms of job opportunities and the quality of the work that they are eventually offered. Those registered with the Job Centres within the Province of Bologna constitute a population (see **Table 4**) dominated by groups with structural characteristics that tend to hinder their employability (such as women, older people, immigrants, and those with few or no educational qualifications).

Table 4 Changes in unemployment (according to the definitions established by Legislative Decree 297/02) within the Province of Bologna (31.12.2006 and 30.06.2007)

	31.12 2006	30.06.2007	% variation
In a state of unemployment	41,761	43,277	+3.6
of which Unemployed	30,331	31,694	+4.5
Non-employed	11,430	11,583	+1.3
Gender			
Male	16,817	17,468	+3.9
Female	24,944	25,809	+3.5
Age			
15-24	4,642	3,896	-16.1
25-34	15,040	14,841	-1.3
35-44	12,179	13,149	+8.0
45-54	6,594	7,389	+12.1
55-64	3,008	3,608	+19.9
65 and over	298	394	+32.2
Nationality			
Italian	32,446	33,306	+2.7
Other	9,295	9,971	7.3
Educational qualifications			
Not indicated	4,858	4,986	+2.6
No qualifications	3,851	3,534	-8.2
Primary or middle school	14,363	15,094	+5.1
Technical college	1,467	1,599	+9.0
High School	10,889	11,368	+4.3
3-yr. degree	473	518	+9.5
University qualification	5,860	6,178	+5.3

Source: Province of Bologna, SILER, figures at the 30th June 2007

The "negative" differential characteristics of those people registered with the Job Centres are obviously reflected on the results of the actions taken. Figures 4 shows the survival curve of job start-ups, calculated using the methods adopted by Cox and Oates (1984), separated into figures for those people starting jobs who are registered with the job Centres, and those starting jobs who have

never been registered with any Job Centres (those who have started work having found jobs either through private employment agencies or through informal relational networks).

It is clear that the likelihood of remaining in the "job starter" status is constantly lower among those registered with the Job Centres than it is among those in the other group[3]. However, assessing causal links between the programmed intervention and observed employment outcomes is not easy, since it requires the effects of Job Centre actions to be disentangled from the effects of the structural characteristics of the unemployed which condition the likelihood of them finding a job. It is incorrect, nevertheless, to draw conclusions about the efficacy of the actions of the public employment services, since the above analysis may be substantially shaped by the compound effect of various factors. The structural characteristics of Job Centre users are such that it is more likely that they will find jobs expected to last for shorter periods of time. Thus in order to express an empirically well-founded judgement, account must be taken of the specific characteristics of those registered with the Job Centres.

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[3] Only the survival curves for those starting temporary jobs have been calculated, as in the case of those starting permanent jobs, such curves are virtually imperceptible.

Figure 4 - Survival curves for those starting temporary jobs: registered Job Centre (CPI) users v those not registered with the Job Centres (2006)
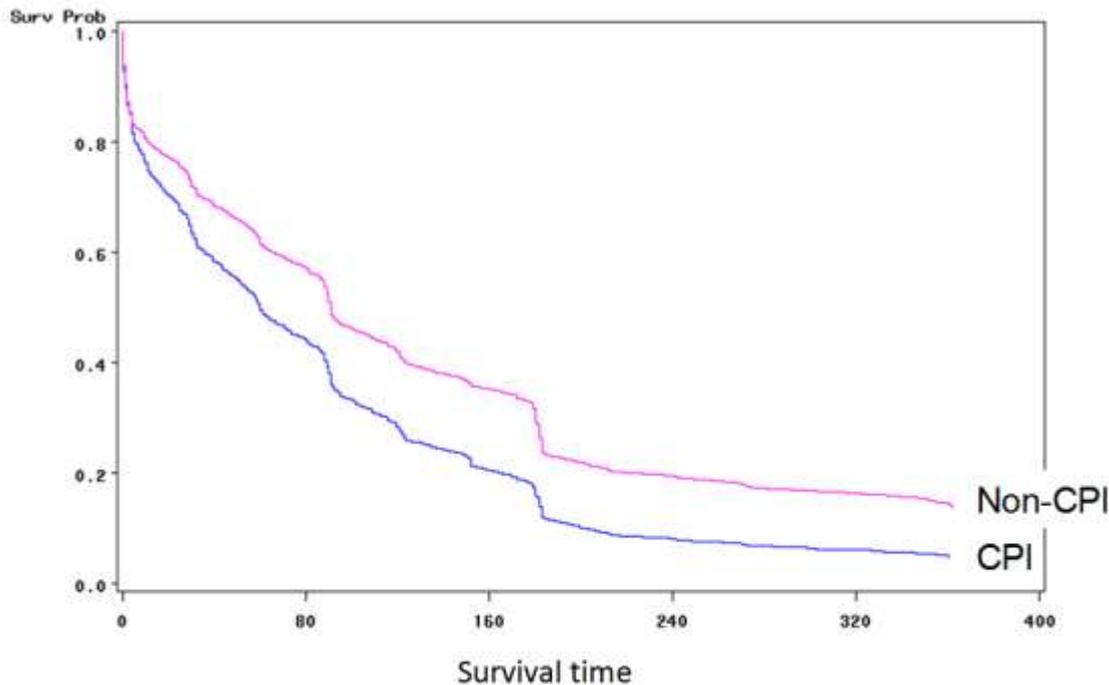
To this end, we may wish to employ a rather complex statistical approach known as the "causal inference" approach (Rosenbaum and Rubin, 1983 & 1984, Bondonio and Grenbaum, 2007). Unlike these works, that use the propensity score approach, we developed a new one (Camillo e Girotti, 2008, Camillo and D'Attoma, 2008), which is based on a multidimensional approach in computing a local (for cluster of units) effect. It can be viewed as a two-stages' procedure:

1. we derive a factorial de-conditioned space using a specific eigenvalues and eigenvectors transformation of the original pre-handling variables; here we adopt a new approach to measuring selection bias and test balance by preserving the multivariate nature of data. The main idea lies in the use of a partial dependence analysis as a tool for investigating the dependence relationship between a set of observable covariates X and a handling indicator variable T, in order to obtain a measure of imbalance according to their dependence;

2. we compute a continuous multidimensional space using an MCA (Multiple Correspondence Analysis) transformation, and we define clusters whereby using the tools in step 1, we can verify the balancing property for each sub-space (cluster) and then it is possible to realize the computation of the evaluation.

The Camillo-D'Attoma method, grounded as it is in a non-theoretical, statistical approach (rather than in economic theory requiring a certain degree of subjectivity), uses patterns in the data to

eliminate any variation associated with handling status, by creating a "de-conditioned" space in which it is possible to conduct an unbiased analysis.

To put it briefly, homogeneous groups of workers who had started jobs in the period 2004-2006 were built, according to a set of demographical and social characteristics present in the SILER database, using however a criterion that made it possible to remove any effects from group homogeneity that are simply associated with the fact of being registered with the Job Centre or otherwise. During the subsequent phase of the procedure, one may compare those workers registered at Job Centres, with those not registered, separately within each group, with reference to certain phenomena which may be considered of relevance to an analysis of the efficacy of the actions of Bologna Province's Job Centres. Our chosen objective variable is the percentage of people hired on permanent employment contracts, as we consider this type of contract to be the one that in general is the best for the workers in question.

The following variables were used to construct the groups: gender (2 options), age group (4 options), civil status (8 options), area of birth (9 options), nationality (9 options), area of residence (9 options), area of home address (9 options) citizenship of the EU or otherwise (2 options). A total of 14 clusters were thus obtained, and their respective weights on the total population are given in **Table 5** below.

Table 5 - Percentage weight of the clusters

	peso complessivo	peso fra gli iscritti CPI	peso fra i non iscritti
cluster1	18.81	17.55	19.05
cluster2	3.29	0.31	3.87
cluster3	5.57	0.76	6.51
cluster4	1.96	5.15	1.33
cluster5	10.17	19.83	8.28
cluster6	13.79	11.45	14.25
cluster7	15.54	16.99	15.26
cluster8	3.05	3.04	3.05
cluster9	8.05	6.70	8.31
cluster10	3.20	1.10	3.61
cluster11	1.90	0.53	2.17
cluster12	1.70	1.54	1.73
cluster13	5.35	6.66	5.09
cluster14	7.63	8.37	7.48
	100.00	100.00	100.00

Table 6 below shows the expected and observed distributions of the percentage of those hired on permanent contracts among the 14 clusters defining a similar number of "common supports" on the basis of which "treated" and "non-treated" can be compared.

Table 6 – Actual and expected distribution according to the non-existence of effects

Cluster	%effettiva	%attesa
1	7.63	33.76
2	8.70	36.01
3	5.36	41.22
4	6.44	1.24
5	4.88	2.48
6	15.53	41.64
7	5.69	0.52
8	2.22	30.65
9	4.54	32.01
10	6.75	35.32
11	3.85	42.80
12	9.65	40.76
13	14.52	13.92
14	14.94	42.65
media	8.29	20.59

The average effect of being registered with the Job Centre is, on the whole, a negative one: the expected figure for hiring on permanent contracts is 20.59%, compared with the actual figure of 8.29%. in other words, if registration with the Job Centre had had no influence on the "permanent – temporary" dichotomy, we would have seen 20,59% of start-ups on permanent contracts, whereas the observed figure was much lower, at 8.29%. Of course, this is all in keeping with the abovementioned criteria concerning the causal inference approach, that is, the elimination of any influence exercised by pre-handling variables, and thus net of any effects associated not with handling, but with the (observed) characteristics of single individuals.

Examining the result more closely, they can be divided into hiring (job start-up) clusters of a homogeneous nature in terms of the characteristics of those subjects included therein. The following clusters are those where "registration with the Job Centre" had a positive effect; 4, 5, 7 and 13 (as shown in the table). In other words, the average effect is really the composition of partial effects, some of which are positive, which means that registration with the Job Centre may be beneficial, depending on the characteristics of the person in question. The meaning of this result could be connected to the varying ability of the diverse Job Centres to orientate job-seekers towards permanent jobs on the basis of the users' various targets, and thus to achieve more effective action with regard to certain specific segments, where registration with the Job Centre leads to people being more easily hired on permanent contracts than average expectations would give us to believe.

The clusters that were positively affected by the actions of the Job Centres are those with certain socio-demographic peculiarities compared with the average. For example, **cluster 4** is mainly

composed of women aged over 40 who live outside of the city of Bologna. It is interesting to see that the married or unmarried status of such subjects does not come into play here. Another positively affected cluster is **cluster 7**, composed mainly of women of child-bearing age, 25-31, most of whom were born and live in the provincial area outside of the city of Bologna, and who are likely to be "single". Another interesting example would seem to be **cluster 13**, where the effect of Job Centre registration is slightly positive: this cluster is composed in the main of persons from North Africa, male and aged between 30 and 40. The other cluster which is positively affected by the Job Centre registration factor is **cluster 5**, and this is the most important of them all for the Job Centres, from the point of view of weight – 19.83% - among those registered with the Jobcentres (see Table 6). This cluster contains a high percentage of older working women, resident and living in Bologna but probably born in the South or North-East of Italy, and in any case married. Altogether, the aforesaid 4 clusters for which Job Centre registration has had a positive effect, account for a total of 32% of all hirings.

It should be pointed out, however, that with reference exclusively to those registered with a Job Centre, the abovementioned four groups account for all of 49% of total hirings; thus we can conclude that among those who register with the public employment services, the work of these services proves to be effective in countering their unfavourable employability ratings.

The results obtained show how the effects of Job Centre registration are not always of the same sign (positive or negative) or of the same intensity, and how this depends toa large extent on the specific characteristics of the people in question. This could be due to a kind of "productive specialisation" that the Job Centres have acquired, over the course of time, when it comes to providing their intermediation services to job seekers and employers; and this specialisation may the reason why they perform better (in terms of the proportion of job seekers who find permanent jobs) when it comes to certain segments that are perhaps socially "weaker", than in the case of other "stronger" segments, where the Job Centres seem to under-perform to a certain extent.

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