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**The Effects of Major Earthquakes on the Labor Market: Evidence from Turkiye**

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**Abstract:** This study centers attention on the impact of earthquakes on the labor market. We try to estimate the impact of two major earthquakes (İzmir and Elazığ) in Turkiye. We consider the earthquake a natural experiment and employ a synthetic control method using the data from TURKSTAT and İŞKUR. The results show that the impact varies based on the labor market structure of the regions. While the earthquake positively affects the labor market of agriculture-oriented regions, it harms the labor market of nonagricultural-oriented regions.

**Keywords:** Natural disaster, Earthquake, Labor market, Quality of employment, Economic impact, Reconstruction policy.

**JEL:** J24, J63, L25, Q54.

# Introduction

Natural disasters have occurred as great movements in different areas of the world and have attracted the attention of humanity throughout history. The most important reason for this interest is that natural disasters cause important consequences such as loss of life and property for human beings (Kim, 2010). As a consequence of a disaster, there may be deaths, inability to carry out basic activities such as education, health, housing activities, the deterioration of the balance in the labor market and unemployment, the temporary failure to provide essential services such as electricity, water, transportation and communication, the shortage of raw materials and food for industrial products, the increase in public activities during the recovery and restructuring period, and the change in the employment structure due to this increase (ECLAC, 1991). Moreover, understanding the impact of a natural disaster on economic growth and how local institutions and economic actors respond is crucial to alleviate a disaster's costs and design financial aid programs.

Note that earthquakes are one of the deadliest natural disasters in the world. In 2019, 231 earthquakes occurred worldwide, with 23 earthquakes per year between 2010 and 2019. Consequently, more than 720,000 people died between 2010 and 2019. In addition to the threat to human life, earthquakes also cause significant economic losses and damages for countries. According to figures published by the International Federation of Red Cross and Red Crescent Societies (IFRC), the annual economic loss caused by earthquakes worldwide is more than $20 billion (IFRC, 2020).

While studies on earthquake research suggest that the effects caused by an earthquake originate from different directions (for example, the location of the hypocenter, distance from the epicenter, geomorphological features of the affected area), economic studies on this subject generally focus on the socio-economic effects that an earthquake can produce according to their differences (according to the initial conditions of the country, the time interval of the recovery process and the spatial differences of the analysis) (Kahn, 2005; Pagliacci and Russo, 2019).

Studies on the earthquake's economic impact are still scarce, and there is no consensus on the economic impacts. For example, some studies report adverse effects on economic growth (Cavallo and Noy, 2011; Cavallo et al., 2013), while some studies report no results (Skidmore and Toya, 2002; Loayza et al., 2009) and even positive effects (Albala and Bertrand, 1993). According to the United Nations and the World Bank (2010), disasters permanently reduce welfare in affected countries. Still, it is unclear what effect they will have on production growth in the medium term (United Nations and World Bank, 2010). While it is widely accepted that in the long run, earthquakes hardly affect the growth path of an economy at the country level (Fisker, 2012), and in the short-run economic outcomes may differ at the regional level (Cavallo and Noy, 2011).

Studies in the macroeconomics literature are concerned with whether natural disasters damage economic growth, stimulate it, impact it only under certain conditions, or have no impact at all. On the other hand, there are microeconomic studies focusing on only modest short-lived negative effects of natural disasters across multiple dimensions and sometimes even point out welfare gains in the long run (Gallagher and Hartley, 2017; Deryugina, Kawano, and Levitt, 2018). The same is true for studies directly focusing on the labor market. For instance, Kirchberger (2017) explores the short-run effect of the Indonesia earthquake in 2006. Results show an increase in wage growth for workers employed in agriculture at baseline. Ohtake et al. (2012) studies how the Hanshin-Awaji earthquake in Kobe, Japan, affected job searches; and Higuchi et al. (2012) analyze the market one year after the Great East Japan Earthquake, finding a severe mismatch in some industries.

The most obvious consequence of an earthquake is physical destruction. As a result of this physical damage, the regional economy also deteriorates. The physical loss of buildings and infrastructure does not only cause damage in the short term, but it also results in a decline in consumer confidence, potential earnings, and the production and quality of the workforce, with significant economic consequences such as recession and slowdown in investment (Amini et al., 2013).

The magnitude of the impact varies depending on the location of the earthquake and its relationship with the population and industry density. Considering that Turkiye is an earthquake zone, it is essential to determine the policies for such demolitions after a disaster.

This study centers attention on the impact of earthquakes on the labor market. We try to estimate the impact of two major earthquakes in Turkiye. One occurred in Elazığ and the other in the İzmir region. Note that a disaster represents a natural experiment that allows testing to assess whether unexpected shocks have long-lasting effects, eventually moving the affected local economy towards a different long-term equilibrium (Barone and Mocetti, 2014). We employ this natural experiment to identify the earthquake impact. The direct way to construct a control region, we use the synthetic control method. The results suggest that earthquake positively affects the labor market of agriculture-oriented regions and harms the labor market of nonagricultural-oriented regions. Although we cannot fully separate the impact of Covid-19 from our estimate, we believe that Covid-19 overestimates the negative impact of earthquakes on the labor market.

The rest of this study is as follows: Section 2 presents a brief overview of the major earthquakes in Turkiye. Section 3 explains the data. Section 4 introduces the synthetic control methodology and its advantages. Section 5 presents the empirical results, and the final section concludes.

# Major Earthquakes in Turkiye

Turkiye experiences disasters of various sizes and frequencies like the rest of the world. These disasters undoubtedly have local, national, and regional dimensions and social, economic, political, and environmental effects. According to the disaster risk index (DRI) published by the United Nations, Turkiye occupies fourth place (UNDP, 2004). Being in the Mediterranean, Alpine, and Himalayan seismic belts increases the likelihood of an earthquake, especially in Turkiye (JICA, 2004). However, literature in Turkiye gave importance to earthquakes with a magnitude of 7.4 Mw on the Richter scale in the Marmara region on August 17, 1999.

**Table 1: Major damaged earthquakes in Turkiye in the last ten years**

|  |  |  |  |
| --- | --- | --- | --- |
| **Date** | **Location** | **Size (Mw)\*** | **Number of Deaths** |
| June 10, 2012 | Fethiye, Muğla | 6 | 1 |
| January 8, 2013 | Aegean Sea (Çanakkale Offshore) | 6.2 | 0 |
| May 24, 2014 | Aegean Sea (Gökçeada Offshore) | 6.9 | 0 |
| June 12, 2017 | Aegean Sea (Karaburun Offshore) | 6.3 | 0 |
| July 21, 2017 | Aegean Sea (Bodrum Offshore) | 6.6 | 0 |
| August 8, 2019 | Denizli | 6 | 0 |
| September 26, 2019 | İstanbul (Silivri) | 5.7 | 1 |
| January 24, 2020 | Elazığ, Sivrice | 6.8 | 41 |
| 23 Şubat 2020 | İran-Türkiye border | 6 | 10 |
| June 14, 2020 | Bingöl | 5.9 | 1 |
| October 30, 2020 | Aegean Sea (İzmir) | 6.9 | 114 |
| Source: \*Kandilli Observatory data were taken for earthquake magnitudes. | | | |

Table 1 shows the earthquakes that caused death, injury, and property loss in Turkiye between 2014 and 2020. We notice that earthquakes of 6 MW and above have devastating effects. Table 1 also indicates that the earthquakes in Elazığ and especially in Izmir caused many casualties. These earthquakes caused loss of life and destroyed the economic balances in the regions where they took place.

# Data

In the study, we use the unemployment benefit application data and the number of job placements as a dependent variable in the models, publicly available in the İŞKUR database at 26 regions. We will also use the monthly Consumer Price Index (CPI), the number of companies established and closed, the distribution of electricity consumption by consumer type, housing sales, and price series. While some of the data is presented on a provincial basis, some of it is accessible at the regional level.

# Model

To determine how the earthquake affected the labor market, we use the Synthetic Control Method (SCM) developed by Abadie and Gardeazabal (2003) and Abadie et al. (2010, 2015). The SCM constitutes the natural approach for evaluating the effects of an unanticipated and exogenous event (such as an earthquake) that affects some areas while leaving other units unaffected (these areas are potential comparison units: the so-called donors). According to the proposed method, the regions forming the control group should not experience destructive earthquakes.

SCMs optimally choose a set of weights that produce an optimally estimated counterfactual to the unit that received the treatment when applied to a group of corresponding units. This counterfactual, called the "synthetic unit," serves to outline what would have happened to the aggregate treated unit had the treatment never occurred. It builds on a generalization of difference-in-differences estimation but uses arguably more powerful comparisons to get causal effects (Athey and Imbens 2017). One of its most important advantages is using a convex combination of comparison units called synthetic control instead of using a single comparison unit alone as a control group. Therefore, we select the comparison unit as the weighted average of all comparison units that best resembles the treated unit(s) characteristics in the pre-treatment period. Briefly, this data-driven procedure reduces decision-making about what to include in the control/comparison group. Also, this method, unlike many other comparative case techniques, allows the effects of unobservable confounders to change over time. Because of these reasons, the application of SCM is becoming increasingly popular in various research fields.

We employ the SCM to quantify the impact of the major earthquakes in Turkiye by constructing a counterfactual as a weighted average of all Turkiye regions that have not been directly affected by the earthquake. The following briefly gives a more formal description of the SCM and its application in this study. Using the notation of Abadie et al. (2010), we take the regions, and without loss of generality, let the first region be the one exposed to the earthquake. Let be the outcome variable that is evaluated based on the earthquake's impact (number of job placement and number of unemployment allowance applications) for region , and the time ( for the periods ; where is the time of the earthquake). is the outcome variable in the presence of the earthquake and is the outcome variable had the earthquake not occurred. The model requires the assumption that the earthquake did not affect the outcome variable before it occurred at the time so that . Although the last assumption is unjustified in cases disaster impact is frequent. Therefore, as expected, we examined two regions (Izmir and Elazıg) that had not experienced a significant earthquake for nearly 200 years.

The observed outcome is defined by where is the effect of the earthquake on the variable of interest and is the binary indicator denoting the event occurrence (otherwise). The aim is to estimate for all for the affected regions (; Izmir and Elazıg). The estimation problem is that for all it is not possible to observe (the counterfactual). This issue is the well-known fundamental problem of causal inference.

In this case, can be calculated as the weighted average of the (for observations from the other regions: . For pre-earthquake observations ( this equation can be estimated to obtain the weights allocated to the different region observations, . Therefore, based only on pre-impact observations, the following equation can be obtained

Abadie et al. (2010) show that under acceptable assumptions, combining the previous equations, we obtain an estimate of the impact of the earthquake as:

for

where are chosen to minimize a specific penalty function (given by the Mean Squared Prediction Error – MSPE) that depends on the pre-earthquake pattern of the outcome variable and pre-earthquake values of some outcome variable predictors.

# Results

The earthquake occurred in Elâzığ province of Turkiye on January 24, 2020, at 20:55 local time and affected the entire Eastern Anatolia region, especially Elâzığ and Malatya. Figure 1 indicates that the earthquake increased the number of job replacements. Note that the labor market of the Elazığ region primarily relies on agriculture. The results imply that new business areas such as construction provide an option for the unemployed worker after the earthquake. This reasoning may increase the number of job replacements in the Elazığ region. Also, note that the number of unemployment allowance applications in the Elazığ region after the earthquake does not differentiate from the control regions. Both results show that the earthquake positively impacted the labor market in the Elazığ region.

|  |  |
| --- | --- |
| ***Figure 1: The Effects of the January 2020 Elazig Earthquake on the Number of Job Placements*** | ***Figure 2: The Effects of the January 2020 Elazig Earthquake on the Number of Unemployment Allowance Applications*** |
|  |  |

The İzmir Earthquake (Aegean Sea Earthquake) occurred on October 30, 2020, at 14.51 local time, with a magnitude of 6.9 Mw, the epicenter located 23 km from Seferihisar district of İzmir province of Turkiye. We also analyze the effects of the earthquake on the number of people applying for job placement and unemployment benefits in İzmir. As seen from Figure 3, the amount of job placement in the synthetically constructed Izmir region was above the Izmir Region values ​​in the months following the earthquake. This observation clearly shows that the earthquake reduced job opportunities in İzmir, especially in the first two months after the earthquake, and that the recovery process took place within 3-4 months.

On the other hand, the earthquake did not appear to have an apparent effect on the number of applications for unemployment benefits. We consider that the most important reason for this is the prohibition of dismissals within the scope of Covid-19 pandemic measures. Similarly, the recovery in job opportunities took longer during the pandemic process. In addition, under the assumption that the job opportunities of İzmir province are higher under normal conditions than in the TRB1 region, we believe that the earthquake affected the economic recovery more than it appears.

|  |  |
| --- | --- |
| ***Figure 3: The Effects of the October 2020 İzmir Earthquake on the Number of Job Placements*** | ***Figure 4: The Effects of October 2020 İzmir Earthquake on the Number of Unemployment Allowance Applications*** |
|  |  |

# Concluding Remarks

In this study, we have analyzed the direct impact of the earthquake on the region's labor market, where the earthquake affected the most. We have chosen two major earthquakes that occurred recently in Turkey. While the Elazığ earthquake occurred in the pre-pandemic period, the İzmir earthquake occurred during the pandemic.

We have shown that while there is a positive impact on the number of job replacement in the Elazığ region, the initial impact of the İzmir earthquake on the İzmir labor market take almost two months. We can say that full recovery after the earthquake appeared after about four months.

Due to the prohibition of dismissals within the scope of Covid-19 pandemic measures, there was no impact of the earthquake on the number of unemployment allowance applications in the İzmir region.

We have interpreted the results as the earthquake may positively impact the labor market, particularly the agriculture-oriented market. The earthquake most likely results in new job opportunities such as construction. Besides, the earthquake may harm the labor market, particularly the services-oriented market. For such a market, the very first two months are vital.

The government should have an action plan that varies between regions based on the complexity and the structure of the regional economies. The subsidies need to be activated immediately after the earthquakes, especially for the nonagricultural-oriented regions.

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# Appendix

**The Effects of the October 2020 İzmir Earthquake on the Number of Job Placements**

|  |  |  |
| --- | --- | --- |
|  | **Treated** | **Synthetic** |
| **residential\_poperty\_price** | 148 | 141 |
| **second\_sale** | 6,197 | 6,011 |
| **first\_sale** | 2,523 | 2,506 |
| **established\_closed\_companies** | 490 | 520 |
| **cpi** | 530 | 507 |
| **industry\_electricity** | 497,189 | 539,756 |
| **agriculture\_electricity** | 38,664 | 10,460 |
| **business\_electricity** | 293,421 | 287,579 |

|  |  |
| --- | --- |
| **Control Region** | **Unit Weight** |
| İstanbul-TR10 | 0.094 |
| Tekirdağ, Edirne, Kırklareli-TR21 | 0.457 |
| Aydın, Denizli, Muğla-TR32 | 0.121 |
| Kocaeli, Sakarya, Düzce, Bolu, Yalova-TR42 | 0.077 |
| Ankara-TR51 | 0.15 |
| Antalya, Isparta, Burdur-TR61 | 0.054 |
| Adana, Mersin-TR62 | 0.046 |

**The Effects of October 2020 İzmir Earthquake on the Number of Unemployment Allowance Applications**

|  |  |  |
| --- | --- | --- |
|  | **Treated** | **Synthetic** |
| **residential\_poperty\_price** | 148 | 151 |
| **second\_sale** | 6,197 | 4,630 |
| **first\_sale** | 2,523 | 2,057 |
| **established\_closed\_companies** | 490 | 553 |
| **cpi** | 530 | 529 |
| **industry\_electricity** | 497,189 | 483,688 |
| **agriculture\_electricity** | 38,664 | 16,335 |
| **business\_electricity** | 293,421 | 258,799 |

|  |  |
| --- | --- |
| **Control Region** | **Unit Weight** |
| İstanbul-TR10 | 0.117 |
| Aydın, Denizli, Muğla-TR32 | 0.243 |
| Ankara-TR51 | 0.007 |
| Gaziantep, Adıyaman, Kilis-TRC1 | 0.634 |

**The Effects of the January 2020 Elazig Earthquake on the Number of Job Placements**

|  |  |  |
| --- | --- | --- |
|  | **Treated** | **Synthetic** |
| **residential\_poperty\_price** | 134 | 124 |
| **second\_sale** | 1,522 | 1,910 |
| **first\_sale** | 992 | 899 |
| **established\_closed\_companies** | 60 | 76 |
| **cpi** | 466 | 462 |
| **industry\_electricity** | 89,239 | 139,499 |
| **agriculture\_electricity** | 10,888 | 10,091 |
| **business\_electricity** | 89,824 | 88,806 |

|  |  |
| --- | --- |
| **Control Region** | **Unit Weight** |
| İzmir-TR31 | 0.048 |
| Aydın, Denizli, Muğla-TR32 | 0.058 |
| Kayseri, Sivas, Yozgat-TR72 | 0.268 |
| Zonguldak, Karabük, Bartın-TR81 | 0.564 |
| Van, Muş, Bitlis, Hakkari-TRB2 | 0.061 |

**The Effects of the January 2020 Elazig Earthquake on the Number of Unemployment Allowance Applications**

|  |  |  |
| --- | --- | --- |
|  | **Treated** | **Synthetic** |
| **residential\_poperty\_price** | 134 | 127 |
| **second\_sale** | 1,522 | 1,396 |
| **first\_sale** | 992 | 907 |
| **established\_closed\_companies** | 60 | 81 |
| **cpi** | 466 | 468 |
| **industry\_electricity** | 89,239 | 88,512 |
| **agriculture\_electricity** | 10,888 | 22,979 |
| **business\_electricity** | 89,824 | 89,141 |

|  |  |
| --- | --- |
| **Control Region** | **Unit Weight** |
| Manisa, Afyonkarahisar, Kütahya, Uşak-TR33 | 0.037 |
| Antalya, Isparta, Burdur-TR61 | 0.021 |
| Kayseri, Sivas, Yozgat-TR72 | 0.056 |
| Zonguldak, Karabük, Bartın-TR81 | 0.115 |
| Samsun, Tokat, Çorum, Amasya-TR83 | 0.191 |
| Van, Muş, Bitlis, Hakkari-TRB2 | 0.434 |
| Mardin, Batman, Şırnak, Siirt-TRC3 | 0.146 |