Journal of Regional and City Planning
vol. 35, no. 1, page. 21-43, April 2024
DOI: 10.5614/jpwk.2024.35.1.2

Unravelling the Economic Impacts: Forecasting the Effects of the February Earthquakes on Türkiye's Economy

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[Received: 4 September 2023; 1st revision: 17 November 2023; 2nd revision: 25 December 2023; accepted in final version: 16 January 2024]

Abstract. *This study aimed to reveal the macroeconomic effects of the earthquakes that occurred in Türkiye in February 2023 on the country as a whole, the affected region (covering 11 provinces), and other provinces. Using secondary data obtained from data sets of various institutions, this research firstly attempted to estimate the negative effects of the February Earthquakes on the country's GDP. The study presents a base scenario using the economic growth forecasts of international organizations such as the IMF and the World Bank for 2023 and 2024 as well as three possible loss scenarios for Türkiye, taking into account the effects of earthquakes of similar magnitude on the GDP in Türkiye and other countries. Furthermore, this study tried to estimate the losses caused by earthquakes in terms of employment, GDP, agriculture, industry, services, and foreign trade at the regional and provincial levels. To do this, we created the Base Scenario, which assumes no earthquake, and Scenario 1, which shows the impact of the earthquake. The findings indicate that, in the worst-case scenario, the country will contract by approximately 2.75%, which means a loss of $8.8 billion. Moreover, the study results point out an average monthly loss of 242 thousand jobs, a loss of $5 billion in GDP, an export loss of $3.5 billion, and an import loss of $4.7 billion in the 11 earthquake-affected provinces. The research underlines the need for comprehensive measures to mitigate the economic consequences caused by earthquakes. This includes disaster prevention plans, effective management strategies and initiatives aimed at strengthening regional economic resilience. Ultimately, the article provides valuable information for policymakers to facilitate informed decisions and the implementation of measures to increase preparedness, risk mitigation, and sustainable recovery in earthquake-prone areas.*

Keywords. *February Earthquakes, Macroeconomic Impacts, National, Regional and Provincial Economy, Türkiye.*

Abstrak. *Studi ini bertujuan untuk mengungkap dampak makroekonomi dari gempa bumi yang terjadi di Türkiye pada Februari 2023 terhadap negara secara nasional, yakni wilayah yang terkena dampak (meliputi 11 provinsi), dan provinsi lainnya. Dengan menggunakan data sekunder yang diperoleh dari berbagai institusi, penelitian ini pertama-tama berupaya memperkirakan dampak negatif Gempa Bumi pada bulan Februari terhadap PDB negara tersebut. Studi ini menyajikan skenario dasar menggunakan perkiraan pertumbuhan ekonomi lembaga internasional seperti IMF dan Bank Dunia untuk tahun 2023 dan 2024 serta tiga kemungkinan skenario kerugian, dengan mempertimbangkan dampak gempa bumi dengan*

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kekuatan serupa terhadap PDB Turkiye dan negara lain di tahun 2024. Lebih lanjut, penelitian ini mencoba memperkirakan kerugian akibat gempa bumi dari segi lapangan kerja, PDB, pertanian, industri, jasa, dan perdagangan luar negeri di tingkat regional dan provinsi. Untuk melakukan hal ini, kami membuat Skenario Dasar, yang mengasumsikan tidak ada gempa, dan Skenario 1, yang menunjukkan dampak gempa. Hasil riset juga menunjukkan bahwa, dalam skenario terburuk, Turkiye akan mengalami kontraksi sebesar 2,75%, yang berarti kerugian sebesar $8,8 miliar. Selain itu, hasil penelitian menunjukkan rata-rata hilangnya 242 ribu pekerjaan setiap bulan, hilangnya PDB sebesar $5 miliar, kerugian ekspor sebesar $3,5 miliar, dan kerugian impor sebesar $4,7 miliar di 11 provinsi yang terkena dampak gempa bumi. Penelitian ini menggarisbawahi perlunya tindakan komprehensif untuk memitigasi dampak ekonomi yang disebabkan oleh gempa bumi. Hal ini mencakup rencana pencegahan bencana, strategi pengelolaan yang efektif, dan inisiatif yang bertujuan untuk memperkuat ketahanan ekonomi regional. Pada akhirnya, artikel ini memberikan informasi berharga bagi para pembuat kebijakan untuk memfasilitasi pengambilan keputusan dan rekomendasi penerapan langkah-langkah untuk meningkatkan kesiapsiagaan, mitigasi risiko, dan pemulihan berkelanjutan di daerah rawan gempa..

***Kata kunci**. Dampak Makroekonomi, Gempa Bumi Februari, Perekonomian Nasional, Regional dan Provinsi, Türkiye.*

Introduction

The unpredictable nature of earthquakes makes them among the most challenging natural disasters to anticipate, as noted by Shakya (2016). Their widespread impact across vast regions results in devastating consequences, including a high toll of casualties and injuries along with severe damage to homes, workplaces, and crucial infrastructure, as highlighted by Shibusawa (2020). These seismic events displace a significant number of people and halt production activities for extended periods, ranging from weeks to even years. Salgado-Galvez (2019) emphasizes how this disruption severely affects supply chains, leading to weakened foreign trade and imbalances in payments. Consequently, the regional economy suffers, witnessing a decline in income levels and a scarcity of employment opportunities. The multifaceted challenges posed by earthquakes, spanning direct, indirect, and macroeconomic impacts, contribute to the contraction of both regional and national economies, creating a profound and far-reaching impact.

The growing interest in the economic effects of earthquakes has resulted in many studies. Existing studies using various analysis methods, such as social calculation matrix (SAM), input-output (I–O) table, geographically weighted regression (GWR) model and computable general equilibrium (CGE) model, have been used to predict the effects of earthquakes on sectoral, regional and national economies (Shibusawa, 2020; Tokunaga & Resosudarmo, 2017; Okiyama, 2017; Resosudarmo, 2017; Shibusawa & Matsushima, 2022). However, the focus of most of the research on Asian countries provides limited information about the effects of earthquakes on other geographies. At the same time, the fact that most studies were conducted several years after earthquakes occurred precludes them from providing satisfactory evidence for the near-future effects of earthquakes. Therefore, this research tried to fill important gaps in the literature both by examining different geographies and making predictions about the period after an earthquake.

Earthquakes are critical natural disasters that cause economic damage not only to the regions they hit but also to a wide geography and even the whole country. On February 6, 2023, earthquakes with magnitudes of Mw 7.7 and 7.6 in the Pazarcık and Elbistan districts of Kahramanmaraş, and on February 20, 2023, an earthquake with a magnitude of Mw 6.4 Yayladağı (Hatay) caused high

levels of destruction and loss of life in the 11 surrounding provinces (Kahramanmaraş, Hatay, Adıyaman, Malatya, Gaziantep, Diyarbakır, Şanlıurfa, Adana, Elazığ, Kilis and Osmaniye) (see Figure 2). The main purpose of this study was to reveal the macroeconomic effects of the February Earthquakes on the country as a whole, the affected region (covering 11 provinces), and other provinces. The study first estimated the negative effects on the country's GDP and then tried to predict losses in agriculture, industry, services, foreign trade, and employment at the regional and provincial levels.

The rest of this article is organized as follows: the first section contains the introduction section, the second section reviews existing literature and Türkiye's seismicity, the third section outlines the measurement of national and regional macroeconomic effects using various scenarios, the fourth section presents the results of these scenarios, and the article is concluded in the final section.

Literature Review

Natural disasters

Natural disasters, such as earthquakes, floods, landslides, tsunamis, typhoons, and droughts, along with human-induced disasters like war, terrorist attacks, riots, and technological disasters such as industrial accidents, nuclear incidents, traffic accidents, fires, cyber-attacks, disrupt human activities and natural processes (UNDHA, 1992; Koç, Çavuş, & Sarış, 2005). The significance of these events is exemplified by historical examples recorded in Europe and Asia. The devastating earthquake in Lisbon, Portugal, in 1755 resulted in widespread destruction and loss of life (Deraniyagala, 2016). In Asia, earthquakes in countries like Pakistan in 2005 and China in 2008 claimed tens of thousands of lives, while the Indian Ocean earthquake and tsunami in 2004 and the Myanmar cyclone in 2008 caused catastrophic loss of life and infrastructure (Deraniyagala, 2016).

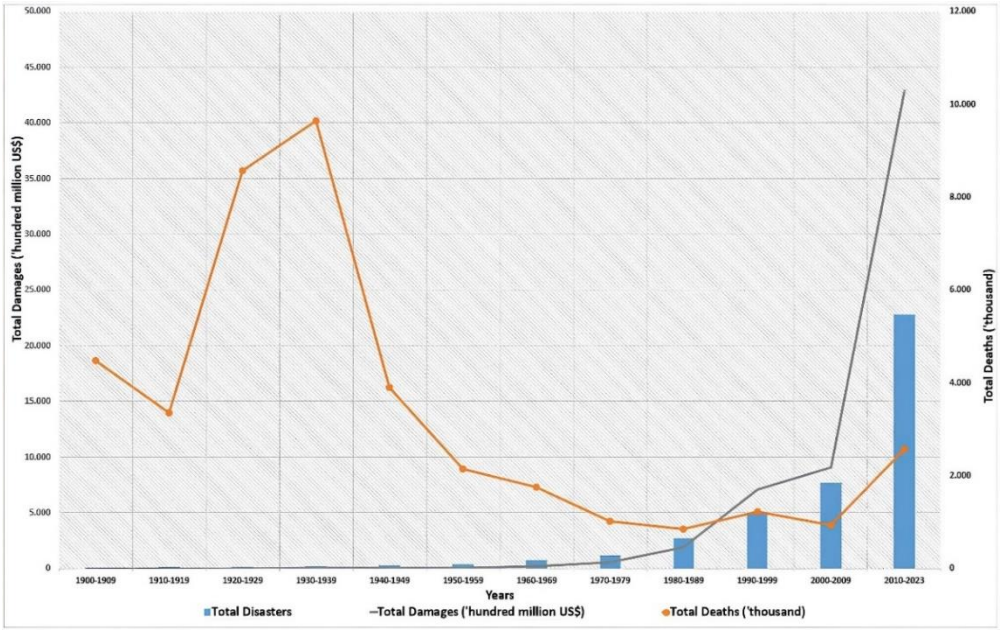

Figure 1. Profiles of natural, technological, and various hazards between 1900 and 2023, including the number of events, total financial loss, and number of casualties (CRED, 2023).

According to the Center for Research on the Epidemiology of Disasters (CRED, 2023), a total of 41,257 natural, technological, and complex disasters have hit the world since 1900. As can be seen in Figure 1, especially after the 1990s, the frequency, fatal effects, and damages of disasters in the world have tended to increase. CRED (2023) also reveal that the earthquake and tsunami that took place in Japan in 2011 is one of the disasters that caused the most economic loss in the world after 1990. This was followed by Hurricane Katrina, which hit the USA in 2005, and earthquakes that hit Türkiye in 2023 and Japan in 1995. Hurricane Ian and Hurricane Harvey, which hit the USA in 2022 and 2017, are among the natural disasters that caused the highest economic losses (see Table 1). These data reveal that earthquakes and hurricanes are natural disasters that cause the highest economic losses.

Table 1. Disasters that caused the highest economic losses worldwide

Year	Disaster Type	Event Name	Country	Total Damages (Million US$)	Total Damages, Adjusted (Million US$)
2011	Earthquake	Tohoku	Japan	210,000	273,218
2005	Storm	Katrina	United States of America (the)	125,000	187,319
2023	Earthquake	February (Kahramanmaraş)	Türkiye	104,000	
1995	Earthquake	Kobe	Japan	100,000	192,051
2022	Storm	Hurricane 'Ian'	United States of America (the)	100,000	100,000
2017	Storm	Hurricane Harvey	United States of America (the)	95,000	113,423
2008	Earthquake	Sichuan	China	85,000	115,538
2017	Storm	Hurricane 'Maria'	Puerto Rico	68,000	81,187
2021	Storm	Tropical storm 'Ida'	United States of America (the)	65,000	70,202
2017	Storm	Hurricane 'Irma'	United States of America (the)	57,000	68,054

Source: (CRED, 2023)

Unveiling the economic impacts of earthquakes: empirical evidence

Studies have categorized earthquake-induced economic losses into direct, indirect, and secondary costs (Shibusawa, 2020; Shibusawa & Matsushima, 2022; Kunreuther & Rose, 2004; Avdar, 2017). Direct costs encompass damage to buildings, infrastructure, and production, while indirect costs refer to income losses from decreased demand, limited job opportunities, and reduced tax revenues (Şahin & Kılınç, 2016). Secondary costs encompass the long-term effects of physical, financial, human, and social capital losses (Akar, 2013). Empirical analysis using input-output models has demonstrated the substantial direct and indirect economic losses caused by earthquakes (Shibusawa & Matsushima, 2022; Tamura, et al., 1982; Tokunaga, Ikegawa, & Okiyama, 2017). The impact of earthquakes on national economies can persist for years, with a typical earthquake leading to a reduction in GDP per capita even after eight years (Lackner, 2018). Moreover, geological-induced disasters have long-term negative economic effects (Baig, Khan, Gilal, & Qayyum, 2018). Earthquakes also affect public finances, leading to fiscal imbalances, increased budget deficits, and slowed economic growth (Shakya, 2016; Avdar, 2017). The economic consequences of earthquakes can be observed through a decrease in GDP, depreciation in stocks, and deterioration of the current account balance (Akar, 2013). Employment in affected regions is significantly impacted by earthquakes, causing a loss of qualified workforce, reduced

production, and disruptions in various sectors (Shakya, 2016; Şahin & Yavuz, 2014). Regional production, exports, imports, and the tourism sector suffer due to damage to infrastructure, production facilities, and tourist areas (Shakya, 2016; Karatağ, 2021). The economic losses caused by earthquakes are closely related to the development level of countries, with lower-income countries experiencing more devastating impacts (Lackner, 2018).

Recent studies have employed econometric models to analyze the economic effects of earthquakes on countries and regions, with a focus on Asian countries, particularly Japan (Tokui, Kawasaki, & Miyagawa, 2015; Okiyama, Tokunaga, & Akune, 2014; Karan & Suganuma, 2016). These studies have explored the effects on supply chains, production loss, and destruction caused by specific earthquakes. Overall, the multifaceted economic consequences of earthquakes highlight the need for comprehensive measures to mitigate their impacts and promote long-term resilience. Various studies have provided differing findings regarding the effects of earthquakes on GDP growth rates. For instance, the 1999 Marmara Earthquake resulted in a 6.1% contraction in GNP and a 4.7% contraction in GDP compared to the previous year (Aktürk, 2002). Similar studies on earthquakes in different countries, such as India, Japan, Indonesia, Nepal, and Mexico, have reported GDP contractions ranging from 0.13% to 2% (Salgado-Galvez, 2019; Resosudarmo, 2017; Kumar & Sinha, 2017). This study sought to gauge the impact on GDP caused by earthquakes with a magnitude of 7 or higher, exploring their effects on national economies, which can range from 0.1% to 6%. To achieve this, the study utilized these findings as a benchmark. Additionally, the analysis section drew upon earlier research to evaluate both regional-scale losses and sectoral contractions.

History of earthquakes in Türkiye

Türkiye, located in the Alpine, Himalayan, and Mediterranean seismic belt areas, is highly susceptible to devastating earthquakes (Avdar, 2017). The country has a long history of experiencing earthquakes with severe consequences (AFAD, 2014). The likelihood of a major earthquake with a magnitude of 9 scale occurring in Türkiye is estimated to be over 60% on average every five years (JICA, 2004). Türkiye ranks among the top three countries in terms of loss of life caused by earthquakes and among the top eight countries in terms of direct or indirect economic losses (AFAD, 2014).

Since the early 1900s, Türkiye has faced 114 earthquakes resulting in loss of life or property (CRED, 2023). These earthquakes had a significant impact, with over 154 thousand people losing their lives due to all types of disasters in Türkiye during this period, and more than 144 thousand deaths specifically attributed to earthquakes (CRED, 2023). The economic damage caused by earthquakes in Türkiye has been substantial, with a total estimated cost of 59 billion dollars, out of the overall damage of 63 billion dollars caused by all types of disasters (CRED, 2023). Among all the disasters, earthquakes are regarded as the deadliest and most destructive events in Türkiye.

Table 2. Damages caused by all disasters and earthquakes in Türkiye.

Period	Location	Total Deaths	Number of Injured	Number of Homeless	Total Affected	Total Damages ('000 US$)	Total Damages, Adjusted ('000 US$)
1900-2023	**All Hazards**	154,136	214,779	1,399,943	19,592,109	63,501,670	54,695,464
	Earthquakes	144,118	209,057	1,298,369	16,971,842	59,568,970	45,616,679
	Ratio	0.94	0.97	0.93	0.87	0.94	0.83

Source: (CRED, 2023)

The occurrence of numerous earthquakes in Türkiye has been recorded, among which certain events stand out as the deadliest, as presented in Table 3. The earthquake that transpired across 11 provinces on February 6, 2023, was the central focus of this study due to its unprecedented severity in terms of both loss of life and destruction. However, it is essential to acknowledge that the earthquakes that ravaged multiple provinces in the Marmara Region in 1999 exhibited the highest level of destructiveness, while the earthquake in Erzincan in 1939 caused the most significant loss of life. Akin to the February Earthquakes under examination, the overall impact of the 1999 Marmara earthquake is succinctly summarized in Table 3 below.

Table 3. List of the most catastrophic earthquake events in Türkiye.

Year	Location	Total Deaths	Number of Injured	Number of Homeless	Total Affected	Total Damages ('000 US$)	Total Damages, Adjusted ('000 US$)
2023	Gaziantep; Kahramanmaras; Sanliurfa, Diyarbakir, Adana, Adiyaman, Osmaniye, Hatay, Kilis, Elazig, Malatya	50,096	107,204	no records	9,207,204	34,000,000 (Reconstruction costs: 104,000,000)	no records
1939	Erzincan (Anatolia)	32,962	no records	no records	585,000	20,000	419,844
1999	Izmit, Kocaeli, Yalova, Golcuk, Zonguldak, Sakarya, Tekirdag, Istanbul, Bursa, Eskisehir, Bolu	18,342[i]	74,242 [i]	600,000	1,358,953	20,000,000	35,137,907
1943	Ladik, Samsun, Havza	4,020	5,000	no records	5,000	40,000	674,981
1914	Burdur, Kilinc, Keciborlu, Isparta	4,000	700	51,000	51,700	no records	no records

Source: (CRED, 2023; AFAD, 2014) (i: These data have been updated according to the Disaster and Emergency Management Authority of Türkiye (AFAD) data)

The devastating earthquakes that struck the Marmara Region of Türkiye in August and November 1999 resulted in a significant loss of life and widespread material damage. Over 18,000 people lost their lives, and more than 70,000 individuals were injured. The affected provinces suffered severe destruction, with 109,000 workplaces and residences completely destroyed and approximately 250,000 buildings sustaining varying degrees of damage. Critical infrastructure such as healthcare facilities, schools, roads, power lines, and gas pipes were also seriously affected. Nearly 600,000 people were displaced, with half of them becoming homeless and seeking shelter in tents or containers (CRED, 2023) The Marmara Region was not only a significant industrial production center in Türkiye but also a crucial contributor to the country's economy. The four directly affected provinces, i.e., Sakarya, Kocaeli, Bolu, and Yalova, accounted for more than 7% of the national GDP and 14% of the industry value added. Although these provinces constituted only 4% of the population, they generated over 16% of the budget revenues. Moreover, the earthquakes indirectly impacted major service and manufacturing centers like Istanbul, Bursa, and Eskişehir. Collectively, the affected area contributed to 35% of the national GDP, nearly half of the total industrial production (OECD, 2000).

The macroeconomic effects of the 1999 earthquakes were extensively analyzed by various organizations, including the World Bank, the State Planning Organization, and the Turkish Businessmen's Association (TUSIAD). Their assessments revealed direct economic costs ranging from 3 to 11 billion dollars, along with indirect costs estimated between 1 and 3 billion dollars. However, according to CRED (2023), the total estimated loss was approximately $20 billion, with $35 billion verified as the actual loss. The earthquakes resulted in a decrease in GNP by 6.1% and GDP by 4.7% compared to the previous year, with factors such as physical capital and labor losses, declining consumption and investment, and stock losses contributing to the economic decline (Aktürk, 2002; DPT, 2001).

Methods

Material

Earthquakes are among the critical natural disasters that cause economic damage not only to the regions they hit but also to a wider geography and even to the entire country. On February 6, 2023, two earthquakes with 7.7 and 7.6 Mw magnitudes occurred in the Pazarcık and Elbistan districts of Kahramanmaraş, and on February 20, 2023, an earthquake of magnitude 6.4 occurred, with the epicenter in Yayladağı (Hatay). These earthquakes caused high levels of material damage and many deaths in the 11 surrounding provinces (Kahramanmaraş, Hatay, Adıyaman, Malatya, Gaziantep, Diyarbakır, Şanlıurfa, Adana, Elazığ, Kilis and Osmaniye) (see Figure 2).

Our main purpose in this study was to reveal the macroeconomic effects of the earthquakes that occurred in February 2023 on the country as a whole, the directly affected region (covering 11 provinces), and other provinces. In the study, we first tried to estimate the negative effects of the earthquake on the country's GDP, and then we tried to predict the losses in agriculture, industry, services, foreign trade, and employment of the region and provinces.

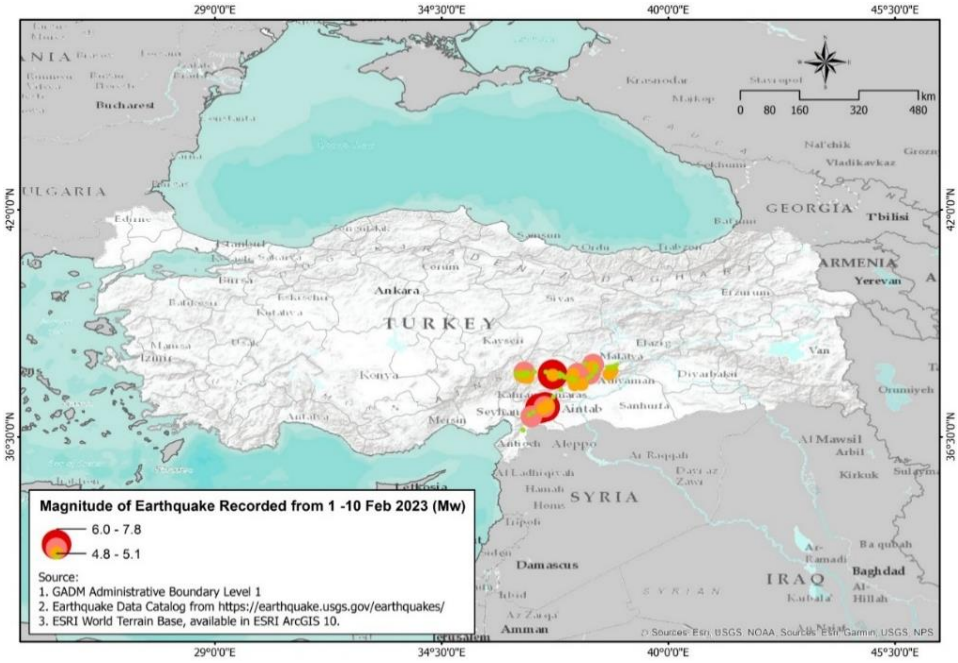

Figure 2: The epicenter of the February 2023 earthquakes and the distribution of their intensity.
Source: Created by the authors

Data

To reveal the results of the macroeconomic effects of the February Earthquakes, this study used secondary data from various data sets. First, the study used data on the number of buildings and residences damaged at different levels from the Strategy and Budget Presidency (SBP) to show the devastating impact of the earthquake on the building stock in the provinces. Second, we got data on the number of monthly compulsory insured employees, which is a critical indicator in calculating macroeconomic losses at regional and provincial levels, from the Social Security Institution. Finally, GDP, agriculture, industry, services, labor force and foreign trade data necessary to measure macroeconomic impacts at national, regional, and provincial levels were obtained from the Turkish Statistical Institute.

Analysis

To estimate the widespread economic impacts of earthquakes, we adopted different approaches at the country and regional (province) levels (see Table 4). We followed two methods to reveal the macroeconomic effects of earthquakes at the country level. First, we calculated a base scenario using the economic growth forecasts of international organizations such as the IMF and the World Bank for 2023 and 2024. Although these predictions include the negative effects of earthquakes on the economy, research on previous earthquakes indicates that these effects may be much deeper (Shakya, 2016; Shibusawa, 2020; Salgado-Galvez, 2019; Resosudarmo, 2017; Tokunaga, Ikegawa, & Okiyama, 2017; Wang, Wu, Buren, Guo, & Liang, 2021; Aksoy, Chupilkin, Kelly, Koczan, & Plekhanov, 2023; Ozudogru, 2023). Second, we created three possible scenarios for Türkiye, considering the effects on GDP of earthquakes of similar magnitude in Türkiye and other countries (e.g., the 1999 Marmara Earthquake, the 2004 Indian Ocean Earthquake, the Great East Japan Earthquake in 2011, the 2015 Nepal Earthquake, and the 2017 Mexico City Earthquake):

- Based on the study of Aksoy et al. (2023), which calculated the average impact of more than 40 earthquakes of similar magnitude in 25 countries with the 'synthetic control' method, we predicted that Türkiye's GDP will shrink by at least 1% in Scenario 1.

- Scenarios 2 and 3 were created by considering the results of the 1999 Marmara (Kocaeli) Earthquake, which heavily affected the Marmara Region (7 provinces) of Türkiye. Like the Marmara Earthquake, which caused an economic contraction of more than 6% (DPT, 2001), the February Earthquakes may also cause a similar loss, so while a 3% loss was predicted in Scenario 2, the loss in Scenario 3 was calculated as 6%.

At the regional and provincial level, the following steps were followed to calculate the losses caused by the earthquake in terms of GDP, agriculture, industry, services, employment, and foreign trade.

- First, we created the Base Scenario, which assumes no earthquake for all indicators. In this scenario, the 2023 values of all indicators were calculated using the average growth rates of the last ten years.
- Second, we created Scenario 1, which shows the impact of the earthquake. We calculated the loss caused by the earthquake for all indicators as follows. First, we calculated the change rates in the number of monthly compulsory insured employees received from SSI (2023) compared to the same months of the previous year. This data set, which was available until August 2023 was not differentiated by sector, clearly showed the extent of employment loss in each province and region due to the earthquake. Then, since it is a

critical input of economic growth, production, and trade, we think that the average loss in employment will be similarly reflected in GDP, other sectors, and foreign trade. Thus, using the loss rates in the average number of compulsory insured employees (between February and August), we calculated the loss amounts in GDP, sectors, labor force indicators and foreign trade for each province and region.

Table 4. Measuring the macroeconomic effects of the February Earthquakes in Türkiye and affected provinces.

Levels	**National**		**Regional**
Indicators	• GDP	• Compulsory insured employees	• GDP • Agriculture • Industry • Service • Foreign trade • Labor force
Scenarios	**4 Different Scenarios** ***Base Scenario*:** The current trend continues ***Scenario 1*:** 1% decrease ***Scenario 2*:** 3% decrease ***Scenario 3*:** 6% decrease	**Step 1** To calculate the change rates in the number of monthly compulsory insured employees (by province)	**Step 2: Two different scenarios** • ***Base Scenario (no earthquake):*** For each indicator, the 2023 values were calculated using the average growth rate of the last ten years. • ***Scenario 1 (after the earthquakes):*** To calculate the change in other indicators using the average rate of change in the number of compulsory insured employees.

Additionally, since the levels of earthquake impact were different, the provinces were divided into three different categories (Table 4). Accordingly, Hatay, Kahramanmaraş, Adıyaman and Malatya, where more than 50% of the total housing stock was damaged in various ways, were in the first-degree damaged category, Gaziantep, Kilis and Osmaniye, where more than 30% of the total housing stock was damaged, were in the second-degree damaged category and finally, Adana, Elazığ, Şanlıurfa and Diyarbakır, which had less than 30% housing damage, were in the third-degree damaged category. These categories allowed us to make comments about the provinces more easily.

Results

Building and residential damage

The February Earthquakes killed more than 50,000 people and injured or left hundreds of thousands homeless. The total population of the 11 provinces directly affected by the earthquake was 14,013,196, corresponding to 16% of the country's population. Additionally, considering that 1.7 million Syrians under Temporary Protection, who migrated to Türkiye due to the civil war in Syria and reside in these provinces, the number of people directly affected by the earthquake approached 16 million. The majority of the population (96.7%) lives in provincial and district centers while the rest lives in villages.

Table 5. The number of buildings damaged in the earthquakes.

	Total Number of Buildings					Damaged Building Rates (%, Total Building Stock)[b]			
Provinces	**Residential**	**Workplace**	**Public**	**Other**	**Total**	**Undamaged**	**Slightly Damage**	**Medium Damaged**	**Ruined or Needs to be Demolished Urgently**
Adana	404,502	29,920	8,916	7,779	451,117	98	1	1	0
Adıyaman	107,242	5,765	4,370	3,119	120,496	23	32	6	39
Diyarbakır	199,138	11,412	11,964	3,165	225,679	86	12	1	1
Elazığ	106,569	7,221	2,872	7,051	123,713	93	4	0	2
Gaziantep	269,212	22,829	5,480	8,162	305,683	51	33	4	12
Hatay	357,467	33,511	10,382	5,489	406,849	36	36	6	27
Kahramanmaraş	219,351	12,358	6,879	4,565	243,153	26	42	3	29
Kilis	33,399	1,526	1,651	736	37,312	39	46	3	12
Malatya	159,896	8,370	6,670	4,051	178,987	36	31	3	30
Osmaniye	128,163	9,428	3,105	2,384	143,080	56	32	1	11
Şanlıurfa	347,902	18,847	11,790	4,089	382,628	77	21	1	1
Total	2,332,841	161,187	74,079	50,590	2,618,697	**61**	**23**	**3**	**13**

Sources: a. (Ozudogru, 2023) b. (SBP, 2023)

Table 6. The number of residences damaged in the earthquakes.

Provinces	**Total Number of residences**	**Undamaged**	**Slightly Damage**	**Medium Damaged**	**Ruined or Needs to be Demolished Urgently**
Adana	972,561	886,769	71,072	11,768	2,952
Adıyaman	216,744	69,044	72,729	18,715	56,256
Diyarbakır	563,295	430,261	113,223	11,209	8,602
Elazığ	292,406	249,577	31,151	1,522	10,156
Gaziantep	893,558	607,655	236,497	20,251	29,155
Hatay	847,380	416,851	189,317	25,957	215,255
Kahramanmaraş	481,362	203,012	161,137	17,887	99,326
Kilis	74,976	43,190	27,969	1,303	2,514
Malatya	345,536	153,451	107,765	12,801	71,519
Osmaniye	243,436	153,737	69,466	4,122	16,111
Şanlıurfa	718,063	506,458	199,401	6,041	6,163
Total	**5,649,317**	**3,720,005**	**1,279,727**	**131,576**	**518,009**

Source: (SBP, 2023)

According to the data of the Presidency of the Republic of Türkiye, Strategy and Budget Directorate (SBP) (2023), the earthquake zone contained more than 2.6 million buildings (see

Table 5). Among these buildings, 13% collapsed or were urgently demolished, 3% had moderate damage, and 23% had slight damage. This means that the earthquakes damaged approximately 40% of the total building stock in the 11 provinces. Additionally, Table 6 reveals that out of a total of 5.6 million residences in the earthquake zone, 518 thousand were destroyed or needed to be urgently demolished, 131 thousand had moderate damage, and 128 thousand had slight damage.

More specifically, 26% of the houses in Adıyaman were completely destroyed, while 25% of the houses in Hatay, 21% in Kahramanmaraş and 21% in Malatya were completely destroyed. However, in other provinces, the destruction rate varied between 0.1% and 7%. Meanwhile, according to SBP (2023), the total damage caused by the earthquakes exceeded 100 billion dollars, while 54.7 billion dollars of this was due to the destruction in the housing sector. Among the provinces, the majority of the total damage originated from Hatay and Kahramanmaraş, with the former accounting for 36% of the total and the latter accounting for 17% (WB, 2023).

February Earthquakes' Impact on National Economic Growth

Numerous studies have demonstrated that the extent and duration of macroeconomic losses resulting from earthquakes are closely linked to the severity of the earthquake itself, the affected areas' size and strategic importance, as well as the overall economic conditions and institutional quality of the country (Shibusawa & Matsushima, 2022; Hallegatte, Jooste, & McIsaac, 2022). Earthquakes can lead to substantial short and long-term economic losses due to the loss of life and property, damage to infrastructure and buildings, and disruptions in employment, production, and services (Ozudogru, 2023; Hallegatte, Jooste, & McIsaac, 2022; DuRose, 2023). The February Earthquakes occurred during a period of economic fragility in the country. As noted by Ozudogru (2023), the economy had already faced high levels of inflation and financial risks resulting from poor economic policies implemented before the earthquake, as well as the impact of international events such as the Ukraine-Russian War. These factors have contributed to income inequality, poverty, and sluggish economic growth.

Undoubtedly, the February Earthquakes occurring during such a challenging period will further destabilize the national economy and result in below-expectation economic growth. Despite achieving growth rates of 11.4% in 2021 and 5.6% in 2022, the IMF projects a modest growth rate of 4% for 2023 and 3.25% for 2024. However, considering the adverse conditions mentioned earlier and the effects of the earthquake, the country's economy is expected to experience even slower growth (see Table 7). The study prepared four different scenarios to assess the potential magnitude of the earthquake's impact on the economy, considering the wide range of effects earthquakes can have on national economies, ranging from 0.01% to 6%, as described in Section 3.

i. According to the Base Scenario, which reflects the growth expectation of the IMF and takes into account the current economic difficulties and geopolitical risks, the country's GDP index value increases to 216.42 for 2023 and 226.42 for 2024 compared to the 2009 base year (100) (see Table 7). In other words, in terms of volume, the Turkish economy is expected to grow by 84 billion TL in 2023 and by 156 billion TL in 2024.

ii. In Scenario 1, which envisages an additional decrease of 1% compared to the current trend, the 2023 and 2024 GDP growth rates were calculated as 3.0% and 2.25%, respectively. This decrease also means that, according to the Base Scenario, the Turkish economy will shrink by 21 billion TL in 2023 and 43 billion TL in 2024. That is, the index values for the same years decrease to 217.18 and 222.07.

iii. Scenario 2 paints a slightly more pessimistic picture than the previous ones. Namely, in this scenario, which predicts an additional 3% decline in GDP, the expected growth rates for 2023 and 2024 are 1% and 0.25%, respectively. Thus, the index values calculated for the same years decrease to 212.97 and 213.50, which means a loss of 64 billion TL for 2023 and 130 billion TL for 2024.

iv. Scenario 3, which yields the worst forecast, predicts an additional 6% decrease compared to the Base Scenario. A similar decline was experienced in Türkiye during the 1999 Marmara Earthquake. Therefore, according to this scenario, the Turkish economy is projected to shrink by -2.0% and -2.75%, in both 2023 and 2024. This means a decline in GDP to 2021 levels. To put it more clearly, compared to the Base Scenario, the Turkish economy loses 127 billion TL in 2023 and 256 billion TL in 2024.

Table 7. Measuring the impact of earthquakes on national GDP growth with different scenarios.

Scenarios	Years	Index	Volume (Thousand TRY)	Change ratio (%)
Previous Years	**2009**	100.00	1,006,372,482	-4.82
	2010	108.43	1,091,180,541	8.43
	2011	120.57	1,213,393,968	11.20
	2012	126.34	1,271,497,249	4.79
	2013	137.07	1,379,394,179	8.49
	2014	143.84	1,447,532,323	4.94
	2015	152.59	1,535,607,237	6.08
	2016	157.66	1,586,636,759	3.32
	2017	169.49	1,705,666,209	7.50
	2018	174.54	1,756,493,104	2.98
	2019	175.90	1,770,257,164	0.78
	2020	179.32	1,804,600,723	1.94
	2021	199.70	2,009,486,002	11.40
Base Scenario: Current Trend Continues	**2022**	210.80	2,122,017,218	5.60
	2023	216.55	2,206,897,907	4.00
	2024	224.34	2,278,622,089	3.25
Scenario 1: 1% decrease	**2023**	214.44	2,185,677,735	3.00
	2024	220.01	2,234,855,484	2.25
Scenario 2: 3% decrease	**2023**	210.02	2,143,237,390	1.00
	2024	211.48	2,148,595,484	0.25
Scenario 3: 6% decrease	**2023**	203.89	2,079,576,874	-2.00
	2024	199.01	2,022,388,510	-2.75

Source: (TurkStat, 2023)

The effect of the February Earthquakes on employment in the provinces

The February Earthquakes, which caused large-scale destruction in the existing infrastructure and superstructure, also caused great losses in the employment structure of the provinces. To measure the impact of the earthquake on employment, we used SSI data on the number of monthly compulsory insured employees (4a). We would have liked to measure the impact of the earthquake on employment and other sectors with different data sets, but the only employment

data published monthly in Türkiye is that of SSI. Therefore, as explained, losses in other sectors and foreign trade were calculated for each province in proportion to the loss rates in the number of insured employees.

The SSI data set publishes the number of compulsory insured employees between January and August 2023, allowing us to make a comparison with the same period of the previous year. The SSI data set strikingly reveals the impact of the earthquake on a total of 11 provinces and regions in the last eight months. As shown in Table 8, when compared with the same months of the previous year, there is a positive increase in the number of compulsory insured employees in all provinces and regions in January, which represents the pre-earthquake period, compared to the same month of the previous year. While the increase rate across the country is over 7%, this rate is calculated as 6.5% for the region. While Şanlıurfa is the province with the fastest increasing number of insured employees compared to the previous period, it is followed by Adıyaman and Diyarbakır provinces. In contrast, Elazığ and Kahramanmaraş provinces were the provinces with the lowest increase rate.

However, after the February Earthquakes, the outlook changed completely. Due to the shock effect of the earthquakes, very sharp decreases in insured employees occurred in all provinces in February. Immediately after the earthquakes, there was a 27% drop in the affected region covering 11 provinces. In comparison, there was a 4% increase across the country. Compared to February of the previous year, provinces in the first-degree damage category experienced an average reduction of 55%, while those in the second-degree damage category experienced a decrease of 22%, and those in the third-degree damage category experienced a decline of around 6%. Meanwhile, the sharpest drop occurred in Kahramanmaraş and Hatay provinces by 68% and 59%, respectively, the smallest decrease occurred in Diyarbakır and Elazığ provinces at 1% and 5%, respectively.

Although the rate of decline in the number of insured employees decreased partially in the following months, it was observed that it remained high, especially in the provinces with first-degree damage. At the end of eight months, while the average monthly decline rate in all 11 affected provinces was around 14%, this rate was twice as high in the first-degree damaged provinces. On the other hand, while there was a drop of 7% in the provinces with second-degree damage, there was a decrease of around 5% in those with third-degree damage. Across the country, there was an average monthly decrease of -0.3%.

In other words, the February Earthquakes caused an average of 242 thousand insured employees to lose their jobs monthly in the entire region. This loss corresponds to 43 thousand people per month for those in the first-degree damage category, 12 thousand people for those in the second-degree damage category, and 8 thousand people for those in the third-degree damage category. Among the provinces, the province with the highest monthly loss of insured employees was Hatay with 65 thousand people, followed by Kahramanmaraş with 62 thousand people, Malatya with 34 thousand people and Gaziantep with 32 thousand people. A significant part of this loss originates from the provinces that were most damaged by the earthquakes. For example, while the average monthly number of insured employee losses in Hatay was calculated as 67 thousand, it was followed by Kahramanmaraş with 66 thousand, Gaziantep with 39 thousand and Malatya with 36 thousand. In proportion, Kahramanmaraş is the province with the highest loss at 37%, followed by Hatay at 34% and Malatya at 29%.

Table 8. Monthly change of the effect of the February Earthquakes on employment in the provinces.

Categories	Provinces	Jan, 2022-23	Feb, 2022-23	Mar, 2022-23	Apr, 2022-23	May, 2022-23	Jun, 2022-23	Jul, 2022-23	Aug, 2022-23	AVERAGE	
		%	%	%	%	%	%	%	%	%	*Number*
	Türkiye	7.2	3.8	5.0	3.7	-2.5	-4.6	-4.6	-2.7	-0.3	-55,427
First-degree damaged category	Adıyaman	9.8	-46.7	-20.0	-29.8	-0.6	-9.7	-0.3	-1.3	-15.5	-10,249
	Hatay	7.4	-57.9	-33.6	-45.8	-17.2	-36.1	-17.3	-28.3	-33.7	-65,607
	Kahramanmaraş	1.8	-68.1	-32.4	-50.1	-24.7	-37.3	-19.3	-24.6	-36.6	-62,454
	Malatya	4.2	-45.9	-29.9	-38.8	-20.4	-30.3	-16.7	-19.9	-28.8	-34,107
Second-degree damaged category	Gaziantep	6.5	-25.8	-1.4	-13.7	-5.9	-15.6	-1.3	2.5	-8.8	-31,747
	Kilis	6.8	-11.2	8.2	-6.3	1.7	-11.1	0.8	2.1	-2.2	-438
	Osmaniye	3.7	-29.0	-3.6	-16.5	-4.4	-8.7	-0.3	3.9	-8.4	-5,250
Third-degree damaged category	Adana	7.7	-6.5	2.4	-5.4	-6.0	-9.9	-3.5	-0.8	-4.2	-14,612
	Diyarbakır	8.1	-1.0	2.2	-1.4	-2.8	-5.6	-2.1	0.2	-1.5	-2,781
	Elazığ	0.1	-4.9	-1.0	-8.1	-7.0	-11.9	-7.6	-4.3	-6.4	-5,159
	Şanlıurfa	10.4	-10.4	1.3	-6.0	-2.5	-11.3	-6.4	-5.0	-5.8	-9,973
Total	**11 Provinces (Region)**	**6.5**	**-26.8**	**-9.1**	**-19.1**	**-9.0**	**-17.7**	**-7.0**	**-7.1**	**-13.7**	**-242,378**

Source: (SSI, 2023)

The Impact of February Earthquakes on Provinces' GDP and Economic Sectors

In the previous section, we calculated the employment loss of each province due to the earthquake, in this section we will try to estimate the losses of the provinces in GDP and economic sectors by using the average employment loss rate experienced by each province. However, since data on employment are not published sectorally, we have to assume that the losses in agriculture, industry, services, and other sectors were at the same rate.

To calculate the GDP and sectoral losses of the provinces after the earthquakes, it is necessary to first calculate the GDP values that each province can produce in 2023 and their sectoral distributions. To achieve this, in the Basic Scenario section of Table 9, we calculated the GDP values that each province can produce and its sectoral distribution, considering the average growth rate of the provinces over the last ten years. Then, in the Scenario 1 section, which includes the impact of the February Earthquakes, we tried to calculate the economic losses of the provinces in each category using the employment loss rates mentioned above.

According to the Base Scenario, in 2023, the share of the 11 affected provinces in GDP was 425 9.89%, while their share in agriculture was 15.21%, in industry was 12.21%, and in the services 426 sector was 7.42%. Regarding the shares of provinces within the country, Adana was the province 427 with the highest share in agriculture at 2.23% and services at 1.85%, while province with the highest share in the industry sector at 3.94%.

However, in Scenario 1, calculated according to earthquake-based simulation, the share of the 11 provinces in the country's GDP decreased to 7.92% for the same year, while their share in the agriculture, industry and services sectors dropped to 13.58%, 10.48% and 6.42%, respectively. Due to the earthquake, the contribution of the 11 provinces to GDP decreased by 14.2%, which meant a loss of approximately 142 billion TL (5 billion USD).

The 11 provinces experienced the highest loss in industry with 54 billion TL, followed by services with 36 billion TL, and agriculture with 10 billion TL. While the total economic loss of the provinces in the first-degree damage category corresponded to 102 billion TL, the total economic loss of the provinces in the second-degree damage category was calculated as 24 billion TL, and those in the third-degree damage category were calculated as 17 billion TL. The province with the highest economic loss was Hatay with 49 billion TL, followed by Kahramanmaraş with 32 billion TL, and Gaziantep with 20 billion TL. In addition, the industrial loss of Adıyaman, Hatay, Kahramanmaraş and Malatya provinces, which were in the first-degree damage category where the earthquake caused the most damage, was estimated as 39 billion TL, while the loss amounts in services and agriculture were calculated as 20 and 7 billion TL, respectively. Losses in other sectors exceeded 25 billion TL. Briefly, the earthquakes were estimated to have caused a loss of 12% in agriculture, 16% in industry and 15% in services across the 11 affected provinces.

The Impact of February Earthquakes on Provinces' Foreign Trade

Earthquakes, which deeply affect the agriculture, industry and services sectors and employment, are undoubtedly expected to hit the regional import and export balances. Due to regional employment and production losses, a significant decrease is estimated in the import and export values of the provinces in the earthquake region and Türkiye.

Table 9. Estimation of the impact of the February Earthquakes on provinces' GDP and sector structure. (Source: (TurkStat, 2023),

Scenarios	Categories	Provinces	Agriculture	Industry	Services	Others	GDP	Agriculture	Industry	Services	Others	GDP
			Volume (Thousand TRY at Current Prices, 2023)					Share in the Country (%)				
Base Scenario: No Earthquake		Türkiye	519,374	2,810,512	2,544,450	3,200,557	10,115,950					
	First-degree damaged category	Adıyaman	4,063	8,021	4,233	11,957	31,519	0.78	0.29	0.17	0,37	0.31
		Hatay	6,480	57,303	38,000	28,919	145,695	1.25	2.04	1.49	0.90	1.44
		Kahramanmaraş	7,367	38,650	11,582	21,663	88,367	1.42	1.38	0.46	0.68	0.87
		Malatya	5,222	14,015	7,789	20,412	52,890	1.01	0.50	0.31	0.64	0.52
	Second-degree damaged category	Gaziantep	7,225	110,717	40,270	42,053	223,302	1.39	3.94	1.58	1.31	2.21
		Kilis	1,373	1,940	1,470	4,364	10,203	0.26	0.07	0.06	0.14	0.10
		Osmaniye	3,038	21,613	6,334	8,871	44,427	0.58	0.77	0.25	0.28	0.44
	Third-degree damaged category	Adana	12,845	62,535	47,099	53,665	196,399	2.47	2.23	1.85	1.68	1.94
		Diyarbakır	11,623	9,830	12,386	41,800	84,336	2.24	0.35	0.49	1.31	0.83
		Elazığ	4,601	7,124	6,536	22,722	45,706	0.89	0.25	0.26	0.71	0.45
		Şanlıurfa	15,176	11,413	13,212	30,251	78,115	2.92	0.41	0.52	0.95	0.77
	Total	**11 Provinces**	**79,015**	**343,162**	**188,912**	**286,677**	**1,000,958**	**15.21**	**12.21**	**7.42**	**8.96**	**9.89**
			Volume (Thousand TRY at Current Prices, 2023)					Share in the Country (%)				
Scenario 1: After Earthquake		Türkiye	509,546	2,756,268	2,517,031	3,164,502	9,973,754					
	First-degree damaged category	Adıyaman	3,433	6,779	3,578	10,105	26,638	0.67	0.25	0.14	0.32	0.27
		Hatay	4,293	37,968	25,178	19,161	96.534	0.84	1.38	1.00	0.61	0.97
		Kahramanmaraş	4,667	24,485	7,337	13,724	55,981	0.92	0.89	0.29	0.43	0.56
		Malatya	3,716	9,972	5,542	14,523	37,632	0.73	0.36	0.22	0.46	0.38
	Second-degree damaged category	Gaziantep	6,593	101,021	36,744	38,371	203,747	1.29	3.67	1.46	1.21	2.04
		Kilis	1,343	1,896	1,437	4,266	9,974	0.26	0.07	0.06	0.13	0.10
		Osmaniye	2,783	19,802	5,804	8,128	40,706	0.55	0.72	0.23	0.26	0.41
	Third-degree damaged category	Adana	12,301	59,886	45,104	51,392	188,078	2.41	2.17	1.79	1.62	1.89
		Diyarbakır	11,450	9,684	12,201	41,177	83,078	2.25	0.35	0.48	1.30	0.83
		Elazığ	4,308	6,669	6,119	21,272	42,789	0.85	0.24	0.24	0.67	0.43
		Şanlıurfa	14,300	10,755	12,449	28,505	73,606	2.81	0.39	0.49	0.90	0.74
	Total	**11 Provinces**	**69,187**	**288,917**	**161,493**	**250,622**	**858,762**	**13.58**	**10.48**	**6.42**	**7.92**	**8.61**
Average Loss Rate of 11 Provinces (%)			**12.4**	**15.8**	**14.5**	**12.6**	**14.2**	**10.7**	**14.2**	**13.6**	**11.6**	**13.0**

Table 10. The magnitude of the impact of the February Earthquakes on the foreign trade of the provinces.

Scenarios	Categories	Provinces	Import		Export	
			Volume*	Share in the country (%)	Volume*	Share in the country (%)
Base Scenario: No Earthquake		Türkiye	38,451,952		268,873,745	
	First-degree damaged category	Adıyaman	92,872	0.02	116,777	0.04
		Hatay	8,389,135	2.20	4,343,468	1.62
		Kahramanmaraş	1,834,740	0.48	1,513,446	0.56
		Malatya	191,582	0.05	482,340	0.18
	Second-degree damaged category	Gaziantep	9,074,427	2.38	11,882,899	4.42
		Kilis	69,588	0.02	151,933	0.06
		Osmaniye	974,095	0.26	448,277	0.17
	Third-degree damaged category	Adana	5,362,997	1.41	3,323,156	1.24
		Diyarbakır	137,232	0.04	450,776	0.17
		Elazığ	55,730	0.01	408,738	0.15
		Şanlıurfa	361,519	0.09	333,610	0.12
	Total	**11 Provinces (Region)**	**26,543,917**	**6.96**	**23,455,422**	**8.72**
		Provinces	**Volume***	**Share in the country (%)**	**Volume**	**Share in the country (%)**
Scenario 1: After Earthquake		Türkiye	376,747,708		265,421,860	
	First-degree damaged category	Adıyaman	78.489	0.02	98,692	0,04
		Hatay	5.558.447	1.48	2,877,881	1,08
		Kahramanmaraş	1.162.320	0.31	958,779	0,36
		Malatya	136.315	0.04	343,195	0,13
	Second-degree damaged category	Gaziantep	8.279.787	2.20	10,842,324	4,08
		Kilis	68.024	0.02	148,519	0,06
		Osmaniye	892.500	0.24	410,727	0,15
	Third-degree damaged category	Adana	5.135.783	1.36	3,182,364	1,20
		Diyarbakır	135.185	0.04	444,053	0,17
		Elazığ	52.173	0.01	382,650	0,14
		Şanlıurfa	340.650	0.09	314,352	0,12
	Total	**11 Provinces (Region)**	**21.839.673**	**5.80**	**20,003,537**	**7,54**
	Average Loss Rate of 11 Provinces (%)		**0.18**	**0.17**	**0.15**	**0,14**

Source: (TurkStat, 2023);* in thousand USD

To simulate the damage that the February Earthquakes will cause in 2023, we first tried to calculate the foreign trade volume that the 11 provinces could create in 2023, using the average increase rate of import and export values over the last ten years in the Base Scenario (see Table 10). According to the Base Scenario, the share of the 11 provinces in the total country imports is

6.96%, while their share in exports is 8.72%. Gaziantep, which is in the second-degree risk category, is the province that contributes the most to the country's foreign trade with 2.38% import and 4.42% export shares, followed by Hatay, which is in the first-degree risk category, with 2.20% import and 1.62% export shares. The shares of the provinces in the first-degree risk category in the country's imports and exports are 2.75% and 2.40%, while those in the second-degree are 2.65% and 4.64%, and those in the third-degree are 1.55% and 1.68%.

Since regional employment and production capacity and foreign trade volume are closely related, we used the decrease rates (monthly average decrease rate in the number of compulsory insured people) used in the previous section in the calculation of Scenario 1 in this section. Accordingly, while the share of the 11 provinces in the country's imports is expected to decrease by 17% to 5.80%, its share in exports is expected to decline by 14% to 7.54%. In other words, earthquakes cause regional exports to be 3.5 billion dollars less and imports to be 4.7 billion dollars less. Provinces in the first-degree damage category cover 63% of the total export loss and 76% of the total import loss, while those in the second-degree damage category account for 31% of the total export loss and 19% of imports. Among the provinces, Hatay is the province with the highest foreign trade volume contraction with an import loss of 2.8 billion dollars and an export loss of 1.5 billion dollars, followed by Gaziantep with an import loss of 794 million dollars and an export loss of 1 billion dollars. These possible losses in the region's foreign trade are expected to reduce Türkiye's total exports by 1.28% and imports by 1.23%.

Discussion

Throughout history, mankind has been consistently exposed to various disasters. Being uncontrollable and occurring unexpectedly makes earthquakes one of the most difficult disasters to deal with. In addition, the width of the affected area and the size of the population make earthquakes much more destructive.

To date, many large and small earthquakes have occurred in various settlements. While earthquakes seriously destroy residential areas, they also cause many people to lose their lives. However, the magnitude of the destruction caused by earthquakes varies significantly depending on the natural and physical characteristics of the area affected and the level of preparedness of the region against risks. Namely, today, the destructive effects of earthquakes of the same magnitude on different countries or regions differ substantially. For example, while the number of deaths caused by the 8.8 magnitude earthquake that struck Chile in 2010 was only 795 people, the number of deaths caused by the 7.3 magnitude earthquake that hit Haiti in the same year exceeded 200 thousand. The fact that Chile is better prepared for earthquakes than Haiti ensures that its possible losses are smaller. Similarly, in Japan, an earthquake country, the 7.9 magnitude Great Kanto Earthquake, which killed more than 140 thousand people in 1923, was an important breaking point. This earthquake, which is considered a milestone for Japan, pushed the country to make critical changes in legal, administrative, institutional, and planning terms and ensured the country's resilience to disasters.

However, in Türkiye, where the probability of a damaging earthquake occurring every year is as high as 63% (JICA, 2004), the earthquakes that occurred in February 2023 caused large-scale human and economic losses. This study, which attempted to estimate the impact of the February Earthquakes on the provincial, regional, and national economy, produced striking results. The study, which took the Marmara Earthquake (Aktürk, 2002) as a reference, indicates that the February Earthquakes will shrink the country's economy by a maximum of 6%. Additionally, the study examined the impact of many earthquakes on the economies of countries (e.g., the Bhuj Earthquake (2001) and Sikkim Earthquake (2011) in India, the Great East Japan Earthquake

(2011), the earthquake that hit Indonesia in 2004, the earthquake that hit Nepal in 2015, and the earthquake that hit Mexico City in 2017), indicates that the February Earthquakes may shrink the country's economy by at least 1% (see (Kumar & Sinha, 2017; Tokunaga & Okiyama, 2017; Resosudarmo, 2017; Salgado-Galvez, 2019; Aksoy, Chupilkin, Kelly, Koczan, & Plekhanov, 2023).

The present study, which attempted to estimate employment, GDP, agriculture, industry, services sectors and foreign trade losses in all provinces and the earthquake region based on the average monthly change in the number of compulsory insured people, points out remarkable losses in the study area. The findings, which are in line with the ILO (2023) report predicting that 657,147 employees will lose their jobs in all 11 provinces, reveal that 465 thousand insured employees lost their jobs in February. Considering the 39% informality rate in the region (TurkStat, 2023), the loss rate in this study is close to the ILO. Further, according to ILO (2023), which indicates that a loss of 150 million dollars will occur the 11 provinces due to loss of employment, the total loss at the end of the year may approach 2 billion dollars. Similarly, this study, which predicts an average monthly employment loss of 242,000, estimates that according to the calculation made on the monthly minimum wage (11402 TL), the monthly economic loss in the 11 provinces will exceed approximately 2.7 billion TL, and the total loss at the end of the year will exceed 33 billion TL ($1.2 billion). While 70% of this loss occurs in the provinces in the first degree-damage category, 30% equally arises from the provinces in the second and third degree-damage categories.

Moreover, this study expects about a 20% contraction in the volume of agriculture, industry, services, GDP, and foreign trade due to workforce loss, housing problems, transportation and communication disruptions and demolitions in the 11 provinces. Studies conducted in different countries support these results. For example, calculating the damage induced by the Great East Japan Earthquake (2011) in different sectors, Tokunaga et al. (2017) revealed a contraction of nearly 30% in production, while Tokunaga and Okiyama (2017) showed a 25% decrease in the industry sector compared to the year before the earthquake. In another study, Shakya (2016) found that there was a 17.5% decrease in agriculture, 51.4% in industry and a 44% decrease in wholesale and retail sales in the year after the earthquake. Recently, Patandianan and Shibusawa (2020) have reported that the earthquake in 2016 caused the number of foreign visitors in Kumamoto to decrease by 44%.

On the other hand, the effects of the February Earthquakes are expected to be more limited compared to the Marmara Earthquake, which struck a region corresponding to 35% of the national GDP and 50% of industrial production (Aksoy, Chupilkin, Kelly, Koczan, & Plekhanov, 2023). Probably for these reasons, the economic losses calculated in the 11 provinces will remain at a lower level compared to previous earthquakes. Additionally, the high informality rate in the region is another factor that keeps the calculation low. Therefore, the picture presented here may be far below the actual values.

However, by calculating losses at different levels and in various sectors separately, this study provides a broad framework for the economic losses that the February Earthquakes may cause. In the next section, policy recommendations that may be effective in reducing these losses will be discussed.

Conclusion

The findings of this study underline that in Türkiye, a country where regional inequalities are increasingly deepening, natural disasters such as earthquakes can lead to further impoverishment

and underdevelopment of provinces. The article aimed to draw attention to the profound consequences of earthquakes by going beyond mere statistical analysis, emphasizing the harmful effects of earthquakes on people and the economic, social, and cultural erosion of the affected provinces. Earthquakes, with the destruction they cause, lead to significant loss of life and external migration, that is, to the erasure of experiences in the region, and naturally to a significant depletion of human and social capital, which are critical sources of economic development and growth, social progress, and innovation.

Moreover, earthquakes go far beyond the affected area, causing the country's economy to contract and the financial resources allocated to social development in the country to be transferred to debris clearing, emergency shelter, and re-planning and construction processes. Earthquakes can cause the state to spend many years of effort that should be spent on the development of the country as a whole only on the improvement of the earthquake-affected region, deepening inequalities in the country. In summary, the findings of this study show that the February Earthquakes, which resulted in great destruction, heavy financial losses, and many deaths in the 11 affected provinces, dealt a heavy blow to employment in the provinces, causing them to contribute less to the country's GDP and a contraction in sectoral and foreign trade volume.

The serious predicted losses in GDP, foreign trade and employment in the affected provinces indicate that comprehensive policy interventions are needed. Measures such as disaster risk reduction, effective disaster management policies, and initiatives to increase regional economic resilience are vital to reducing the effects of earthquakes and facilitating recovery. In other words, it is of critical importance to abandon the wound-healing strategy and switch to pre-disaster risk reduction policies and actions.

Although Türkiye tried to combat disasters with some legal regulations following the 1939 Erzincan Earthquake, the real breaking point was the 1999 Marmara (Kocaeli and Düzce) Earthquake. After these earthquakes, radical changes occurred in legal and administrative terms. In 2009, Türkiye established the Disaster and Emergency Management Presidency (AFAD) and moved to the Integrated Disaster Management System. By moving from a crisis management approach to a risk management approach, Türkiye has prepared various action plans, for example, the National Earthquake Strategy and Action Plan (UDSEP 2012-2023) in 2011, the Türkiye Disaster Response Plan (TAMP) in 2014, and Türkiye Disaster Risk Reduction Plan (TARAP 2022-2030) in 2021.

However, despite all these developments, the February Earthquakes that occurred in 2023 demonstrated that Türkiye is inadequate in disaster risk reduction and response. Moreover, despite the Provincial Disaster Risk Reduction Plan (İRAP) and the Disaster Response Plans (TAMP) prepared for Türkiye's 81 provinces, the February Earthquakes caused large-scale material and moral damage in the 11 directly affected provinces. This result reveals that the action plans prepared to reduce disaster risk in Türkiye cannot go beyond rhetoric and, at the same time, cannot be adequately integrated into the existing planning system. Although these action plans clearly set out the responsibilities of all institutions from the national to the local level, they failed to prevent the destruction caused by the February Earthquakes.

There may be several reasons for this failure. Firstly, there is a conflict of authority in the implementation of these action plans. Secondly, the integration of these action plans into the existing planning system and hierarchy is difficult in terms of legal legislation and practice. Thirdly, the resources required for action plans are insufficient. For this reason, this study recommends creating a risk mitigation and management plan integrated into the existing planning hierarchy. In particular, such a plan, which has a hierarchy above the zoning plans, can contribute

to the provinces being more risk-sensitive and more resilient. To achieve this, the current zoning legislation (Law No. 3194) needs to be rewritten.

Furthermore, this study makes various policy recommendations to minimize economic losses. First of all, the legislation regarding construction needs to be revised, because the majority of commercial functions in Türkiye are located on the lower floors of buildings. A possible earthquake may cause both serious financial loss and interruption of commercial activities, and thus loss of employment. Additionally, by ensuring sectoral diversification, the destructive impact of earthquakes on some sectors can be compensated by gains in other sectors.

While this article contributes to the literature by estimating post-earthquake damages and presenting a provincial-level analysis, it has limitations due to data limitations. Future research can expand on these findings by employing more comprehensive analysis methods and investigating the multidimensional economic, social, and cultural impacts of earthquakes. How the norms, values, beliefs, and expectations, which are of critical importance in the socio-economic development of regions, are affected by earthquakes or other disasters can be a different research topic.

Acknowledgements

This study was conducted through partial funding from LPPM Universitas Muhammadiyah Purwokerto with contract No. A.11-III/865-S.Pj./LPPPM/II/2023 granted to the second author. All data are accessible in publications from each institution.

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