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Abstract

This study focuses 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 earthquakes a natural experiment and employ a synthetic control method using 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 non-agricultural-oriented regions.

Keywords: Natural disaster, earthquake, labor market, quality of employment, economic impact, reconstruction policy.

JEL Classifications: J24, J63, L25, Q54.

ملخص

تركز هذه الدراسة على تأثير الزلازل على سوق العمل. نحاول أن نقدر تأثير زلزالين كبيرين (إزمير وإيلازيغ) في تركيا. وبالنسبة لنا، يعتبر الزلزال تجربة طبيعية ونستخدم طريقة تحكم اصطناعية باستخدام بيانات من معهد الإحصاء التركي **(TURKSTAT)**ومؤسسة العمل التركية (إيش كور) **.(İŞKUR)** تظهر النتائج أن التأثير يختلف بناءً على هيكل سوق العمل في المناطق. بينما يؤثر الزلزال إيجابيًا على سوق العمل في المناطق الزراعية، فإنه يضر بسوق العمل في المناطق غير الزراعية**.**

1. Introduction

Natural disasters around the world have attracted the attention of humanity throughout history. The most important reason for this interest is that natural disasters cause significant consequences, such as loss of life and property (Kim, 2010). Disasters may cause deaths; an inability to carry out basic activities such as education, health, and housing activities; the deterioration of the balance in the labor market and unemployment; a temporary failure to provide essential services such as electricity, water, transportation and communication; a shortage of raw materials and food for industrial products; an increase in public activities during the recovery and restructuring period; and a 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 alleviating a disaster's costs and designing financial aid programs.

Earthquakes are among the deadliest natural disasters in the world. In 2019, 231 earthquakes occurred worldwide, with 23 earthquakes per year between 2010 and 2019. More than 720,000 people lost their lives to earthquakes between 2010 and 2019. In addition to the threat to human life, earthquakes cause significant economic losses and damages to 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 USD 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, and the 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 economic impact of earthquakes 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). However, 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, microeconomic studies only focus on the modest and 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 the baseline. Ohtake et al. (2012) study how the Hanshin-Awaji earthquake in Kobe, Japan, affected job searches, while 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; 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 focuses on the impact of earthquakes on the labor market. We try to estimate the impact of two major earthquakes in Turkiye, one in Elazığ and the other in the İzmir region. A disaster represents a natural experiment that allows testing to assess whether unexpected shocks have long-lasting effects, eventually moving the affected local economy toward a different long-term equilibrium (Barone and Mocetti, 2014). We employ this natural experiment to identify the earthquake impact. We use the synthetic control method as a direct way to construct a control region. The results suggest that earthquakes positively affect the labor market of agriculture-oriented regions and harm the labor market of non-agricultural-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 organized as follows. Section 2 presents a brief overview of the major earthquakes in Turkiye. Section 3 explains the data, while section 4 introduces the synthetic control methodology and its advantages. Section 5 presents the empirical results, and the final section concludes.

2. 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 as well as social, economic, political, and environmental effects. Turkiye ranks fourth in the Disaster Risk Index (DRI) published by the United Nations (UNDP, 2004). Being in the Mediterranean, Alpine, and Himalayan seismic belts increases the likelihood of an earthquake, especially in Turkiye (JICA, 2004). However, most of the literature in Turkiye focuses on an earthquake with a magnitude of 7.4 Mw on the Richter scale that occurred in the Marmara region on 17 August 1999.

Table 1: Major damaged earthquakes in Turkiye in the last 10 years

Date	Location	Size (Mw)*	Number of Deaths
10 June 2012	Fethiye, Muğla	6	1
8 January 2013	Aegean Sea (Çanakkale Offshore)	6.2	0
24 May 2014	Aegean Sea (Gökçeada Offshore)	6.9	0
12 June 2017	Aegean Sea (Karaburun Offshore)	6.3	0
21 July 2017	Aegean Sea (Bodrum Offshore)	6.6	0
8 August 2019	Denizli	6	0
26 September 2019	İstanbul (Silivri)	5.7	1
24 January 2020	Elazığ, Sivrice	6.8	41
23 February 2020	İran-Türkiye border	6	10
14 June 2020	Bingöl	5.9	1
30 October 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 higher have devastating effects. Table 1 also indicates that the earthquakes in Elazığ and especially in Izmir have caused many casualties. In addition, these earthquakes destroyed the economic balances in the regions where they took place.

3. Data

In the study, we use the unemployment benefit application data and the number of job placements as a dependent variable in the models, which are publicly available in the İŞKUR database for 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 are presented on a provincial basis, some are accessible at the regional level.

4. Model

To determine how the earthquakes 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 a difference-in-differences estimation but arguably uses more powerful comparisons to get causal effects (Athey and Imbens, 2017). One of its most important advantages is the use of 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 resemble the characteristics of the treated unit(s) 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. Therefore, the application of SCMs 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 the regions in Turkiye 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 $J + 1$ regions, and without loss of generality, let the first region be the one exposed to the earthquake. Let Y_{it} be the outcome variable that is evaluated based on the earthquake's impact (number of job placements and number of unemployment allowance applications) for region i ($i = 1, \ldots, J + 1$), and the time t (for the periods $t = 1 \ldots, T_0, \ldots, T$; where T_0 is the time of the earthquake). Y_{it}^I is the outcome variable in the presence of the earthquake and Y_{it}^N 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 T_0 so that $Y_{it}^I = Y_{it}^N, \forall t < T_0$. However, the last assumption is unjustified in cases where disaster impact is frequent. Therefore, as expected, we examine two regions (Izmir and Elazıg) that had not experienced a significant earthquake for nearly 200 years.

The observed outcome is defined by $Y_{it} = Y_{it}^N + \alpha_{it} D_{it}$, where α_{it} is the effect of the earthquake on the variable of interest ($Y_{it}^I - Y_{it}^N$) and D_{it} is the binary indicator denoting the event occurrence ($D_{it} = 1\ for\ t \geq T_0\ and\ i = 1; and\ D_{it} = 0$ otherwise). The aim is to estimate α_{it} for all $t \geq T_0$ for the affected regions ($i = 1$; Izmir and Elazıg). The estimation problem is that for all $t \geq T_0$, it is not possible to observe Y_{1t}^N (the counterfactual). This issue is the well-known fundamental problem of causal inference.

In this case, Y_{1t} can be calculated as the weighted average of the Y_{it} (for $i = 2, \ldots, J + 1$) observations from the other regions: $Y_{it}^N = \delta + \sum_{j=2}^{J+1} w_j\, Y_{jt}^N + \alpha_{1t} D_{1t} + \varepsilon_{1t}$. For pre-earthquake observations ($t < T_0$), this equation can be estimated to obtain the weights allocated to the different region observations, w_j. Therefore, based only on pre-impact observations, the following equation can be obtained $Y_{it}^N = \delta + \sum_{j=2}^{J+1} w_j\, Y_{jt}^N + \varepsilon_{1t}$.

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

$$\hat{\alpha}_{it} = Y_{it}^I - Y_{it}^N = Y_{it}^I - \sum_{j=2}^{J+1} w_j\, Y_{jt}^N \quad \text{for } t \geq T_0$$

where w_j is 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.

5. Results

The Elâzığ earthquake occurred on 24 January 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 unemployed workers after the earthquake. This reasoning may increase the number of job replacements in the Elazığ region. It is also important to note that the number of unemployment allowance applications in the Elazığ region after the earthquake does not differ 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

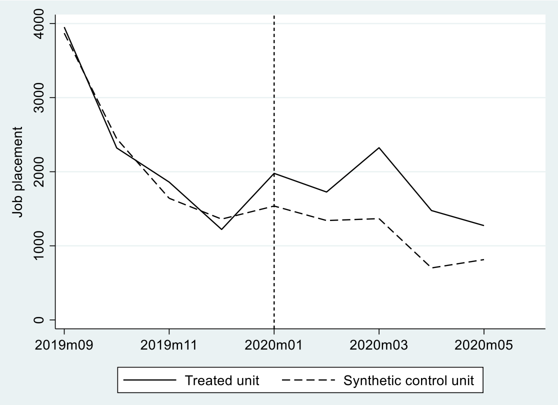
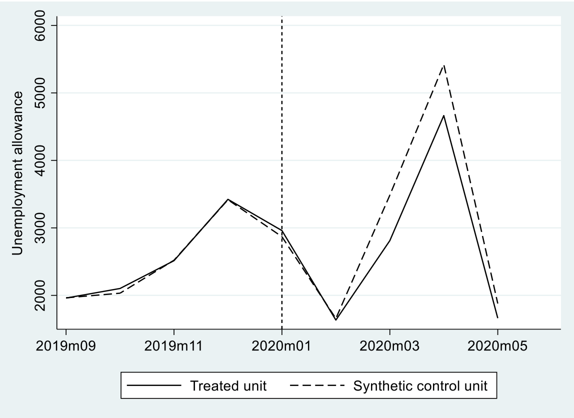


Figure 2: The effects of the January 2020 Elazig earthquake on the number of unemployment allowance applications

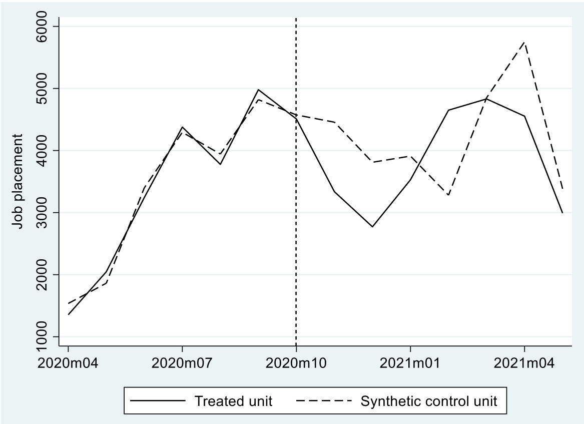


The İzmir earthquake (Aegean Sea earthquake) occurred on 30 October 2020 at 14.51 local time, with a magnitude of 6.9 Mw and with an epicenter 23 kilometers away from the

Seferihisar district of the İzmir province of Turkiye. We analyze the effects of the earthquake on the number of people applying for job placement and unemployment benefits in İzmir. As seen in Figure 3, the amount of job placements in the synthetically constructed Izmir region was higher than 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 three to four months.

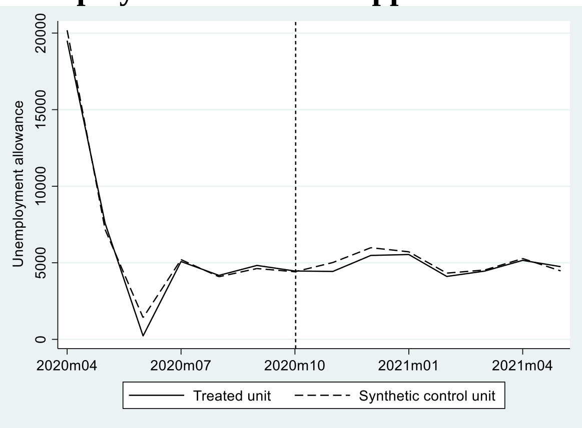
On the other hand, the earthquake did not appear to have an apparent impact on the number of applications for unemployment benefits. We consider that the most important reason for this is the prohibition of dismissals within the scope of COVID-19 pandemic measures. Similarly, the recovery in job opportunities took longer during the pandemic. In addition, under the assumption that the number of job opportunities in the İzmir province are higher than in the TRB1 region under normal conditions, we believe that the impact of the earthquake on economic recovery is more than it appears.[3]

Figure 3: The effects of the October 2020 İzmir earthquake on the number of job placements



[3] Synthetic and treated values obtained for both earthquake zones are given in the Appendix. In addition, the weights of the control regions used when applying the synthetic control method are also shown in the Appendix. The closer the synthetic values given in these tables are to the treated values, the better the approximation. The control group used for each treated group and the weights of this control group are different. These values are shown in the table.

Figure 4: The effects of the October 2020 İzmir earthquake on the number of unemployment allowance applications



6. Concluding remarks

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

We find that while there is a positive impact on the number of job replacements in the Elazığ region, the initial impact of the İzmir earthquake on the İzmir labor market takes almost two months. We can say that full post-earthquake recovery appeared after around four months.

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

Our results show that 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. On the other hand, the earthquake may also harm the labor market, particularly the services-oriented market. For such a market, the first two months are vital.

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