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Cities and Innovation

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ABSTRACT: Using Labour Force Survey individual-level data recently released by the Italian Institute of Statistics (ISTAT) where information is for the first time at available at provincial level, this paper looks at the short-term effects of the L'Aquila earthquake on labour market outcomes. Our estimates are based on a difference-in-differences (DiD) strategy that compares residents of L'Aquila with residents of a control area before and after the earthquake. The empirical results suggest that while the earthquake had no significant effect on the employment-population ratio, it led to a modest, but significant, reduction in labour force participation. There is also evidence of significant heterogeneous effects by gender and level of education.

JEL Codes: J21

Keywords: Disaster, labour force participation, employment-population ratio, difference-in-differences

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1. Introduction

On April 6th 2009 central Italy was struck by a severe earthquake measuring up to 8-9 on the MCS (Mercalli-Cancani-Sieberg) scale. Its epicenter was near L'Aquila, the capital of the Abruzzo region, which is situated about 70 miles northeast of Rome. The earthquake killed 309 people, which makes it the deadliest earthquake to hit Italy since the 1980 Irpinia earthquake. In addition to this, it injured about 1,600 people and rendered more than 65,000 people[1] homeless (Masi, 2009). Thousands of buildings and infrastructure were seriously damaged or destroyed. The historical centre of the city of L'Aquila, which hosts numerous public offices, a university campus and several medieval buildings, was especially hit hard. More than 2,000 firms were forced to close their business while others remained operational in business but suffered major damages because of the loss of stocks, tools and machinery. The economic damage caused by the L'Aquila earthquake is estimated to be approximately 540 million of euro[2].

Not only have press, media and the international community shown great interest in L'Aquila in the days immediately following the earthquake, but further attention was paid to the situation in L'Aquila in July 2009 during the G8 summit. Following the natural disaster, the Italian government decided in fact to move the location of the 35th G8 summit from the Sardinian city of La Maddalena to L'Aquila. This decision was taken as a sign of solidarity for the victims and in an attempt to raise additional relief funds.

Using Labour Force Survey individual-level data recently released by the Italian Institute of Statistics (ISTAT) where information is for the first time at available at provincial level[3], this papers looks at the effect of the L'Aquila earthquake on labour force participation and employment-population ratio. Policymakers who are assessing economic recovery in L'Aquila and those who are concerned how to deal with future disasters need to be aware how the earthquake impacted various aspects of the local economy, including the local labour force and local employment levels. Our estimates are based on a difference-in-differences (DiD) strategy that compares residents of L'Aquila with residents of a control area before and after the earthquake.

[1] In 2008, the total population of the province of L'Aquila was 309,131.
[2] These figures come from the report "Prime considerazioni sugli scenari di sviluppo e le strategie di intervento da mettere in campo per il territorio de L'Aquila" available at http://www.commissarioperlaricostruzione.it/Informare/Normative-e-Documenti/Atti-e-documenti-della-Struttura-Tecnica-di-Missione-STM/Idee-e-strumenti-per-la-ricostruzione-pesante/Prime-considerazioni-sulle-strategie-di-sviluppo-e-gli-scenari-di-intervento-da-mettere-in-campo-per-il-territorio-dell-Aquila
[3] Information was previously available only at regional level.

Our work adds to previous research on the impact of natural disasters on labour market outcomes in two main aspects. First, although there are many studies on this topic, to the best of our knowledge, this is the first one focusing on Europe. This is not surprising as Europe is significantly less exposed to natural catastrophes than other areas of the world. For instance, Jones (1981) argues that in Asia the probability of dying in a seismic disaster is about 30 times higher than in Europe. More recently, Cavallo and Noy (2009) report that between 1970 and 2008 approximately 99% of individuals affected by natural disasters lived in the Asia-Pacific region, Latin America, the Caribbean or Africa. However, whilst studies based on the experiences of these areas are instructive, it would be rather hazardous to make inference exclusively based on them. As outlined by Loayza *et al.* (2009), the effects of natural disasters are quite heterogeneous as they vary depending on the type, intensity and level of development of the affected country. Second, unlike much of the prior literature that has used area-level data to analyse the impact of natural disasters on labour market outcomes, this is one of the few studies relying on individual-level data. This allows us to examine the effect of the earthquake on labour force participation and employment-population ratio controlling for a number of demographic characteristics. Another advantage of employing individual-level data is that it enables us to examine whether the earthquake had a differential impact across important subgroups of the population.

One main concern with this type of analysis is that, since natural disasters typically lead to short- and long-distance migration of the affected population, the sample drawn from the hit area in the aftermath period is often quite small as it does not include information on evacuees. However, the ISTAT, which is responsible for the administration of the Italian Labour Force Survey, has ensured that the samples collected from L'Aquila in the months immediately after the earthquake are comparable with those collected in the months preceding the natural disaster[4]. ISTAT employees were in fact able to contact the large majority of the individuals who were displaced from their homes as a result of the earthquake[5]. This is also supported by the fact that in the dataset average characteristics of residents of L'Aquila before and after the earthquake are found to be relatively similar[6]. Given that following natural disasters individuals with certain characteristics are more likely to be displaced (even temporarily) than others (see, for instance, Gabe *et al.*, 2005 and

[4] See ISTAT press release, March 24th 2010
[5] This has also been possible due to the fact that most evacuees relocated to areas relatively close to where they had been living before the natural disaster.
[6] These statistics are reported in the Appendix.

McIntosh, 2008), if the post-earthquake samples did not include evacuees, the demographic attributes of residents of L'Aquila would have probably changed.

To preview the main results, our estimates indicate that while the earthquake had no significant effect on the employment-population ratio, it led to a modest, but significant, reduction in labour force participation. Additionally, there is no evidence suggesting that negative effect on labour force participation rate decreased over time. Finally, our empirical findings indicate that there are significant heterogeneous effects between genders and educational levels.

The remainder of the paper is organized as follows. Section 2 briefly reviews those studies that have investigated the impact of natural disasters on labour market outcomes using individual-level data. While Section 3 describes the data and depicts the empirical strategy, estimates are presented and discussed in Section 4. Section 5 concludes.

2. Related Literature

There is a quite large body of research looking at the effect of various natural disasters on labour market outcomes. The vast majority of these studies, however, rely on area-level data, exploiting the fact that several natural catastrophes are confined to clearly identifiable geographic areas for which data on employment and unemployment are typically available. Some of the challenges faced by using this approach are that aggregate measures conceal several individual-level factors that may significantly affect labour market outcomes. To address this concern, a few recent works, published since 2007, employ individual-level data from household or labour force surveys. To provide context for our paper, we briefly review the findings of some of these studies. It is worth to note that US-based studies tend to dominate this line of research.

Using data from the monthly Current Population Survey (CPS), several studies analyse the effects of Hurricane Katrina on labour market outcomes of evacuees. Exploiting the additional questions included in the CPS following Katrina, these studies have the advantage relative to previous research of being able to observe the labour market status of individuals who, as a result of the storm, were displaced to other parts of the affected regions or had to relocate to other regions of the US. Groen and Polivka (2008) conclude that Katrina had quite significant negative effects on the labour market outcomes of evacuees in the 13 month period following the hurricane. Specifically, they estimate that it reduced the labour force

participation by 3.5 percentage points, lowered the employment-population ratio by 7.1 percentage points, and increased the unemployment rate by 6.3 percentage points. These effects, however, tend to substantially diminish over time. Vigdor (2007) also finds that Katrina led to short-term detrimental effects on the labour market performance of evacuees. These effects are more persistent for evacuees who do not return relative to those who return. In addition to confirming the findings of the two aforementioned studies, Zissimopoulos and Karoly (2010) emphasise the important role played by self-employment as part of the post-hurricane economic recovery.

There are also a few studies that use individual-level data to analyse the effect of natural disasters on labour market outcomes in less developed countries. Using data from household surveys, Muller and Osgood (2009) study the log-term impact of droughts in Brazil. Their analysis shows that these droughts have led to lower wages in the affected rural areas for a period of five years after the event. In a recent paper, Muller and Quisumbing (2011) look at the effect of a major flood experienced by Bangladesh in 1998. They conclude that this natural disaster produced short-term reductions in agricultural and non-agricultural wages.

3. Data and Methodology

The ISTAT has recently released 4 waves of its quarterly labour force survey[7], containing for the first time information at provincial level[8]. Whilst one of these waves (i.e. first quarter of 2009) covers the period before the L'Aquila earthquake, the other three waves (i.e. second, third and fourth quarters of 2009) refer to the period after this earthquake.

To estimate the effect of the L'Aquila earthquake on labour market outcomes, we adopt a DiD approach. Denote by Y_{Aquila}^{After} the labour force participation or employment-population ratio[9] in L'Aquila after the earthquake, and by Y_{Aquila}^{Before} the labour force participation or employment-population ratio in L'Aquila before the earthquake. The difference (Y_{Aquila}^{After} - Y_{Aquila}^{Before}) is then an estimator of the effect of the earthquake. However, this estimator is

[7] This survey is a nationally representative sample of approximately 77,000 households (corresponding to around 180,000 individuals) per quarter.
[8] There are no other waves of this survey either in the pre or post-earthquake period containing information at provincial level.
[9] Following the ISTAT definition of labour force participation and employment rate, we focus our attention on individuals aged between 15 and 64. Labour force participation is defined as the number of individuals aged between 15 and 64 in the labour force (those employed plus those unemployed) divided by the population aged 15 to 64. Employment-population ratio is defined as the number of individuals aged between 15 and 64 employed divided by the population aged 15 to 64.

confounded to the extent that it also picks up the effect of other factors influencing our indicators of labour market outcomes and changing at the same time as the earthquake. In an attempt to correct for that, we contrast this difference with the difference between labour force participation or employment-population ratio before and after the earthquake in an appropriate control area that was plausibly uninfluenced by this natural disaster. The choice of this comparison area is crucial, as it should capture counterfactual trends in labour force participation and employment-population ratio in the absence of the earthquake. Although the choice of the counterfactual is, by definition, not testable as it involves unobserved scenarios, we argue that the province of Perugia constitutes a suitable control area in light of the following six considerations:

1) Both Perugia and L'Aquila are capitals of regions. While Perugia is the capital of Umbria, L'Aquila is the capital of Abruzzo. This means that they both host regional governments' offices in addition to the provincial and municipal ones. This suggests that, although data on the proportion of workers in the public sector are not available, one would expect this figure to be relatively comparable across the two provinces.

2) Both Perugia and L'Aquila have a university campus attracting a considerable number of students. This means that in both provinces a significant proportion of the population is made up by university students. In the first quarter of 2009, among people aged between 15 and 64, the proportion of university students in L'Aquila was 6.9%, while the corresponding figures in Perugia was 4.9%[10].

3) As illustrated in Figure 1, the province of Perugia is geographically close, but not adjacent to the province of L'Aquila. As suggested by Marchand (2011), it would be best not to employ control areas directly bordering the target area as it is important to create a buffer between the treatment and comparison groups in an attempt to avoid spill-over effects[11]. This consideration is reinforced by the finding of a recent study by McComb *et al.* (2011). They argue that in the aftermath of natural disasters, output in adjacent unaffected regions may actually increase as it provides substitute production capacity and shelter.

Insert Figure 1 about here

[10] These figures were calculated using our dataset. Survey weights are used in all analyses presented in this paper.

[11] Based on this consideration, the other provinces of the Abruzzo region (i.e. Teramo, Pescara and Chieti) do not constitute suitable control areas (some municipalities of Teramo and Pescara were also directly affected by the earthquake)

4) The industry structure is reasonably similar across the control and target areas. In 2008, the year before the earthquake, in L'Aquila the proportion of workers employed in the agriculture and fishing sectors was 4.9%, while the corresponding figure in Perugia was 3.9%[12]. The proportions of people working in manufacturing and services are also quite close across these provinces. Specifically, in 2008 in L'Aquila the proportions of workers employed in manufacturing and services were 29.6% and 65.5% respectively, whereas the corresponding figures in Perugia were 33.1% and 63%, respectively. As observed by Korkeamäki and Uusitalo (2009), it is especially important that the control and target areas display a similar industrial composition as this suggests that they are likely to follow the same business cycle.

5) A necessary condition for our DiD strategy to be valid is that in the pre-earthquake period the control and target areas exhibited similar time trends in labour force participation and employment-population ratio. In fact, if these time trends were similar in the pre-earthquake period, then it is likely that they would have been similar in the post-earthquake period if L'Aquila had not been hit by the earthquake. Unfortunately, our dataset cannot be used to test the validity of this assumption since, as stated above, only one wave of the Labour Force Survey before the earthquake is available. Due to data availability, the only way to test for this assumption is to employ annual ISTAT data between 2004 and 2008[13]. Data before 2003 are not comparable with later years because of a change in the methodology used by the ISTAT to calculate these labour market indicators. Additionally, quarterly data for this period are unavailable. Figure 2 shows that between 2004 and 2008 the movements of labour force participation and employment-population ratio in L'Aquila followed quite closely those observed in Perugia. This similarity is reassuring as it suggests the DiD assumption of parallel trends in the absence of treatment is met. At this point, it is worth emphasizing that the DiD approach does not require that the level of the outcome variable is similar across the target and control areas. All that is required is that the time trend is similar in the pre-treatment period (Dorsett, 2005).

Insert Figure 2 about here

[12] Data on the industrial composition of Perugia and L'Aquila in 2008 come from "Forze di Lavoro-Media 2008" published by ISTAT and downloadable from http://www.istat.it .
[13] These data can be downloaded from http://www.istat.it

Although Figure 2 provides visual evidence that in the pre-earthquake period time trends in labour force participation and employment-population ratio in the target and control areas were similar, we formally test this by employing an approach followed by Görlitz (2010). Using annual data for the 2004-2008 period, we first compute the difference in each of our two labour market indicators between L'Aquila and Perugia, and then we regress it against a constant and a linear time trend. As in both regressions the coefficient on the linear time trend is not statistically significant at the usual confidence levels[14], we cannot reject the hypothesis that the target and control areas had the same time trends in labour force participation and employment-population ratio before the earthquake.

6) Residents of L'Aquila and Perugia had very similar characteristics before the earthquake. Table 1 shows mean equality tests for several variables using data for the first quarter of 2009. From this Table one can observe that no statistically significant differences for all our control variables were found between residents of the target and control areas in the pre-earthquake period.

Insert Table 1 about here

We can denote the second difference by $(Y^{After}_{Perugia} - Y^{Before}_{Perugia})$, so that our DiD estimator is $\delta = (Y^{After}_{Aquila} - Y^{Before}_{Aquila}) - (Y^{After}_{Perugia} - Y^{Before}_{Perugia})$.

In practice δ is estimated using regression analysis. Therefore, in line with the approach employed by Staubli (2011) and Groen and Polivka (2008), we estimate the following regression specification, clustering standard errors at the quarter level to account for within-quarter correlation:

$$(1) \qquad Y_{it} = \alpha + \beta_1 Treat_{it} + \delta\ (Treat_{it} * Post_{it}) + \lambda_t + X'_{it}\varphi + \varepsilon_{it}$$

where Y_{it} is the labour market outcome for individual i in quarter t; *Treat* is a dummy for treatment group (1 if the individual resides in L'Aquila, and 0 if the individual resides in Perugia); *Post* is a dummy that takes a value 1 for observations after the earthquake, and 0 otherwise; λ is a quarter-fixed effect; X is a vector containing a set of time-varying individual-level covariates (gender, age, aged squared, marital status, presence of at least one child aged less than 6 in the household, education, the interaction of gender and marital status and the interaction of gender and presence of at least one child aged less than 6 in the

[14] Results of these regressions are available upon request from authors.

household) and ε is an individual-by-quarter specific error term. The coefficient of interest, δ, identifies the (average) effect of the earthquake on the probability of participating in the labour force or the probability of being employed among residents in the province of L'Aquila in the post-earthquake period relative to those outcomes for residents in the province of Perugia. The key identifying assumption is that residents of the target area would have experienced the same labour market outcomes as residents of the control area in the absence of the earthquake, after conditioning on observables.

In line with the approach of Groen and Polivka (2008), to analyse how the effect of the earthquake varies over time, we add to the explanatory factors of the equation above an interaction between a linear time trend (time), which ranges from 0 for the first quarter after the earthquake (i.e. second quarter of 2009) to 2 for the second quarter after the earthquake (i.e. fourth quarter of 2009), and the $Treat_{it} * Post_{it}$ variable.

We estimate the above equation using a linear model irrespective of the fact that both our outcome measures are binary. The linear probability framework is more robust to mis-specifications (Falck *et al.,* 2010) and it allows us to directly estimate the parameter of interest. Furthermore, as pointed out by Angrist (2001), the problem of causal inference does not significantly differ between limited dependent variables and continuous outcomes. This means that if there are no covariates or the covariates are sparse and discrete, then linear models can be used to estimate models with limited dependent variables as well as models with other types of dependent variables

Our analysis is accompanied by one drawback**.** One should observe that not all the municipalities of the province of L'Aquila were affected by the earthquake. However, in our dataset, given that information is only available at provincial level and not at municipality level, we are forced to assume that our treatment group is composed by all individuals residing in the province of L'Aquila. Though this is not ideal, the following arguments suggest that this is a relatively good approximation. In the aftermath of the natural disaster, the Italian Department of Civil Protection made a list of municipalities that were severely affected by the earthquake - defined as a magnitude 6 or greater on the MCS scale. This list, which initially included 37 municipalities of the province of L'Aquila (including the municipality of L'Aquila), has grown over time and currently comprises 46 of them[15]. In 2008, the year before the earthquake, the proportion of individuals residing in these

[15] The total number of municipalities in the province of L'Aquila is 108.

municipalities accounted for approximately 51% of the total population of the province of L'Aquila. The Italian Department of Civil Protection also came up with a second list of municipalities significantly affected by the earthquake, though the registered magnitude was lower than 6 on the MCS scale. This list comprises 12 municipalities of the province of L'Aquila, whose residents in 2008 accounted for more than 24% of the total population of the province of L'Aquila.

4. Empirical results

Table 2 reports DiD estimates of the effect of the L'Aquila earthquake on labour force participation. All specifications include a set of quarter dummies[16], as indicated in Equation (1). Column (1), which presents estimates from a specification that does not include individual-level variables, suggests that the L'Aquila earthquake is associated with a 2.6 percentage point drop in the probability of participating in the labour force[17], though our DiD coefficient is only very marginally statistically significant (p=0.10). However, our basic estimates do not account for the possibility that characteristics of residents of L'Aquila and Perugia vary across time, and these can be correlated with labour force participation. Therefore, in Column (2) we control for a number of individual-level demographic attributes. These additional variables considerably improved the fit of the model and show a quite sensible path of results. Labour force participation is particularly strong among males, older and higher-educated individuals. Not surprisingly, the effect of marital status differs by gender- whilst being married increases labour force participation among males, the opposite occurs for females. Moving to the variable of primary interest in this study, one may note that not only has the statistical significance of the DiD coefficient greatly improved, but also its magnitude is slightly larger than the comparable estimate in Column (1). Specifically, this coefficient is approximately 23% larger in the less parsimonious specification compared to the basic specification[18]. Next, we investigate whether the effect of the earthquake on labour force participation varied over time by including the triple interaction term discussed in the previous Section. As shown in Column (3), the estimated coefficient on this interaction term is statistically insignificant at conventional levels. Therefore, such a result suggests that the

[16] The first quarter, i.e. the pre-earthquake period, is the omitted quarter.
[17] Given our imperfect measure of the treatment group (see end of Section 3), this estimate can be interpreted as a lower bound of the treatment effect.
[18] The inclusion of age squared is basically driving this finding. If this variable is omitted from the specification, the value of the DiD coefficient is -0.024 and it is still statistically significant at the 5 percent level.

negative effect of the L'Aquila earthquake on labour force participation did not change over time.

Insert Table 2 about here

Table 3 reports DiD estimates of the effect of the L'Aquila earthquake on the probability of being employed. Estimates from the basic specification, which are reported in Column (1), indicate that our DiD coefficient has a positive sign and it is not statistically significant at the usual confidence levels. This finding does not change when we control for individual-level variables. Estimates depicted in Column (2) show that the effect of the L'Aquila earthquake on the probability of being employed is still indistinguishable from zero. One may also observe that the results on individual demographic attributes are in line with our expectations. Therefore, being male, older and more educated increase the likelihood of having a job. As it occurred with labour force participation, the impact of marital status on the probability of being employed is also found to vary by gender. Finally, looking at Column (3), we observe that there is no evidence suggesting that the effect of the L'Aquila earthquake on the employment-population ratio changed over time.

Insert Table 3 about here

Although in this paper we are unable to identify why the L'Aquila earthquake did not have a statistically significant impact on the probability of being in employment not even in the short-term, several reasons could be suggested for this finding. First, one should observe that Italy is characterised by a relatively high level of public spending. This may imply a high ability of the Italian government to rapidly mobilize resources for reconstruction. Noy (2009) argues that countries with larger governments (measured as government consumption as percent of GDP) are better able to withstand the initial disaster shock. Second, the organisation of the G8 summit in L'Aquila shortly after the earthquake is likely to have lessened the adverse consequences of the natural disaster. In fact, the organisation of this event has probably accelerated some aspects of the post-recovery efforts[19]. Additionally, the G8 summit has given L'Aquila more international visibility therefore potentially generating larger international capital inflows. For instance, whilst they were in L'Aquila, the leaders of the G8 countries committed their governments to helping for the reconstruction of specific

[19] For instance, some apartments were rapidly built to accommodate members of international delegations and journalists. After the summit some of these apartments were given to people who had lost their home due to the earthquake.

historical buildings in the city of L'Aquila. Third, although data are unavailable regarding the number of people working in the public sector in the centre of the city of L'Aquila, this figure is likely to be quite high given that, as outlined above, many public institutions are located in this area. These workers are not at risk of losing their job following the earthquake.

On the other hand, our results suggest that the L'Aquila earthquake is associated with a reduction in labour force participation. Although it is unclear through which channels the earthquake did depress labour force participation, the following hypothesis can be advanced. Poor local economic conditions caused by the earthquake could have deterred individuals from joining the labour force. This effect is known in the literature as the discouraged-worker effect (see, for instance, Benati, 2001). Discouraged workers are those who do not look for a job given the low employment prospects, but they would have searched for it if economic conditions were more favorable. Another explanation for the negative effect exerted by the earthquake on labour force participation is related to relief funds. The large inflows of non-wage resources [20] for aid purposes could have discouraged many individuals from participating in the labour force.

The aggregate results reported in Tables 2 and 3 may mask differential experiences for relevant subgroups of the population. To address this issue, in Tables 4 and 5 we perform DiD analysis separately by gender and level of education. In Table 4, we find that while the earthquake did have a relatively small effect on labour force participation among males, it adversely affected labour market attachment among females. Following the earthquake, while males experienced an insignificant 1.4 percentage points decline in the probability of participating in the labour market, this probability dropped by a significant 5.5 percentage points among females[21]. This result is consistent with the observation that the discouraged-worker effect is particularly relevant for women given that they are more responsive to market incentives than men. Using data for the 1998-2008 period in Norway, Dagsvik *et al.* (2010) find that the discouraged-worker effect is very significant among married or

[20] Those evacuees who were living in municipalities that were severely affected by the earthquake - defined as a magnitude 6 or greater on the MCS scale- are entitled to housing benefits, up to a maximum of 400 euro per month per household. However, if the household comprises a person with disability or aged over 65, an additional sum of 100 euro per month is added.

[21] Heterogeneous effects by gender are also investigated by using the entire sample and adding to the specification in column 2 of Table 2 an interaction term between the DiD variable and the female dummy (in addition to interactions between the target area dummy and the female dummy, and between the first quarter dummy and the female dummy). While the coefficient on this triple interaction term is imprecisely estimated ($p=0.14$) it implies that, relative to males, the earthquake is associated with a 4.7 percentage point decrease in labour force participation among females.

cohabiting women. Furthermore, one should also note that in the post-earthquake period employment prospects tend to be especially poor for females. Several studies (see, for instance, Kroll *et al.*, 1991; Webb *et al.*, 2000) show that the in the aftermath of natural disasters considerable growth is experienced by construction-related businesses, which are male-dominated.

Insert Table 4 about here

There are also heterogeneous effects across educational levels. Column (3) of Table 4 show that the L'Aquila earthquake is associated with a significant 4.6 percentage points increase in the probability of participating in the labour force for our lowest education group, those with primary education or less. By contrast, the labour market participation effect for the highest education group, those with a tertiary education, is negative and significant (10.4 percentage points).

From Table 5, it emerges that, though the effect of the earthquake on the probability of being in employment is positive among males and negative among females, it is, in both cases, not statistically significant at standard levels. Similar to what occurred in Table 4, while the employment effect is positive and significant for individuals with primary education or less (5.3 percentage points), it is negative (though only marginally significant) for those with a tertiary education (-9.3 percentage points)[22].

Insert Table 5 about here

The estimates depicted in Tables 4 and 5 suggest that the post-earthquake reconstruction offered employment opportunities for low-skilled individuals. This is consistent with the fact that, as stated above, in the aftermath of natural disasters local economies tend to experience a significant increase in the demand for construction, to rebuild buildings and infrastructure that were destroyed or damaged. Additionally, as argued by Kircheberger (2011), there are also important indirect employment effects for low-skilled workers associated with the expansion of the construction industry. The development of the construction sector is in fact

[22] Heterogeneous effects by education are also examined by employing the entire sample and adding to the full-control specification interactions between the DiD variable and our education dummies (in addition to interactions between the target area dummy and the education dummies, and between the first quarter dummy and the education dummies). The estimates confirm that the earthquake is associated with better labour market outcomes for individuals with primary education or less relative to those with a tertiary education. The relevant coefficients of the triple interaction terms are statistically significant at conventional levels.

accompanied by an increase in the demand for intermediate goods that are produced both in the service and manufacturing sectors.

On the other hand, our estimates indicate that the earthquake exerted a negative effect on the employment prospects of more educated individuals. Following the worker displacement literature (Hamermesh, 1987), one explanation for this is that those skilled workers suffering a separation from their firm may find it hard to get a new job given that a significant part of their human capital is firm or industry specific. Our findings are, however, at variance with the hypothesis that natural disasters may induce affected firms to invest in human capital. This hypothesis hinges on the idea that natural disasters provide firms with an opportunity to update their capital stock and hence adopt new technologies (Skidmore and Toya, 2002) that, in turn, require highly skilled workers. Nevertheless, it is quite possible that this process tends to occur in the longer-run and especially in less developed countries (Cuaresma *et al.*, 2008) that are in the process of catching –up.

5. Concluding remarks

In this article, we use Labour Force Survey individual-level data to examine the short-term impact of the L'Aquila earthquake on labour market outcomes. Our empirical strategy relies on a difference-in-differences (DiD) method that compares residents of L'Aquila with residents of a control area before and after the earthquake. Our estimates indicate that while the earthquake had no statistically significant effect on the employment-population ratio, it produced a modest, but statistically significant, reduction in labour force participation. Additionally, there is no evidence suggesting that negative effect on labour force participation rate decreased over time.

However, the above results hide differential effects within relevant subgroups of the population. While the earthquake led to an overall decline in labour force participation, this effect is confined for most part to females. There are also significant heterogeneous effects across different educational levels. When the sample is cut by education group, two opposite and significant effects for individuals with low and high education are found. While the earthquake is related to higher labour force participation and higher employment opportunities for individuals with primary education or less, it is associated with worsening labour market conditions for those with a tertiary education.

The findings from this study suggest that natural disasters may have important policy implications. Given that females and less-educated individuals are likely to experience negative labour market outcomes following earthquakes, in the post-recovery period policymakers should consider the possibility of adopting measures aimed at increasing labour force participation and employment prospects for these groups of people.

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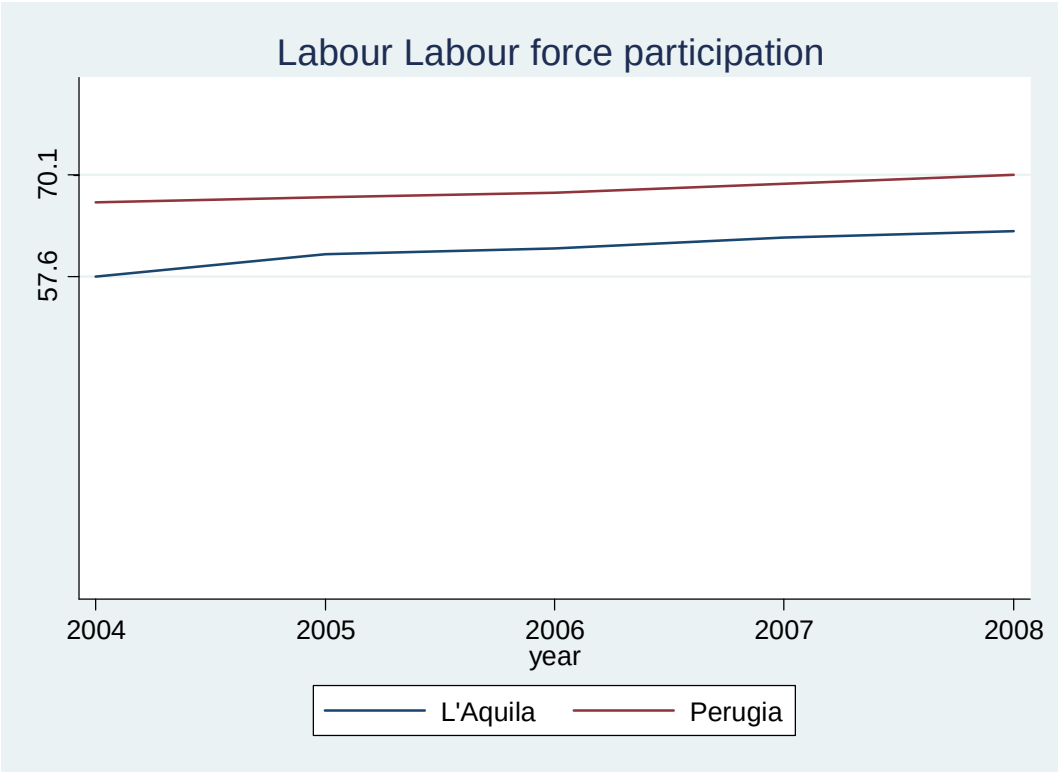
Figure 1: Central Italy -provinces of Perugia and L'Aquila

Figure 2: Trends in labour market outcomes in the target and control areas before the L'Aquila earthquake



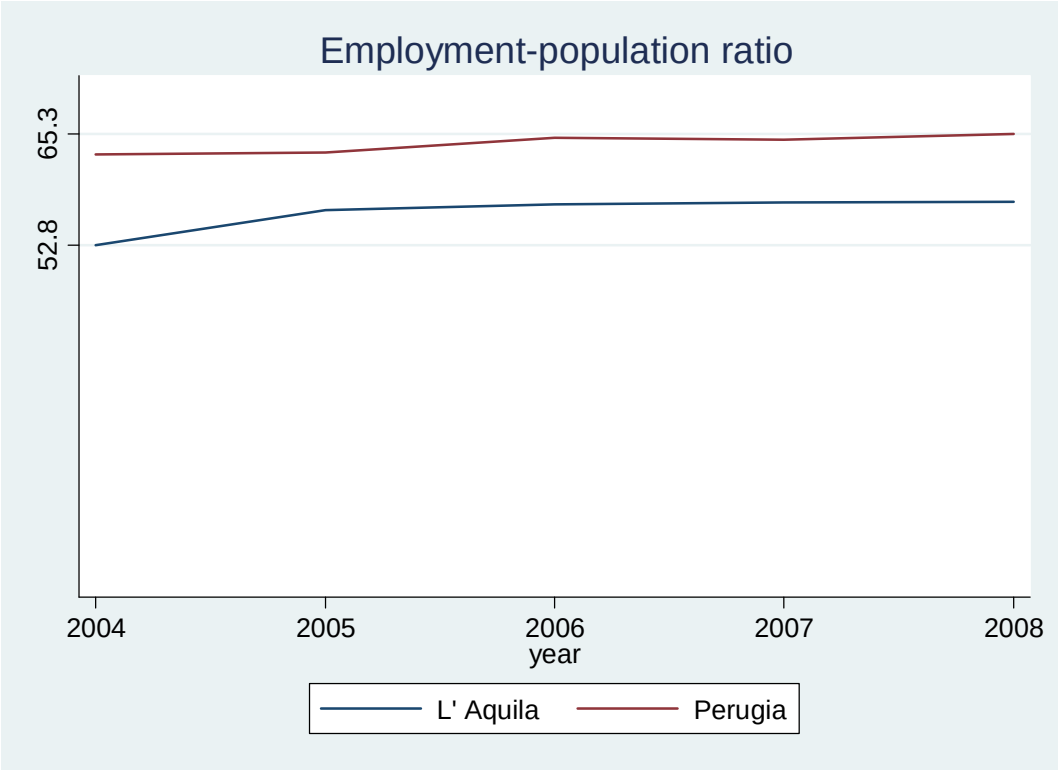


Table 1: Mean equality tests

Individual characteristic	**Treatment group (Residents of L'Aquila)**	**Control group (Residents of Perugia)**	**Diff.**
Female	0.495 (0.500)	0.502 (0.500)	-0.007 (0.027)
Age (years)	40.497 (13.895)	40.472 (13.432)	0.025 (0.734)
Married	0.539 (0.499)	0.570 (0.495)	-0.031 (0.027)
Presence of at least one child aged less than 6 in the household	0.113 (0.317)	0.133 (0.340)	-0.20 (0.020)
Education			
Primary education or less	0.072 (0.258)	0.083 (0.276)	-0.011 (0.013)
Secondary education	0.782 (0.413)	0.768 (0.422)	0.014 (0.023)
Tertiary education	0.146 (0.354)	0.149 (0.357)	-0.003 (0.020)
Observations	533	1,623	

Notes
Data refer to the first quarter of 2009 (i.e. pre-earthquake period)
Standard deviations are reported in brackets
Labour Force Survey sampling weights are used

Table 2: Effects of the L'Aquila earthquake on labour force participation

Dependent variable	**(1)**	**(2)**	**(3)**
Constant	0.695*** (0.004)	-1.168*** (0.041)	-1.171*** (0.039)
Treat	-0.065*** (0.000)	-0.053*** (0.000)	-0.053*** (0.000)
Treat Post*	-0.026* (0.011)	-0.032** (0.007)	-0.041*** (0.007)
Treat Post* *time			0.009 (0.005)
Female		-0.102*** (0.008)	-0.102*** (0.008)
Age (years)		0.112*** (0.003)	0.112*** (0.003)
Age squared		-0.001*** (0.000)	-0.001*** (0.000)
Married		0.038* (0.014)	0.038* (0.014)
Presence of at least one child aged less than 6 in the household		0.000 (0.020)	0.000 (0.020)
Female*Married		-0.118*** (0.005)	-0.118*** (0.005)
Female* presence of at least one child aged less than 6 in the household		-0.063 (0.035)	-0.063 (0.035)
Education- Reference category is "Tertiary education"			
Primary education or less		-0.275*** (0.018)	-0.275*** (0.018)
Secondary education		-0.081** (0.021)	-0.081** (0.021)
R-squared	0.007	0.353	0.353
Observations	8,765	8,765	8,765

Regressions are estimated as linear models and weighted using Labour Force Survey sampling weights. Robust standards errors, which are clustered by quarter level, are reported in brackets. All regressions include quarter fixed effects.

*** indicates statistical significance at 1%, ** indicates statistical significance at 5%; *** indicates statistical significance at 10%

Table 3: Effects of the L'Aquila earthquake on employment-population ratio

Dependent variable	**(1)**	**(2)**	**(3)**
Constant	0.646***	-1.161***	-1.167***
	(0.005)	(0.083)	(0.082)
Treat	-0.107***	-0.095***	-0.095***
	(0.000)	(0.000)	(0.000)
Treat Post*	0.011	0.005	-0.011
	(0.016)	(0.012)	(0.012)
Treat Post* *time			0.016
			(0.008)
Female		-0.110***	-0.110***
		(0.008)	(0.008)
Age (years)		0.106***	0.106***
		(0.004)	(0.004)
Age squared		-0.001***	-0.001***
		(0.000)	(0.000)
Married		0.065**	0.065**
		(0.020)	(0.020)
Presence of at least one child aged less than 6 in the household		0.013	0.013
		(0.014)	(0.014)
Female*Married		-0.126***	-0.126***
		(0.015)	(0.015)
Female* presence of at least one child aged less than 6 in the household		-0.074*	-0.074*
		(0.031)	(0.030)
Education- Reference category is "Tertiary education"			
Primary education or less		-0.285***	-0.285***
		(0.024)	(0.024)
Secondary education		-0.078**	-0.078**
		(0.021)	(0.021)
R-squared	0.009	0.319	0.319
Observations	8,765	8,765	8,765

Regressions are estimated as linear models and weighted using Labour Force Survey sampling weights. Robust standards errors, which are clustered by quarter level, are reported in brackets. All regressions include quarter fixed effects.

*** indicates statistical significance at 1%, ** indicates statistical significance at 5%; *** indicates statistical significance at 10%

Table 4: Effects of the L'Aquila earthquake on labour force participation by gender and level of education

	(1)	(2)	(3)	(4)	(5)
	Males	**Females**	**Individuals with primary education or less**	**Individuals with a secondary education**	**Individuals with a tertiary education**
Treat	-0.044***	-0.058***	-0.058***	-0.066***	-0.080***
	(0.001)	(0.001)	(0.002)	(0.000)	(0.001)
Treat Post*	-0.014	-0.055**	0.042***	-0.028	-0.104**
	(0.014)	(0.015)	(0.004)	(0.013)	(0.024)
R-squared	0.397	0.285	0.281	0.342	0.171
Observations	4,359	4,406	788	6,788	1,189

Regressions are estimated as linear models and weighted using Labour Force Survey sampling weights. Robust standards errors, which are clustered by quarter level, are reported in brackets. All regressions include quarter fixed effects.

Regressions whose results are presented in Columns (1) and (2) include the following individual-level covariates: age, age squared, marital status, education, presence of at least one child aged less than 6 in the household, education

Regressions whose results are presented in Columns (3), (4) and (5) include the following individual-level covariates: gender, age, age squared, marital status, presence of at least one child aged less than 6 in the household, the interaction of gender and marital status and the interaction of gender and presence of at least one child aged less than 6 in the household

*** indicates statistical significance at 1%, ** indicates statistical significance at 5%; *** indicates statistical significance at 10%

Table 5: Effects of the L'Aquila earthquake employment-population ratio by gender and level of education

	(1)	(2)	(3)	(4)	(5)
	Males	**Females**	**Individuals with primary education or less**	**Individuals with a secondary education**	**Individuals with a tertiary education**
Treat	-0.087***	-0.100***	-0.040***	-0.115***	-0.003
	(0.001)	(0.002)	(0.001)	(0.001)	(0.006)
Treat Post*	0.016	-0.012	0.053**	0.015	-0.093*
	(0.015)	(0.011)	(0.011)	(0.020)	(0.034)
R-squared	0.353	0.252	0.237	0.311	0.188
Observations	4,359	4,406	788	6,788	1,189

Regressions are estimated as linear models and weighted using Labour Force Survey sampling weights. Robust standards errors, which are clustered by quarter level, are reported in brackets. All regressions include quarter fixed effects.

Regressions whose results are presented in Columns (1) and (2) include the following individual-level covariates: age, age squared, marital status, education, presence of at least one child aged less than 6 in the household, education

Regressions whose results are presented in Columns (3), (4) and (5) include the following individual-level covariates: gender, age, age squared, marital status, presence of at least one child aged less than 6 in the household, the interaction of gender and marital status and the interaction of gender and presence of at least one child aged less than 6 in the household

*** indicates statistical significance at 1%, ** indicates statistical significance at 5%; *** indicates statistical significance at 10%

Appendix: Average characteristics of residents of L'Aquila before and after the earthquake

Individual characteristic	**Residents of L'Aquila before the earthquake**	**Residents of L'Aquila after the earthquake**
Female	0.495 (0.500)	0.495 (0.500)
Age (years)	40.497 (13.895)	40.407 (13.667)
Married	0.539 (0.499)	0.586 (0.493)
Presence of at least one child aged less than 6 in the household	0.113 (0.317)	0.117 (0.322)
Education		
Primary education or less	0.072 (0.258)	0.082 (0.275)
Secondary education	0.782 (0.413)	0.786 (0.410)
Tertiary education	0.146 (0.354)	0.132 (0.338)
Observations	533	1,737

Notes
Data refer to the first quarter of 2009 (i.e. pre-earthquake period) and to the second, third and fourth quarter of 2009 (i.e. post-earthquake period).
Standard deviations are reported in brackets
Labour Force Survey sampling weights are used

2010

2010/1, De Borger, B., Pauwels, W.: "A Nash bargaining solution to models of tax and investment competition: tolls and investment in serial transport corridors"
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