2009 events

- At 3.32 AM on the 6th of April 2009 a strong earthquake jolt of magnitude 6.3 hit the province of L'Aquila and the Abruzzo region at large, causing 309 victims and over 1500 injured, most of them being in the city of L'Aquila and in the fraction of Onna.

- The natural disaster had a devastating impact especially on residential buildings, most of them being old and with scarce or absent anti-seismic maintenance.

- Moreover, in those years Italy and the World were going through something that had even more devastating effects than a natural disaster.

Research question

- The objective of our research is to understand the effects that the earthquake had on the economy of Abruzzo, and whether those effects can be recognized by comparing Abruzzo to other Italian regions. It is divided in two sections:
  - Impact of the Earthquake on the Labour market of Abruzzo
  - Effects of the earthquake on GDP

Implications of concurrent events

- It is important to take into account the fact that, from a micro- and macroeconomic point of view, the financial crisis was having enormous effects on the economy.

Previous research

- Previous research, especially on GDP, has resulted to be inconclusive on the matter, not being able to assess the real effects of the Earthquake on economy.

Data

- The data we collected to carry out the analysis comes from two main sources:
  - The INPS dataset (2005-2016) used in previous projects carried out during this course, for data on the labour market.
  - The ISTAT dataset, considering the period 2003-2016 for the analysis on GDP.

Model

- Our original plan was to use a Diff-in-Diff analysis
- However, we needed a synthetic control model to construct the control region

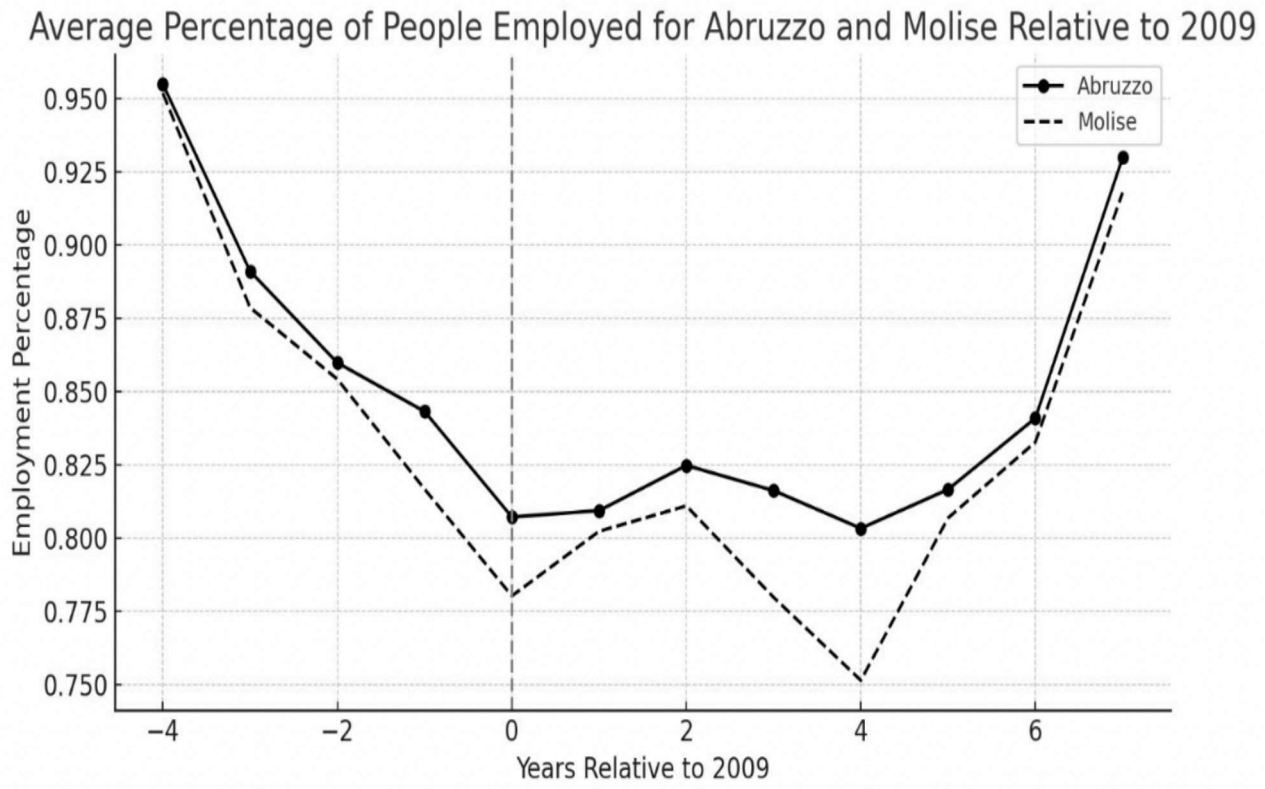
Assumptions

- In order to carry out a Diff-in-Diff analysis it is necessary that the baseline assumptions of the model are satisfied:
  - Common Trends Assumption
  - No Spillover Effects Assumption
  - Time-Invariance Assumption
  - **Parallel Trends Assumption**

Control region

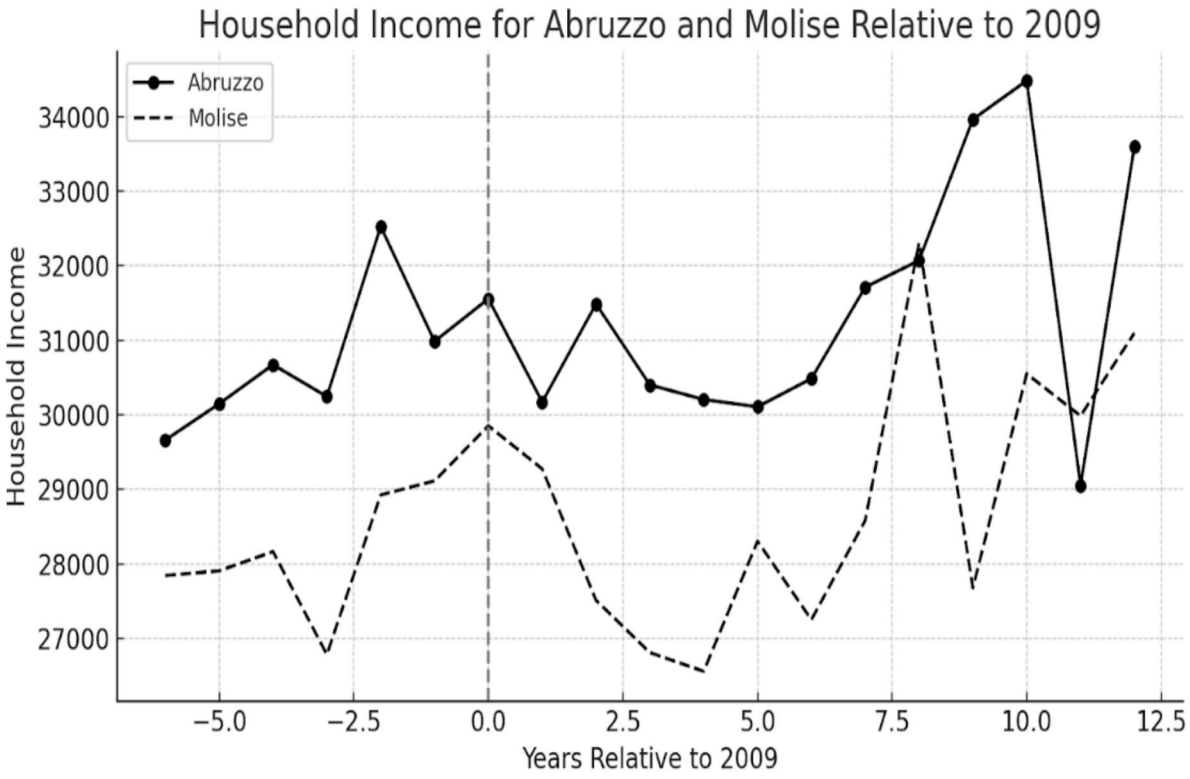
- We looked for a suitable control region among the ones comparable to Abruzzo, and we chose Molise

Control region



- Data for Abruzzo and Molise on household employment rates

Control region



- Data for Abruzzo and Molise on household income

Employment Analysis

Source	SS	df	MS
Model	1.6247e+09	13	124978502
Residual	2196840.94	10	219684.094
Total	1.6269e+09	23	70735537.5

Number of obs	24
F(13, 10)	568.90
Prob > F	0.0000
R-squared	0.9986
Adj R-squared	0.9969
Root MSE	468.7

total_employed	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
1.abruzzo	16440	331.4243	49.60	0.000	15701.54	17178.46
1.treatyears	-377.3125	510.7591	-0.74	0.477	-1515.355	760.7297
abruzzo#treatyears	-20.375	405.9102	-0.05	0.961	-924.7992	884.0492
year						
2005	-885	468.7047	-1.89	0.088	-1929.339	159.3391
2006	-656.5	468.7047	-1.40	0.192	-1700.839	387.8391
2007	-221.5	468.7047	-0.47	0.647	-1265.839	822.8391
2008			0	(omitted)		
2010	211.5	468.7047	0.45	0.661	-832.8391	1255.839
2011	524.5	468.7047	1.12	0.289	-519.8391	1568.839
2012	-44	468.7047	-0.09	0.927	-1088.339	1000.339
2013	-742.5	468.7047	-1.58	0.144	-1786.839	301.8391
2014	-840.5	468.7047	-1.79	0.103	-1884.839	203.8391
2015	-996.5	468.7047	-2.13	0.059	-2040.839	47.83915
2016	-669	468.7047	-1.43	0.184	-1713.339	375.3391
_cons	5036.5	370.5436	13.59	0.000	4210.877	5862.123

Interpretation of result

- Analysing the result given by the implementation of the model on Stata, and in particular the coefficient (-20.375) and p-value (0.96) for abruzzo#treatyears, it is easy to note that the initial hypothesis that the earthquake would have had some sort of impact on employment in Abruzzo was, in fact, wrong.
- The overall model still has a particularly high R-squared of 99 percent due to the fact that there are year dummies and probably an over specification of the model.

Income analysis

Source	SS	df	MS
Model	68331839	3	2277279.7
Residual	7985327	34	2348636.09
Total	148185466	37	40052012.6

Number of obs	384
F(3,34)	9.70
Prob > F	0.0001
R-squared	0.4611
Adj R-squared	0,4136
Root MSE	1532.5

income	coefficient	Std. err.	t	P>|t|	[95% confidence interval]	
treatment	2584.833	884.8043	2.92	0.006	786.6946	4382.972
time	782.7564	7563753	1.03	0.308	-754.3832	2319.896
time_treatment	-4.294872	1069.676	-0.00	0.997	-2178.139	2169.549
_cons	28121.17	625.6511	44.95	0.000	26849.69	29392.64

- Consider the Treatment Coefficient (2584.833). Holding all other factors constant, income in Abruzzo was considerably higher than that of Molise for the period preceding the earthquake (that is, before 2009).

Interpretation of result

- The DiD estimator is indicated by the Time-Treatment coefficient, which represents the effect of the earthquake on household income, relative to the control region. Being negative, the coefficient would suggest that the natural event had a negative impact on income. Nonetheless, this effect is not statistically significant either (p-value = 0.997).
- While the treatment and constant terms are significant, the key variable of interest for the DiD analysis (the interaction term) is not. Therefore there is not sufficient evidence to conclude that the earthquake had a statistically significant impact on the household income in Abruzzo.

Robustness checks

- As the coefficients representing the effect of the earthquake on employment and income in Abruzzo presented no statistical significance, there is no need to run a robustness check on that data.

Limitations

- Limited sample size and inadequate sample
- We disregarded the effect if the financial crisis as it was not possible to properly identify its effect

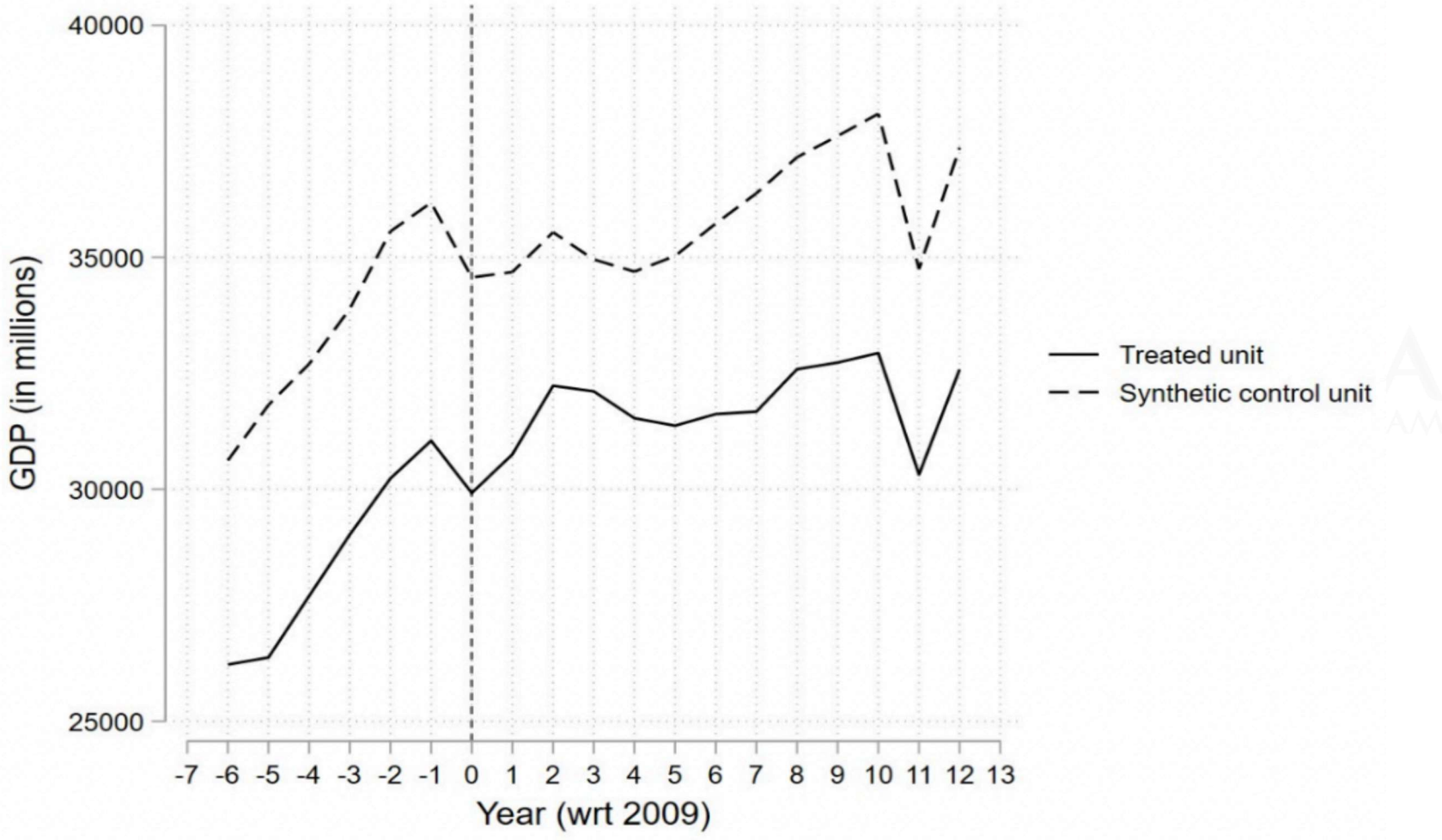
Control region

- We couldn't find an Italian region whose pre-treatment trend was sufficiently similar to that of Abruzzo, so we decided to implement a synthetic control model, and then run the DiD.

Assumptions on Synthetic control

- In order to construct the synthetic control it is necessary that the baseline assumptions of the model are satisfied:
  - Donor pools are comparable
  - No interference
  - No anticipation
  - Sufficient pre-treatment data
- To construct the synthetic control, we used the following variables:
  - unemployment
  - size of the population older than age 15
  - household income
- More variables, such as inflation, would have been useful, but were not available in the required form.

Control group



GDP Analysis

DiD of GDP with synthetic control

R-squared = 0.9894

gdp	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
1.treat	-4973.579	242.8515	-20.48	0.000	-5485.951	-4461.207
1.Post	865.5622	479.3371	1.81	0.089	-145.7506	1876.875
treat#Post1 1	846.0496	305.5815	2.77	0.013	201.329	1490.77
2003	-3822.826	454.3336	-8.41	0.000	-4781.387	-2864.266
2004	-3148.29	454.3336	-6.93	0.000	-4106.85	-2189.73
2005	-2042.031	454.3336	-4.49	0.000	-3000.591	-1083.471
2006	-787.1746	454.3336	-1.73	0.101	-1745.735	171.3855
2007	652.8624	454.3336	1.44	0.169	-305.6977	1611.423
2008	1368.212	454.3336	3.01	0.008	409.6516	2326.772
2009	0	(omitted)				
2010	-814.065	454.3336	-1.79	0.091	-1772.625	144.4952
2011	353.1987	454.3336	0.78	0.448	-605.3614	1311.759
2013	-420.3652	454.3336	-0.93	0.368	-1378.925	538.195
2014	-332.464	454.3336	-0.73	0.474	-1291.024	626.0962
2015	142.4912	454.3336	0.31	0.758	-816.069	1101.051
2016	494.7323	454.3336	1.09	0.291	-463.8278	1453.292
2017	1340.598	454.3336	2.95	0.009	382.0374	2299.158
2018	1641.614	454.3336	3.61	0.002	683.0538	2600.174
2019	1983.468	454.3336	4.37	0.000	1024.907	2942.028
2020	-1000.445	454.3336	-2.20	0.042	-1959.005	-41.88509
2021	1444.668	454.3336	3.18	0.005	486.1081	2403.228
_cons	34730.51	343.4439	101.12	0.000	34005.91	35455.12

Interpretation

- The average treatment effect in the entire post-treatment period is -4973.579. This coefficient captures the overall difference in the outcome variable (GDP) between the treated group and the control group after the treatment. The standard error is quite large, but the P-value is zero, thus indicating that this coefficient is significant.

Dummy analysis

- The coefficient of the time effect (1.Post), with value 865.5622, captures the immediate time effect of the treatment period and it is significant.
- The interaction effect is estimated to have a value of 846.0496. This value is positive and significant, as the P-value is 0.013, and the 95 percent confidence interval is fully positive. The main conclusion that can be drawn from this observation is that the immediate effect of the earthquake on GDP was positive.

Robustness checks

- We conducted a falsification check using a placebo test to assess the robustness of our analysis.
- We substituted the interest year from 2009 to 2007 and re-ran the regression.

Falsification Check

Robustness check

$R^2 = 0.9879$

gdp	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
1.treat	-5007.746	306.5872	-16.33	0.000	-5654.589	-4360.904
1.Post	249.9472	516.605	0.48	0.635	-839.9941	1339.889
treat#Post1	771.5547	357.1633	2.16	0.045	18.00594	1525.103
2003	-4475.689	484.757	-9.23	0.000	-5498.437	-3452.941
2004	-3801.153	484.757	-7.84	0.000	-4823.901	-2778.405
2005	-2694.893	484.757	-5.56	0.000	-3717.641	-1672.145
2006	-1440.037	484.757	-2.97	0.009	-2462.785	-417.2892
2007	0	(omitted)				
2008	79.6247	484.757	0.16	0.871	-943.1232	1102.373
2009	-1288.587	484.757	-2.66	0.017	-2311.335	-265.8392
2010	-814.065	484.757	-1.68	0.111	-1836.813	208.6829
2011	353.1987	484.757	0.73	0.476	-669.5492	1375.947
2013	-420.3652	484.757	-0.87	0.398	-1443.113	602.3827
2014	-332.464	484.757	-0.69	0.502	-1355.212	690.2839
2015	142.4912	484.757	0.29	0.772	-880.2567	1165.239
2016	494.7323	484.757	1.02	0.322	-528.0155	1517.48
2017	1340.598	484.757	2.77	0.013	317.8497	2363.345
2018	1641.614	484.757	3.39	0.004	618.8661	2664.362
2019	1983.468	484.757	4.09	0.001	960.7198	3006.216
2020	-1000.445	484.757	-2.06	0.055	-2023.193	22.30264
2021	1444.668	484.757	2.98	0.008	421.9204	2467.416
_cons	35400.46	375.4912	94.28	0.000	34608.24	36192.68

Falsification check

- Notably, the coefficient for treat#Post1 is statistically significant (P-value = 0.045), contrary to the initial expectations. It follows that potential methodological limitations must be acknowledged.

Limitations

- Limited availability of data to construct the synthetic control.
- Restricted number of variables, a greater number could have helped better specifying the model.
- Potential differences across regions of the effect of the financial crisis have not been investigated.

Conclusion

- In conclusion, while it is possible to construct a model that fits the data well, the lack of significance in the interaction term suggests that it is not possible to make any strong claim on the effect of the earthquake on household income and employment based on this analysis alone.
- Even though the main regression of GDP indicated a significant positive effect of the earthquake, the robustness check highlighted the possibility that the analysis contains methodological errors.

Further research

- It would be beneficial in the future to find more suitable variables to discern the effect of the financial crisis from the one of the earthquake in Abruzzo. This can be done by:
  - enlarging the sample
  - providing a greater number of variables
  - taking into account a longer timespan

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