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SIS 2018
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1. Preface

This book includes the papers presented at the "49th Meeting of the Italian Statistic Society". The conference has registered 445 participants, 350 reports divided into 4 plenary sessions, 20 specialised sessions, 25 sessions solicited, 27 sessions spontaneous, 2 poster sessions. The high number of participants, the high quality of the interventions, the productive spirit of the conference, the ability to respect the time table, are the main indices of the full success of this conference. The meeting hosted also, as plenary sessions, the ISTAT annual report 2018, and a round table on statistics and job markets. Methodological plenary sessions concerned with ordinal data, the dynamics of climate change and models in biomedicine.
Moreover, two related events were held: Start-up Research (SUR) and Stats Under the Stars (SUS4). The SUS4 event attracted many sponsors of statistical, financial, editorial fields as well as numerous students, not only from Italy but also from abroad (Groningen, Tyumen, Barcelona, and Valencia): 98 students for a total of 25 teams. The SUR was a 2-day meeting where small research groups of young scholars, advised by senior researchers with a well-established experience in different areas of Statistics, was asked to develop innovative methods and models to analyse a common dataset from the Neurosciences.

Labour market condition in Italy during and after the financial crises: a segmented regression analysis approach of interrupted time series

Le condizioni del mercato del lavoro in Italia nel periodo durante e successivo alle crisi finanziarie: un'analisi basata sulle serie temporali interrotte

Lucio Masserini and Matilde Bini

Abstract
One of the most widely recognized indicators of the labour market condition is a rising unemployment rate. In Italy, after the 2008 global financial crisis and the 2012 European sovereign debt crisis, this indicator continuously increased over time until late 2014, after which it seems to happen a trend reversal. The aim of this paper is to assess the existence a significant trend reversal in the unemployment rate after 2014, by analysing quarterly data collected from the Italian National Institute of Statistics using a segmented regression analysis approach of interrupted time series. In particular, the analysis is carried out considering some subpopulations of interest, by stratifying unemployment rate for age groups, in order to examine youth unemployment, gender and macro-regions. Moreover, a focus is given to the analysis of the percentage of people Not Engaged in Education, Employment or Training, to provide a more in-depth analysis of the labour market.
Abstract *Uno degli indicatori più ampiamente riconosciuti come misura della recessione è il tasso di disoccupazione. A partire dalle due recenti crisi mondiali, quella finanziaria globale del 2008 e quella del debito sovrano europeo del 2012, questo indicatore in Italia è costantemente aumentato fino a quando al termine del*

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2014 subisce un'inversione di tendenza, ciò forse dovuto ai recenti interventi locali introdotti nel mercato del lavoro. Lo scopo di questo lavoro è di valutare l'esistenza di un'inversione di tendenza significativa dell'indicatore dopo il 2014, analizzando i dati trimestrali raccolti dall'Istituto Nazionale di Statistica Italiano, utilizzando un approccio di analisi di regressione segmentato delle serie temporali interrotte. In particolare, l'analisi è stata realizzata considerando alcune sottopopolazioni di interesse, stratificando il tasso di disoccupazione per fasce di età, al fine di esaminare la disoccupazione giovanile, sul genere e sulle macro-regioni. Inoltre, un'attenzione particolare è stata data all'analisi della percentuale di persone non impegnate nell'istruzione, nell'occupazione o nella formazione per fornire un'analisi più approfondita del mercato del lavoro.

Key words: unemployment rate, interrupted time series analysis, segmented regression, NEET

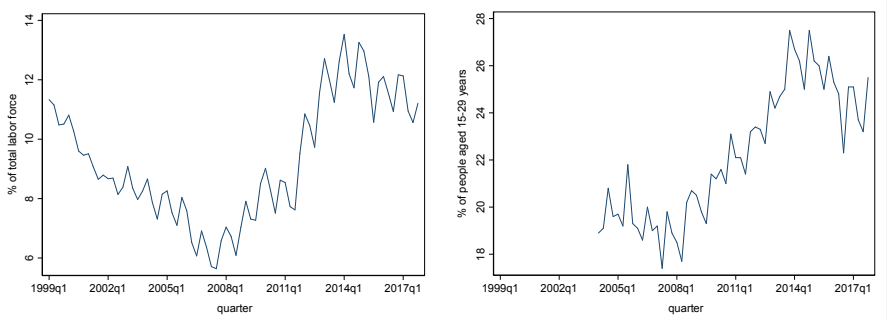
1 Introduction

The recent two economic crises occurred around the world during the period from late 2000s to late 2011, produced negative effects on countries' economies, particularly on GDP growth, on labour productivity and on labour market. As revealed by the International Labour Organization (ILO, 2001), already since the 2009 about 22 million people were unemployed worldwide in particular in developed economies and in the European Union. The unemployment rate continued towards a dramatically increase with high and persistent levels of unemployment until 2014 after which, it seems to happen a trend reversal, maybe due to the recent domestic interventions introduced in the labour market. The aim of this paper is to assess the existence of a significant trend reversal in the unemployment rate after 2014, using a segmented regression analysis approach of interrupted time series. Quarterly data were collected from the website of the Italian National Institute of Statistics. the analysis is carried out considering some subpopulations of interest, by stratifying unemployment rate for age groups, in order to examine youth unemployment, gender and macro-regions. Changes in the trend are also evident in the percentage of a particular sub group of young people, defined as neither employed nor in education or training (NEET). This could mean that local interventions produced effects in some extent also to this category.

2 Data and empirical strategy

Data were collected from I.Stat, the warehouse of statistics currently produced by the Italian National Institute of Statistics (ISTAT) which provides an archive of about 1,500 time series (http://dati.istat.it/). Quarterly data on two different kind of

indicators were downloaded from the theme 'Labour and wages': UR for the period 1993–four quarter of 2017, overall and stratified by gender, age groups and macro-regions; and the percentage of NEET for the period 2004– four quarter of 2017, overall and stratified by gender. Such data are derived from the official estimates obtained in the Labour force survey, carried out on a quarterly basis interviewing a sample of nearly 77,000 households representing 175,000 individuals. According to the Eurostat definition (Eurostat, 2017), UR is given by the number of people unemployed as a percentage of the labour force. The youth unemployment rate (YUR) is the number of unemployed 15–24 years-old expressed as a percentage of the youth labour force, and the NEET refers to the percentage of people aged between 15 and 29 years who currently do not have a job, are not enrolled in training or are not classified as a student. Figure 1a illustrates the trend in the overall UR in Italy from 1999 to the end of 2017. The choice of such a long period allows for a more accurate estimate of the secular trend, and this will be useful for the subsequent analysis. Looking at the graph, UR steadily declines until the third quarter of 2007 (2007q3). Then, starting from the fourth quarter of 2007 (2007q4), period in which the effects of the financial crisis following the bankruptcy of Lehman Brothers begin to appear, UR undergoes a first shock and shows a trend reversal. Afterwards, UR increases even more dramatically up to 13.26% at the end of 2014 (2014q4), after the European sovereign-debt crisis occurred in the late 2011 (2011q4). After this peak, UR seems to show a new trend reversal, showing a possible structural change.



(a) (b)

Figure 1: Total UR (a) and percentage of NEET (b) in Italy over the observed period

Figure 1b illustrates the trend of the overall percentage of NEET in Italy from the first quarter of 2004 (2004q1) to the four quarter of 2017 (2017q4). Here the series is shorter because data from previous years are not available. This trend seems, at least partly, to be similar to that of UR. Indeed, after a slight decrease in the period before the onset of the global financial crisis (2007q3), the percentage of NEET starts a steeply and steady growth that continues unchanged also after the occurrence of the sovereign debt crisis (2011q3). And as in UR, a trend reversal occurred starting from the end of 2014 (2014q4).

In the light of the previous considerations, the analysis period was divided into the following four sub-periods: the period before the so-called 2008 global financial crisis (until 2007q3); the subsequent three-year period known as the Great Recession aftermath of the financial crisis, characterised by a general economic decline observed in world markets (2007q4–2011q3); the period following the European sovereign debt crisis, which resulted in a second economic recession (2011q4–2014q4); and finally, the last three years (2015q1–2017q4), during which it seems to glimpse a slight decrease in both the UR and the percentage of NEET. Consequently, the three breaks in the series were set in 2007q4, 2011q4 and 2015q1. Therefore, the analysis period is limited to the years 1999q1–2017q4 for the UR and to 2004q1–2017q4 for the percentage of NEET. The identified interruptions allow to highlight: the severity of the two financial crises, respectively, the continuation of their effects in the subsequent years of recession, and the more recent trend reversal occurred after the end of 2014.

3 Interrupted time series analysis

In this study, a segmented regression approach of interrupted time series (ITS) analysis was carried out in order to assess and measure, in statistical terms, whether and how much the two financial crises have changed the level and trend in the outcome variables, immediately and over time, and to see if these changes are short- or long-term (Wegner, Soumerai and Zhang, 2002).

ITS analysis (Shadish, Cook and Campbell, 2002) is a simple but powerful tool used in quasi-experimental designs for estimating the impact of population-level or large scale interventions on an outcome variable observed at regular intervals before and after the intervention. In such circumstances, ITS allows to examine any change on the outcome variable in the post-intervention period given the trend in the pre-intervention period (Bernal, Cummins and Gasparrini, 2016). In this respect, the underlying secular trend in the outcome before the intervention is determined and used to estimate the counterfactual scenario, which represents what would have happened if the intervention had not taken place and serves as the basis for comparison. For the purposes of our study the interventions are given by two unplanned and real-world events, the aforementioned and well recognized financial crises, and by the subsequent already mentioned trend reversal. In segmented regression of ITS, each sub-period of the series is allowed to exhibit its own level and trend, which can be represented by the intercept and slope of a regression model, respectively. The intercept indicates the value of the series at the beginning of an observation sub-period; and the slope is the rate of change during a segment (or sub-period). Therefore, by following this approach it is possible to compare the pre-crisis level and trend with their post-crisis counterpart, in order to estimate the magnitude and statistical significance of any differences.

The ITS regression model with a single group under study (here, the Italian population), two interventions, which in this study are given by the two economic recessions in 2007q4 and 2011q4, and a possible UR trend reversal in 2015q1, can

be represented as it follows (Linden and Adams, 2011; Bernal, Cummins and Gasparrini, 2016):

$$y_t = \beta_0 + \beta_1 T_t + \beta_2 x_{t2007q4} + \beta_3 T_{t2007q4} x_{t2007q4} + \beta_4 x_{t2011q4} + \beta_5 T_{t2011q4} x_{t2011q4} + \\ + \beta_6 x_{t2015q1} + \beta_7 T_{t2015q1} x_{t2015q1} + \varepsilon_t .$$

In particular, y_t is the aggregated outcome variable at each equally-spaced time-points t, here represented by quarters; T_t is the time elapsed since the start of the study, where t varies between 1999q1 to 2017q4 for UR and between 2004q1 to 2017q4 for NEET, respectively; $x_{t2007q4}$ is a dummy variable indicating the onset of the global financial crisis in fourth quarter of 2007, coded as 0 (pre-crisis period) and 1 (post-crisis period); $T_{t2007q4}x_{t2007q4}$ is the interaction term between time and the 2007q4 global financial crisis; $x_{t2011q4}$ is a dummy variable indicating the onset of the 2011q4 European sovereign debt crisis, coded as 0 (pre-crisis period) and 1 (post-crisis period); and $T_{t2011q4}x_{t2011q4}$ is the interaction term between time and 2011q4 European sovereign debt crisis. Finally, $x_{t2015q1}$ is a dummy variable indicating the time in which a new trend reversal occurred, coded as 0 (before the trend reversal) and 1 (after the trend reversal); and $T_{t2015q1}x_{t2015q1}$ is the usual interaction term. Accordingly, β_0 is the intercept and represents the starting level of the outcome variable at T = 1999q1 for UR and T = 2004q1 for NEET, respectively; β_1 is the slope and represents the trajectory (or secular trend) of the outcome variable until the 2007q4 global financial crisis; β_2 is the level change that occurs immediately following the 2007q4 global financial crisis (compared to the counterfactual); β_3 is the difference between the slope pre and post the global financial crisis; β_4 is the level change that occurs immediately following the 2011q4 European sovereign debt crisis; β_5 is the difference between the slope pre and post the European sovereign debt crisis; β_6 is the level change that occurs immediately following the 2014q4 (compared to the counterfactual); β_6 is the difference between the slope pre and post the trend reversal; and ε_t represents the random error term which is assumed to follow a first auto-regressive (AR1) process. The regression coefficients are estimated by using Ordinary least-squares (OLS) method with the Newey-West (1987) standard errors.

4 Results

Four periods of linear trend were considered to analyse UR and NEET, with interruptions at 2007q4, 2011q4 and 2015q1, respectively. Separate segmented regression models were then estimated for age groups, gender and macro-regions via ordinary least-squares by using Newy-West standard errors in order to handle one lag autocorrelation. To account for the correct autocorrelation structure, Cumby-Huizinga test (Cumby and Huizinga, 1992) was performed and results confirm that autocorrelation was present at lag 1, but not at higher orders (up to the 9 lags were

tested). Results are shown in Table 1 for the UR and in Table 2 for the NEET. As regards the UR, the 1999 base rate showed some variability in the considered sub-groups. In fact, starting from 10.754 at national level, its value was particularly higher for the age group 15–24 (26.726) and for the South macro-regions (20.211) but lower for the North East (4.538) and North West (5.831) macro-regions, as well as for the males (8.177) and for the 45–54 age group. Moreover, the trend prior to the 2008 global financial crisis (1999q1–2007q3) showed a significant and general decrease, both at national level (-0.137; $p < 0.001$) and for the different age groups, macro regions and gender. Such reduction was more pronounced for the sub-groups traditionally considered as the most vulnerable ones, namely South macro-regions (-0.266; $p < 0.001$), females (-0.202; $p < 0.001$) and YUR (-0.182; $p < 0.001$). The onset of the global financial crisis (2007q4) caused an immediate and substantial UR increase at national level (+0.788; $p < 0.05$) and in almost all the considered sub-groups but no significant change was detected for younger people (age groups 15–24 and 25–34) and the North-East macro region. In particular, the more severe direct consequences were observed among females (+1.061; $p < 0.001$), for people in the central (+1.047; $p < 0.001$) and southern regions (+0.978; $p < 0.05$) and for the intermediate age group 35–44 (+0.997; $p < 0.001$). The aftermath of the financial crisis was quite strong and resulted in the Great recession in the subsequent years during which a substantial and significant trend change was observed compared to the previous period (+0.253 $p < 0.001$). However, in this case, the most serious consequences occurred particularly for YUR (+0.717; $p < 0.001$) and, to a much lesser extent, for the South macro-regions (+0.365; $p < 0.001$). On the other hand, the immediate consequences of the second financial crisis, following the European sovereign debt crisis (2011q4) were even stronger when compared to the previous financial crisis and resulted in a second economic recession, with an UR increase almost double at the national level (+1.540; $p < 0.001$). Such increase was higher for YUR (+3.676; $p < 0.05$) and for the South macro region (+2.611; $p < 0.001$) while there was no significant increase again for North East macro region.

After this second financial shock, the UR seems to further accelerate its increase only in some sub-groups while at national level no significant trend difference was observed. In particular, such acceleration was particularly higher for the South macro-regions (+0.355; $p < 0.001$), age group 25–34 (+0.246; $p < 0.05$) and females (+0.187; $p < 0.001$) while no significant further rate increase was detected for YUR. However, it should be emphasized here that this further increase, although lower than the one highlighted during the Great Recession, where present has to be added to that already existing, thus making particularly critical the situation.

Table 1: Estimates of the impact of the 2007q4 and 2011q4 financial crises on the UR in Italy and trend reversal after 2015q1

…	*Base rate (1999)*	*Trend 1999q1-2007q3*	*Rate change 2007q4*	*Trend change 2007q4*	*Rate change 2011q4*	*Trend change 2011q4*	*Rate change 2015q1*	*Trend change 2015q1*
Overall	10.754***	-0.137***	0.788**	0.253***	1.540***	0.136**	-1.234**	-0.357***
Males	8.177***	-0.095***	0.602*	0.250***	1.426***	0.101	-1.018	-0.396***
Females	14.655***	-0.202***	1.061***	0.261***	1.675***	0.187***	-1.515***	-0.304***
15–24	26.726***	-0.182***	0.955	0.717***	3.676**	0.350	-3.371	-1.607***
25–34	11.074***	-0.068***	0.127	0.290***	1.566**	0.246**	-1.811*	-0.600***
35–44	7.771***	-0.095***	0.997***	0.177***	1.245***	0.166***	-1.225***	-0.285***
45–54	6.401***	-0.099***	0.725***	0.196***	1.111***	0.109**	-0.869*	-0.242***
55–64	7.901***	-0.166***	0.847***	0.219***	1.350***	-0.005	-0.143	-0.031
North West	5.831***	-0.067***	0.800**	0.221***	0.892**	0.008	-0.776	-0.320***
North East	4.538***	-0.037***	0.220	0.166***	0.855	0.007	-0.673	-0.269***
Center	8.540***	-0.097***	1.047***	0.188***	1.364***	0.134**	-1.021	-0.329***
South	20.211***	-0.266***	0.978**	0.365***	2.611***	0.355***	-2.290***	-0.501***

Table 2: Estimates of the impact of the 2007q4 and 2011q4 financial crises on the percentage of NEET in Italy and trend reversal after 2015q1

…	*Base rate (2004)*	*Trend 2004q1-2007q3*	*Rate change 2007q4*	*Trend change 2007q4*	*Rate change 2011q4*	*Trend change 2011q4*	*Rate change 2015q1*	*Trend change 2015q1*
Overall	19.866***	-0.062	-0.250	0.316***	0.103	0.094	-1.510**	-0.529***
Males	15.152***	0.014	-0.398	0.334***	-0.037	0.099	-1.787**	-0.680***
Females	24.584***	-0.125*	-0.221	0.285***	0.269	0.084	-1.135	-0.369***
North West	12.575***	-0.079	0.664	0.382***	-1.242	0.103	-1.632	-0.572***
North East	10.522***	-0.009	-0.558	0.364***	-0.268	-0.069	-1.169	-0.545***
Center	15.406***	-0.090	-0.995	0.404***	0.989	-0.001	-1.053	-0.561***
South	29.798***	-0.072	0.295	0.258***	0.564	0.204***	-1.801***	-0.482***

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$

The consequences of this second financial crisis seem to run out by the end of 2014. Indeed, a trend reversal occurs staring from 2015q1. In particular, the rate change decreases significantly only overall (-1.234; $p < 0.05$), for females (-1.515; $p < 0.001$), age group 35–44 (-1.225; $p < 0.001$) and the South macro-region (-2.290; $p < 0.001$). On the other hand, the trend change is more evident and is significant for all categories except for age class 55–64 and shows a stronger reduction for young generation 25–34 (-1.607; $p < 0.001$) and, to a lesser extent, for the South macro-region (-0.501; $p < 0.001$).

As regards the percentage of NEET, a considerable heterogeneity was found in the 2004 base rate, which was 19.866 at national level. Its value was higher for the South macro-regions (29.798) but lower for the North East (10.522) and North West (12.575) macro-regions; moreover, it was higher for females (24.584) than males (15.152). On the other hand, its trend prior to the 2008 global financial crisis (2004q1–2007q3) was basically constant at national level. The onset of the of the global financial crisis (2007q4) did not cause an immediate impact on the percentage of NEET, overall and in any of the considered sub-groups. However, a significant trend change was found both at national level (+0.316; $p < 0.001$) and for all the other sub-groups; such change was particularly higher only for the macro-regions of Center (+0.404; $p < 0.001$). The European sovereign debt crisis (2011q4) does not seem to alter this situation, neither for the rate change nor for the trend change. This means that after this second financial crisis the rise of the percentage of NEET remains steady and equal to the previous period without showing any jump. But for the last trend change (2015q1), results reveal to be significant for all sub groups, particularly for females (-0.680; $p < 0.001$). This confirms that after the end of the two crises and local interventions, a new period of recovery has finally started again. Also for the percentage of NEET, a trend reversal occurs staring from 2015q1. In particular, analogously to the UR, this reduction is significant for all the considered sub-groups, but it is more pronounced for males (-0.680; $p < 0.001$) and lower for females (-0.369; $p < 0.001$) and South marco-region (-0.482; $p < 0.001$).

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