Sosyoekonomi

2023, Vol. 31(56), 151-169

RESEARCH ARTICLE

ISSN: 1305-5577
DOI: 10.17233/sosyoekonomi.2023.02.07
Date Submitted: 08.06.2022
Date Revised: 19.01.2023
Date Accepted: 26.02.2023

Analysis of The Causality Relationship Among Digitalisation, Unemployment Rate, and Divorce Rates: A Research on Türkiye

Pınar KOÇ *(https://orcid.org/0000-0002-7843-1228), Gümüşhane University, Türkiye; pinartorun@gumushane.edu.tr*

Kadriye İZGİ-ŞAHPAZ *(https://orcid.org/0000-0002-2766-5921), Sakarya University, Türkiye; kadriyeizgi@sakarya.edu.tr*

Dijitalleşme, İşsizlik Oranı ve Boşanma Oranları Arasındaki Nedensellik İlişkinin Analizi: Türkiye Üzerine Bir Araştırma

Abstract

This study investigates the relationship between digitalisation, unemployment, and divorce rates in Türkiye by using the Fourier Toda Yamamoto Causality Test from 2007 to 2021. International Digital Economy and Society Index (I-DESI) has been used to indicate digitalisation. The results suggest that there is unilateral causality from digitalisation to divorce rates. However, there is no causality linkage between digitalisation and unemployment rates for the period 2007-2021. Moreover, there is no causal connection between unemployment rates and divorce rates. The findings show that digitalisation affects divorce rates by disrupting family communication.

Keywords : Digitalisation, Divorce Rates, Fourier Toda Yamamoto Causality Test, Unemployment Rates.

JEL Classification Codes : E24, O33, J12.

Öz

Bu çalışma Türkiye'de dijitalleşme, işsizlik ve boşanma oranları arasındaki nedensellik ilişkisini 2007-2021 dönemi için Fourier Toda Yamamoto Nedensellik Testi'ni kullanarak araştırmaktadır. Uluslararası Dijital Ekonomi ve Toplum Endeksi dijitalleşme göstergesi olarak kullanılmıştır. Çalışma sonuçları sadece dijitalleşmeden boşanma oranlarına doğru tek yönlü bir nedensellik ilişkisinin var olduğunu göstermektedir. Fakat, 2007-2021 döneminde Türkiye'de dijitalleşme ile işsizlik arasında herhangi bir nedensellik ilişkisi bulunmamaktadır. İşsizlik ile boşanma oranları arasında da herhangi bir nedensellik ilişkisi yoktur. Bu bulgu, dijitalleşmenin aile içi iletişimi bozarak boşanma oranlarını etkilediğini göstermektedir.

Anahtar Sözcükler : Dijitalleşme, Boşanma Oranları, Fourier Toda Yamamoto Nedensellik Testi, İşsizlik Oranları.

1. Introduction

Technological developments significantly affect economic and social life. The First Industrial Revolution, which began with the invention of the steam engine and other industrial revolutions, are the most important milestones in human history. In this context, population growth, urbanisation, and globalisation dynamics emerged with developments in transportation and communication technologies that have considerably increased global income. Still, they also have negative consequences, such as environmental degradation and working in poor conditions for low wages.

Even though unemployment rates are expected to rise after all industrial revolutions due to capital-intensive technologies instead of labour-intensive technologies, a new business model was adopted in each industrial revolution. Industrial revolutions also impacted labour markets in different ways. For example, with the first industrial revolution, the share of capital in production increased, and a new social class, the working class, emerged. This process led to the adoption of a new hierarchical structure based on boss-worker relations instead of master-apprentice relations (Prisecaru, 2016: 57). In the Second Industrial Revolution, electricity was covered in 1870-1914, and oil began to be used as the primary energy sources. The Fordist production model was adopted instead of the Taylorist production model. Contrary to expectations, this production process transformation caused an increase in unskilled labour demand (Mokyr, 2003: 1-2).

The Third Industrial Revolution, triggered by the end of the Second World War and rapidly growing in the 1970s, is also called the era of information technology. In this period, automation in production reached advanced levels, and the indirect production model instead of the direct product model was adopted. Unlike the second industrial revolution, in this period, qualified labour demand increased (Castells, 2005).

Production became much more complicated in the transition from the First Industrial Revolution to the Third Industrial Revolution, and consumer demands diverged. Manufacturing mechanisms based on cyber-physics systems were developed to overcome the problems arising from increased production and consumption diversity, which were the beginning of the fourth industrial revolution. It is possible to control and interfere with production processes over the internet by using production mechanisms based on cyber-physics systems. Moreover, the lower labour costs in developing countries than developed countries have led to increased foreign capital investments, and developing countries have become production centres (Eğilmez, 2017). Significantly, China became one of the countries where American and European companies invested the most. This process can be explained by the product cycle hypothesis developed by Vernon (1966). China began to produce many products previously made in Europe and devoured the export markets of these countries. China's industrial export rose from 170 billion US dollars in 2006 to 580 billion US dollars in 2011 (Ersoy, 2016: 8). This rise of China and the Far East get moved Germany, and the German government brought up Industry 4.0 in the 2011 Hannover Fair. The purpose of Industry 4.0, representing a new industrial revolution, is to eliminate production errors by minimising labour-based production, increasing flexibility in production, and enabling faster and more consumer-oriented product design. When these targets are achieved, the competitive production advantage of China and other Far East countries based on cheap labour is expected to end (Wyrwicka & Mrugalska, 2017: 383).

It is expected that scientific and technological advancements called digitalisation significantly impact labour markets and unemployment rates. Also, changes in unemployment rates can affect family and community life. Using Fourier Toda Yamamoto Causality Test, this study investigates the causality linkage between digitalisation, unemployment, and divorce rates in Türkiye.

The rest of this study is organised as follows. The second section gives information about literature explaining the relationship between technological developments, unemployment and divorce rates. The third second provides information on the methodology and data set. Estimation results are given in the fourth section. In the last section, the conclusion and policy implications take place.

2. Literature Review

Technological developments affect the needed labour demand in production by changing production processes. However, there is no consensus on how changes in labour demand will affect unemployment rates. Although it was first highlighted by Ricardo (1817) that technological development would increase unemployment, the concept of technological unemployment was first used by Keynes (1930), which two reasons can explain. First, unemployment rates didn't reach a high level until the 1929 Depression. It is believed that Say's Law states that the production of goods creates its demand is valid in the liberal economic system. Therefore, even if unemployment is seen in the economy, this will not last long. The flexibility of prices and wages brings about full employment in the economy. Technological development contributes to economic wealth by increasing capital accumulation, and the economy comes to equilibrium at a higher full employment level. Therefore, unemployment rates don't cause technological development in the liberal economic system. Ricardo is the first liberal economist to state that technology will enhance unemployment rates.

Marx (1867) explained how capital-labour substitution would be reflected in labour markets based on the Labour Theory of Value. The use of technology leads to higher unemployment rates by raising capital accumulation and surplus value.

With the 1929 economic crisis, classical economics started to be questioned. Keynesian economics emerging with the crisis stated that unemployment is temporary, and the economy will only sometimes stabilise at full employment. Keynes (1930) expressed that technological development would increase unemployment rates and first used the concept of technological development.

Schumpeter (1942) explained the effects of technological innovations on labour markets and economic growth with the concept of "creative destruction." According to Schumpeter (1942), entrepreneurs contribute to economic development by developing new products and innovation. Companies with low competitiveness are wiped off the market, and economic development occurs through those with high competitiveness. Schumpeter (1942) divided innovations into five types; the use of a new production technique, the creation of a new market, the creation of an organisational structure, to obtain a new source of raw materials, the production of a new good or the improvement of the quality of goods.

Solow (1957) indicated that factor productivity plays a vital role in economic development, and technological development is the primary source of factor productivity. Although Solow (1957) stressed that technological development promotes factor productivity, he didn't indicate how it occurs. Therefore, technological development is an exogen variable determining economic growth.

Katsoulacos (1986) addressed the relationship between technological innovations and employment in terms of innovations in products and processes. Product innovation refers to expanding the range of goods and services enterprises offer. In contrast, process innovation refers to changes in enterprises' production techniques and service development methods. Katsoulacos (1986) argued that product innovations were more effective than process innovations in enhancing employment within the scope of horizontal and vertical product differentiation theories.

Technological innovations affect employment through product and process innovations. Van Reenen (1997) analysed the effect of technological innovations on employment for British manufacturing firms through panel regression. The results show that technological innovations have a positive impact.

Harrison et al. (2008) investigated the influence of process and product innovations on employment growth for companies in France, Germany, Spain, and the UK. The findings indicate that technological innovations positively affect employment. However, the availability of this employment-enhancing effect of process innovations relies on the effective functioning of the market mechanism and the price elasticity of demand. Process innovations increase consumer demand by reducing unit production costs and commodity prices.

Bogliacino & Pianta (2010) stated that product innovations could create jobs and that such a situation would positively affect employment. Hall et al. (2008) and Harrison et al. (2008) held the same view. However, they also highlighted that the effect size would be specified depending on income and substitution effects. The income effect is the development of new products and sectors based on technological innovations. Designing a more unique and different product to replace an old product that meets the same need is called a substitution effect. If the income effect is greater than the substitution effect, the effect that creates jobs and, therefore, the effect that enhances employment would be more significant.

With the Industry 4.0 process, the impact of technological developments on labour markets and the unemployment rate began to be reassessed. Walwei (2016) examined how digitalisation affects labour markets in Germany. According to the study, digitalisation may cause crucial shifts and problems in labour markets. The increasing demand for new positions can enhance skill gaps between job requirements and workers' abilities. Therefore, regulations decreasing skill gaps must be made in Germany.

Ezell (2016) investigated the linkage between digitalisation, unemployment rates, and exports. The results show a negative correlation between digitalisation and the unemployment rate, while there is a positive correlation between digitalisation and exports.

Piva & Vivarelli (2018) examined how technological innovations affect employment based on R&D expenses. The effect of R&D expenses on employment depends on the technology intensity employed in production. R&D expenses in sectors with low technology intensity don't affect employment.

Veronika & Werner (2018) examined the influence of digitalisation on labour markets. According to the study, technological developments have a dual impact on employment. Even though some occupations are shed, new professions are created due to product and process innovations. In this context, the excellent management of the transformation caused by technological developments for economic development is essential.

The Ireland National Skills Council (2018) explored the impact of the digital transformation process in the Irish labour markets. The digitalisation process changes the structure of labour markets by creating new jobs and eliminating some jobs. But total unemployment rates don't change in the country.

Freddi (2018) stressed that changes in production and service delivery caused by digital industrialisation how to shift the demand for labour.

Fossen & Sorgner (2019) searched whether the risk of digitalisation leads people working in high-risk sectors to change their jobs. The results of the study show that the risk of digitisation does not have an impact on non-institutional entrepreneurship.

Arntz et al. (2019) investigated the digitalisation process and how it affects applied business models and demand for qualified labour. According to the findings, demand for unskilled labour will decrease, and new business lines and professions, especially those related to informatics, will emerge.

Magwentshu et al. (2019) analysed the effect of digitalisation on the labour markets in Africa. A similar study was conducted by Cirillo et al. (2019) in Italy. In this study, it is stated that digitalisation will raise the demand for high-quality labour. The digitalisation process is expected to encourage economic growth by improving labour efficiency.

Zemtsov (2020) examined how covid 19 economic crisis and new technologies influence potential unemployment in Russia by using the Frey-Osborne methodology. The results show that employment in traditional services can be significantly decreased.

Bertani et al. (2020) assessed whether digital transformation significantly impacts productivity and unemployment. There is a significant correlation between technology investments and labour and total factor productivity. But technological unemployment will enhance in the long term.

Shapiro & Mandelman (2021) investigated how digital adaptation and automation affect developing countries' labour markets. According to the study, there is a negative connection between digital adaptation and self-employment rates. However, there is no linkage between digital adoption and unemployment rates.

Başol & Yalçın (2021) tested the impact of the digital economy on labour market indicators in EU countries. It was concluded that the digital economy was improving labour market indicators. With the digital economy process, the long-term unemployment rate decreased in EU countries.

Gürtzen et al. (2021) analysed whether digital information technologies improve the possibilities of reemployment of unemployed job seekers in Germany. The study revealed that internet access enhanced the number of job applications.

Fodranová & Antalová (2021) addressed the influence of digitalisation on labour markets through the correlation between internet users and unemployment rates in European countries. According to the results, there is a statistically significant and negative correlation in European countries.

Abbasabadi & Soleimani (2021) examined the nexus between digital technology expansion and unemployment rates through cross-sectional regression. According to the results, there is an inverted U-shaped relationship between Digital technology and unemployment rates.

Haykal & Makki (2022) dealt with the effect of digitalisation on unemployment rates during covid 19 pandemic. The findings show a statistically significant negative relationship between digitalisation and unemployment rates, while covid 19 cases are statistically insignificant.

Bogoslov et al. (2022) proved the existence of a strong positive correlation between digitalisation and labour market indicators such as employment rates, labour force participation and unemployment rates.

Lederman & Zouaidi (2022) investigated the linkage between the incidence of the Digital economy and long-term frictional unemployment rates across countries. There is a negative partial correlation between national unemployment rates and the incidence of the digital economy.

The OECD (2008) published a report stressing that increasing poverty and inequalities have a negative impact on the psychological states of people and family life. Also, digitalisation is an essential factor contributing to poverty and inequality. In this context, especially in developing countries, technological developments are expected to affect divorce rates by changing unemployment rates and disrupting family communication through technology addiction. The literature explains the nexus between unemployment and divorce rates with four approaches. The first approach is the psychological stress approach. According to this approach, developed by Komarovsky (1940), the stress stemming from unemployment encourages divorce rates by increasing conflicts in the family. Thus, unemployment rates are expected to positively affect divorce rates in this approach. The findings obtained by Elder (1974), South (1985), Jensen & Smith (1990), OECD (2008), Daliri (2019), Bhalotra et al. (2021), and Virgolino et al. (2022).

Çakı (2022) stressed that growing inequality due to the liberal economic system has an adverse impact on family life. Kersbergen & Vis (2022) noted that digitalisation accelerates social change, and rising divorce rates are a part of this social change.

The second approach is the marital instability approach. By extending the married instability model Becker (1973) developed to divorce, Becker et al. (1977) claimed that increases in male unemployment enhance divorce rates. However, the opposite is likely actual if marriage is considered insurance in economic difficulties. The results obtained by Roy (2011), Doiron & Mendolia (2011), Ariizumi et al. (2015), Alola et al. (2020), and Hewitt (2021) confirmed the existence of a positive relationship between male unemployment rates and divorce rates. But González-Val & Marcén (2017) concluded that increasing male unemployment rates decreases divorce rates. Nallo et al. (2022) stated that unemployment encourages divorce rates. However, this impact does not vary by gender.

Another approach is the divorce cost approach. This approach, developed by Hoffman (1977), is based on the thought that people decide to divorce by considering the losses in welfare and income that may arise after divorce and the costs of divorce. Spouses prefer to stay married rather than divorce during high unemployment due to the high divorce costs. Thus, there is a negative linkage between unemployment and divorce rates. In this context, Peterson (1996) and Smock et al. (1999) argued that divorce has an adverse impact on female welfare. Amato & Beattie (2011), Hellerstein et al. (2013), González-Val & Marcén (2015), Harman (2021) and, Çuhadar & Cafrı-Açcı (2021) concluded that the cost of divorce approach is valid.

The fourth approach is the hybrid approach developed by Cherlin (2009). The results obtained from the psychological stress approach and the cost of divorce approach are addressed in the hybrid system. Relationships between divorce rates and unemployment rates may vary over time. The direction of the relationship between unemployment rates and divorce rates depends on divorce costs and household living standards. Schaller (2013) has emphasised that increases in unemployment rates play a determinative role in marriage and divorce rates. Unemployment shocks have a lasting impact on marriage rates, whereas they have temporary effects on divorce rates. Baghestani & Malcolm (2014) have found that marriage and divorce rates are moving in the same direction as the economic conjuncture. González-Val & Marcén (2017) advocated that the unemployment rates are negatively related to the marriage rate while the response of the divorce rate to the economic conjuncture is mixed. Amri et al. (2022) examined the connection between poverty and divorce. The findings show that divorce rates are associated with income level.

Another channel explaining the impact of technological developments on divorce is technological additions; they promote divorce by disrupting family communication. Especially in recent years, internet and social media user growth significantly affects family life. Studies investigating technology's impact on divorce are increasing daily in this context. In this framework, Eichenberg et al. (2017) stated that digital media can be shaped couple and family relationships. Valenzuela et al. (2014) revealed that Facebook penetration is associated with increasing divorce rates.

Pekanian & Farhadi (2017) analysed the impact of internet addiction on divorce in Isfahan by employing logistic regression. The study how that internet addiction has a statistically significant effect on divorce rates.

Zhang et al. (2018) investigated the linkage between mobile phone penetration and divorce rates drawing attention to the rapid rise in the divorce rate in China from 2001-2016. The study results show a statistically significant and positive correlation between mobile phone penetration and the divorce rate in China. Zaitov & Teshayev (2022) stressed that technology enhances divorce rates by contributing to family conflicts.

The crude divorce rate in Türkiye has increased by 47% in the last 20 years, while the natural marriage rate has reduced by 20%. In this context, the number of studies on factors determining divorce rates in Türkiye has increased recently. This paper focused on studies examining the impact of unemployment and technology on divorce rates in Türkiye. Yıldırım (2004) claimed that economic problems are one of the factors causing divorce in Türkiye.

Topbaş & Kurt (2007) investigated the nexus between unemployment and divorce rates in Türkiye from 1970-2005 by employing the VAR model. The study shows that there is a causality from unemployment to divorce.

Sandalcılar (2012) tested the connection between unemployment and divorce rate using a panel causality test at the regional level for 2004-2010. According to the study results, the divorce cost approach is valid for Türkiye.

Bayrak (2019) analysed the long-term linkage between unemployment rates and divorce rates in Türkiye for the period 1980-2017 through the cointegration test with structural breaks and Toda Yamamoto Causality Test. According to the findings, there is bilateral causality between unemployment and divorce rates from 1980-2017.

Bayrakçı (2020) examined the impact of unemployment on the individual and the family in terms of patriarchy. According to the study’s findings, the increase in the share of female labour in the economy can adversely affect family life by exerting pressure on it in patriarchal societies like Türkiye.

Igdeli and Ay (2021) investigated socioeconomic determinants of divorce at the regional level through panel regression. The education level of women and male unemployment rates are the main determinants of divorce in developed regions.

Yılmaz (2022) concluded that increasing the 1% in male unemployment rates reduces divorce rates by 0.07%. In this context, the marital instability hypothesis is valid in Türkiye for 1990-2020.

Technological developments can affect divorce rates through two channels. The first is the unemployment channel. New technologies can indirectly affect divorce rates by promoting unemployment. Second, technological developments can directly influence divorce rates by creating technical addition. The studies examining the relationship between unemployment and divorce rates don’t consider the dynamic relationship between digitalisation, unemployment, and divorce rates. In this context, this study contributes to related literature in two ways. First, the study investigates the dynamic relations among technological development, unemployment, and divorce rates. Second, unlike previous studies, the study employs the Fourier Toda Yamamoto Causality Test considering smooth structural breaks. Therefore, the study is original methodologically.

3. Data & Methodology

This study investigates the causality linkage among digitalisation, unemployment rates, and divorce rates. The analysis consists of two phases; firstly, Digital Economy and Society Index for Türkiye were created using the 2020 I-DESI Report by published EUROSTAT. Then, the causality relationship between digitalisation, unemployment, and the divorce rate was investigated through Fourier Toda Yamamoto Granger Causality Test. Industry 4.0 was first used at the Hannover Fair in Germany in 2011, and the Digitization Index calculated by EUROSTAT began to be estimated in 2013. Calculating the index and its components varies from year to year. Therefore, firstly, I-DESI Index for Türkiye was calculated by the author using 2020 I-DESI reports -published by EUROSTAT- for 2007-2021, and the time dimension was expanded to cover previous years. The time dimension of the study was limited to 2007-2021. Because the data required to calculate the index are limited to this period. Details for the index construction method are given below.

- Data collection,

- Normalization,
- Estimations of weights,
- Calculations of the final index.

The variables used to calculate I-DESI Index for Türkiye are given in Table 1.

Table: 1
The Main and Sub-Components of the I-DESI Index

Component	Rate	Sub-Component	Rate	Database
Connectivity	0,25	Fixed Broadband Subscriptions (Per 100 people) (FBS)	0,33	OECD
		Mobile Cellular Subscriptions (Per 100 people) (MCS)	0,22	ITU
		Speed (International Bandwidth, in Mbit/s)	0,33	ITU
		Affordability (Fixed Broadband Basket Prices)	0,11	ITU
Human Capital	0,25	Percentage of the ICT personnel in total employment	100	EUROSTAT
Use of Internet Services	0,15	Use of Internet	0,25	TURKSTAT
		Individuals purchase goods or services over the Internet	0,25	TURKSTAT
		The use of İnternet Banking	0,25	The Banks Association of Türkiye
		The use of the Internet in Individuals interact with public authorities	0,25	TURKSTAT
Digital Integration	0,20	Having Website of Enterprises	0,25	TURKSTAT
		Enterprises that receive orders for goods/services via website or EDI	0,25	TURKSTAT
		Computer Usage in Enterprises	0,25	TURKSTAT
		İnternet Usage in Enterprises	0,25	TURKSTAT
E-Government	0,15	The number of E-Government user	0,33	CBDDO
		The number of E-Government Institutions	0,33	CBDDO
		The Number of E-Government Service	0,33	CBDDO

After the data set had been compiled, the normalisation was made using the min-max method because the data set includes different units of measurement. The Min-max method is formulated as follows.

$$\frac{X_i - X_{min}}{X_{max} - X_{min}} \quad (1)$$

where X_i, X_{min} and X_{max} denote original observation value, minimum observation value, and maximum observation value, respectively.

Another stage is to determine the weights. The size of the weights depends on the number of subdimensions. The equal weights imply that all variables are worth the same in the composite. The total weighting of all factors must equal 100%. In the case of unequal weights, the higher weights can be applied to data with broad coverage (OECD, 2008: 32). In this study, the weights are determined through the 2020 I-DESI Report published by EUROSTAT. In the last stage, the value of I-DESI is calculated using the components and their weights.

The causality linkage among technological development, divorce, and unemployment rates is analysed after calculating I-DESI for Türkiye. The variables are as follows.

$$(\text{I-DESI; DR; UR}) \quad (2)$$

where DESI represents technological developments. DR donates divorce rates. UR indicates unemployment rates. Divorce rates and unemployment rates have been obtained from TURKSTAT. The causal linkage between the variables can be described as follows.

$$\mathrm{I-DESI}_t = \alpha_0 + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + \beta_1 \sum_{i=1}^{I+d_{max}} \mathrm{I-DESI}_{t-i} + \beta_2 \sum_{i=1}^{I+d_{max}} \mathrm{UR}_{t-i} + u_t \quad (3)$$

$$\mathrm{UR}_t = \alpha_0 + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + \beta_1 \sum_{i=1}^{I+d_{max}} \mathrm{UR}_{t-i} + \beta_2 \sum_{i=1}^{I+d_{max}} \mathrm{DESI}_{t-i} + u_t \quad (4)$$

$$\mathrm{DR}_t = \alpha_0 + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + \beta_1 \sum_{i=1}^{I+d_{max}} \mathrm{DR}_{t-i} + \beta_2 \sum_{i=1}^{I+d_{max}} \mathrm{UR}_{t-i} + u_t \quad (5)$$

$$\mathrm{UR}_t = \alpha_0 + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + \beta_1 \sum_{i=1}^{I+d_{max}} \mathrm{UR}_{t-i} + \beta_2 \sum_{i=1}^{I+d_{max}} \mathrm{DR}_{t-i} + u_t \quad (6)$$

$$\mathrm{I-DESI}_t = \alpha_0 + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + \beta_1 \sum_{i=1}^{I+d_{max}} \mathrm{I-DESI}_{t-i} + \beta_2 \sum_{i=1}^{I+d_{max}} \mathrm{DR}_{t-i} + u_t \quad (7)$$

$$\mathrm{DR}_t = \alpha_0 + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + \beta_1 \sum_{i=1}^{I+d_{max}} \mathrm{DR}_{t-i} + \beta_2 \sum_{i=1}^{I+d_{max}} \mathrm{I-DESI}_{t-i} + u_t \quad (8)$$

where γ_1 and γ_2 represent smooth structural breaks, β_1 measures whether the previous values of the dependent variable play a decisive role on the current values of the dependent variables in each of the equations above, while β_2 measure the previous values of the independent variable play a decisive role on the current values of the dependent variables in each of equations above. If β_2 is statistically significant, there is a causal connection between selected variables.

3.1. Fourier Toda Yamamoto Causality Test

The causality test was developed by Granger (1969). If there is causality from x_t to y_t, then past values of x_t can be used to predict y_t. Both of the series must be stationary to test the causality relationship between two variables. If the series aren't stationary in level value, the first difference of the series must be calculated. Like Granger causality, this test requires a differencing process in case the series are non-stationary. The differencing process causes leads to loss of information. Toda Yamamoto causality test developed by Toda &Yamamoto (1995) offers the ability to test causality between the variables without needing the differencing process. Granger and Toda Yamamoto's causality tests do not consider structural breaks. To compensate for this deficiency, Enders & Jones (2016) developed Fourier Granger Causality Test by extending the Granger Causality test equation with Fourier functions. That way, structural breaks in causality tests have not been ignored. Nazlıoğlu et al. (2016) developed Fourier Toda Yamamoto Causality Test, which considers structural breaks without needing the differencing process. Fourier Toda Yamamoto Causality Test is formulated as follows.

$$Y_t = \alpha_0 + \gamma_1 sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 cos\left(\frac{2\pi kt}{T}\right) + \beta_1 \sum_{i=1}^{I+d_{max}} Y_{t-i} + \beta_2 \sum_{i=1}^{I+d_{max}} X_{t-i} + u_t \quad (9)$$

$$X_t = \alpha_0 + \delta_1 sin\left(\frac{2\pi kt}{T}\right) + \delta_2 cos\left(\frac{2\pi kt}{T}\right) + \theta_1 \sum_{i=1}^{I+d_{max}} Y_{t-i} + \theta_2 \sum_{i=1}^{I+d_{max}} X_{t-i} + v_t \quad (10)$$

where k, T, I and d_{max} represent the number of optimal frequencies, the number of observations, the number of optimal lag length and degree of the maximum integration, respectively. The test is based on Wald Statistic. The null hypothesis denotes there is no causality one variable to the other variable. If the value of calculated Wald is less than the value of critical Wald, the null is not rejected.

4. Estimation Results

Firstly, the stationarity degree of the variables must be determined. Fourier ADF Uni Root Test was applied to determine the stationarity degree of the variables. The Fourier terms, including the model, must be statistically significant for the FADF test statistic to be valid. If the Fourier terms are not statistically significant, the ADF test statistic must be used. The Fourier ADF and ADF unit root test results are given in Table 2.

Table: 2
The Results of the Fourier Unit Root Test

Variables	Fourier ADF				ADF	
	f	Min KKT	F Test Stat	FADF	ADF	P
I-DESI	1	0,2237	4,09	0,199	-1,726	0,3965
UR	1	11,396	17,237*	-3,73***	-	-
DR	1	0,0096	3,4677	0,020	-2,215	0,4464
Δ I-DESI	-	-	-	-	-5,012	0,0020*
ΔDR	-	-	-	-	-3,832	0,0498**

F critical values for k =1 ve T=100 at 1%, 5%, and 10% are 10,35, 7,58, 6,35 and FADF.
Critical values are -4,42, -3,81 and -3,49, respectively.
, **, * represent 1%, 5% and 10% significance levels, respectively.*

F statistics are used to test the validity of Fourier ADF test statistics. According to Table 2, the F statistic calculated for UR is statistically significant. But the F statistic calculated for I-DESI and DR is not statistically significant. In that case, the FADF unit root test results can be used for UR, while the effects of the ADF unit root test can be used for I-DESI and DR. The findings show that UR is stationary in level while I-DESI and DR are stationary at first differences. Thus, the degree of maximum cointegration is one. The results of the Fourier Toda Yamamoto Causality Test are given in Table 4.

Table: 3
The Results of the Fourier Toda Yamamoto Causality Test

H_0	k	Wald Stat	Bootstrap P Value	Decision
I-DESI ⇏UR	1	1,384	0,278	**H_0 is not rejected**
UR ⇏I-DESI	1	3,543	0,113	**H_0 is not rejected**
UR ⇏DR	1	0,587	0,469	**H_0 is not rejected**
DR ⇏UR	1	0,033	0,859	**H_0 is not rejected**
I-DESI ⇏DR	1	3,868	0,098***	**H_0 is rejected**
DR⇏I-DESI	1	0,437	0,527	**H_0 is not rejected**

**** represents a 10% significance level. k is the optimal frequency value.*

Whether there is, the causality linkage is decided by using bootstrap p values. If bootstrap p values are more significant than 0.10, there is unilateral causality from one variable to another variable. The existence of the causal relationship between the variables means that the selected independent variables can be used as a policy instrument in controlling the dependent variables. As shown in Table 3, It is seen that there is no causality relationship between digitalisation and unemployment rates. Also, there is no causality linkage between unemployment rates and divorce rates. Only there is unilateral causality from digitalisation to divorce rates. These findings imply that digitalisation levels of the past period cannot be used to predict unemployment rates in the next period in Türkiye. Also, unemployment rates of the past period are not a leading indicator for digitalisation in Türkiye. Similarly, the previous period's unemployment rates don't provide information on future divorce rates.

5. Conclusion and Policy Recommendations

Divorce and high unemployment are the most critical problems of modern life. When statistics are examined, it is seen that the crude marriage rates have decreased by about 20%, and the crude divorce rates have increased by about 50% in the last 20 years. In addition, Türkiye is one of the countries with the highest unemployment rate among EU countries. The available statistics show that divorce rates have followed a similar course to unemployment rates. Therefore, studies examining unemployment's impact on divorce rates have recently increased. The studies analysing the connection between unemployment and divorce rates in Türkiye don't consider the digitalisation process's influence on unemployment and divorce rates. But digitalisation can affect divorce rates via unemployment and technological addiction channels. High unemployment from digitalisation is expected to promote divorce rates by triggering psychological stress. Also, digitalisation can enhance divorce rates by disrupting family communication through technological addiction. This study investigated dynamic relationships among digitalisation, unemployment, and divorce rates in Türkiye. The findings show no causality relationship between digitalisation and unemployment rates. This result can be explained digitalisation process in Türkiye is still in its fancy. 0.3% of SMEs in Türkiye have used high-tech (Kalkınma Bakanlığı, 2018: 23). Also, according to TURKSTAT (2021) statistics, the share of R&D expenditures in GDP was 1,13% in 2021.

As of December 2022, the number of companies operating in technology development zones was 8677. It's too early to say that the digital transformation process's net impact on employment is negative. Moreover, not only will the digitalisation process destroy some businesses, but it will also create new businesses. What's important here is how to eliminate increasing job-skill mismatch due to new technology. It is estimated that smart automation systems can eliminate job-skill mismatches (KPMG, 2021).

Also, there is no causality linkage between unemployment rates and divorce rates. This result is not consistent with the results obtained by Topbaş and Kurt (2007) and Bayrak (2019). This inconsistency in results comes from the differences in the method. Causality tests that do not consider structural breaks were applied in mentioned studies. But structural breaks may cause changes in the causal relationships between the variables. Unlike other studies, this study finds structural breaks. In addition, all studies cover different periods. The absence of a causality relationship between unemployment and divorce rates means that policies to improve employment cannot effectively reduce divorce rates in Türkiye. However, there is unilateral causality from digitalisation to divorce rates. This finding is consistent with the results of Zhang et al. (2018) and Zaitov & Teshayev (2022). When the conclusions obtained are evaluated together, it can be said that digitalisation increases divorce rates not via unemployment but through technological addition. Problems such as internet addiction and excessive social media encourage divorce by disrupting family communication. According to data from TURKSTAT (2021), the most important reasons for divorce in Türkiye were irresponsible and careless attitudes and cheating. In this context, reckless and negligent attitudes and cheating may be linked to technological addition.

One practical recommendation of this study for policymakers is to give rehabilitation services based on personality tests and consulting and training services in family and community health centres. And further, education programs on the use of informed technology for both children and adults must be organised. Stress and anger management are essential to decrease family conflicts and improve family life quality. Therefore, stress and anger management in education programs can also be organised. In practice, the quality of consulting and training services offered by family and community health centres is measured by conducting satisfaction surveys to persons who benefit from their services. The efficiency of the rehabilitation models based on personal characteristics can be measured by developing the quality of family life index for people offering training and consultancy services.

This study examined the causality relationship among technological development, unemployment and divorce rates in Türkiye. Further research can investigate the causality between technological development and male unemployment. The same model can be tested using different econometric techniques, and the results can be compared. Another research can examine the causal nexus among technological development, female employment, and divorce rates in Türkiye. In addition, this study analyses the causal linkage among technological development, unemployment and divorce rates in Türkiye at the macro level. However, the impact of the technical acquisition on divorce in Türkiye has not yet been analysed empirically. In this context, the effect of technological expansion on divorce rates. The number of studies examining technological developments' implications on economic and social life is limited. In this framework, this study is expected to shed light on future research.

In terms of limitations of the study, the time dimension in this study covers the period 2007-2021. Because the datasets used to calculate the values of I-DESI can be reached only during this period.

References

Abbasabadi, H.M. & M. Soleimani (2021), "Examining the Effects of Digital Technology Expansion on Unemployment: A Cross-Sectional Investigation", *Technology in Society*, 64, 101495.

Alola, A.A. et al. (2020), "The role of income and gender unemployment in divorce rate among the OECD countries", *Journal of Labor and Society*, 23(1), 75-86.

Amato, P.R. & B. Beattie (2011), "Does the Unemployment Rate Affect the Divorce Rate? An Analysis of State Data 1960-2005", *Social Science Research*, 40(1), 705-715.

Amri, K. et al. (2022), "Does Poverty Affect Divorce Rates? The Role of Women's Income As Moderating Variable", *Cogent Social Sciences*, 8(1), 2069908.

Ariizumi, H. et al. (2015), "Stand Together or Alone? Family Structure and the Business Cycle in Canada", *Review of Economics of the Household*, 13, 135-161.

Arntz, M. et al. (2019), "Digitalization and the Future of Work: Macroeconomic Consequences", IZA Institute of Labor Economics, *Discussion Paper Series*.

Baghestani, H. & M. Malcolm (2014), "Marriage, Divorce and Economic Activity in the US: 1960-2008", *Applied Economics Letters*, 21(8), 528-532.

Başol, O. & E.C. Yalçın (2021), "How Does the Digital Economy and Society Index (DESI) Affect Labor Market Indicators in EU Countries?", *Human System Management*, 40(4), 503-512.

Bayrak, S. (2019), "Türkiye'de İşsizlik ve Boşanma İlişkisi: 1980-2017 Dönemi İçin Nedensellik Analizi", *Çalışma İlişkileri Dergisi*, 10(1), 39-54.

Bayrakçı, O. (2020), "İşsizliğin Birey ve Aile Üzerindeki Etkisinin Ataerkillik Bağlamında İncelenmesi", *Toplumsal Politika Dergisi*, 1(2), 167-178.

Becker, G.S. (1973), "A Theory of Marriage: Part I", *Journal of Political Economy*, 81(4), 813-846.

Becker, G.S. et al. (1977), "An Economic Analysis of Marital Instability", *Journal of Political Economy*, 85(6), 1141-1187.

Bertani, F. et al. (2020), "The Productivity and Unemployment Effects of the Digital Transformation: An Empirical and Modelling Assessment", *Rev Evol Polit Econ*, 1, 329-355.

Bhalotra, S. et al. (2021), "Intimate Partner Violence: The Influence of Job Opportunities for Men and Women", *The World Bank Economic Review*, 35(2), 461-479.

Bogliacino, F. & M. Pianta (2010), "Innovation and Employment: a Reinvestigation using Revised Pavitt Classes", *Research Policy*, 39, 799-809.

Bogoslov, I.A. et al. (2022), "The Labor Market in Relation to Digitalization-Perspectives on the European Union", in: C. Ciurea et al. (eds), *Education, Research and Business Technologies. Smart Innovation, Systems and Technologies*, Singapore: Springer.

Çakı, F. (2022), "COVID-19 Sonrası Aile Projeksiyonları: Bir Dönüm Noktası Mı?", *İmgelem*, 6(10), 1-20.

Castells, M. (2005), "The Network Society: from Knowledge to Policy", in: M. Castells & G. Cardoso (eds.), *The Network Society from Knowledge to Policy within* (3-23), Washington DC: Johns Hopkins Center for Transatlantic Relations.

Cherlin, A.J. (2009), "The Origins of the Ambivalent Acceptance of Divorce", *Journal of Marriage and Family*, 71, 226-229.

Cirillo, V.E. et al. (2019), "Digitalization, Routineness and Employment: An Exploration on Italian", Growimpro *Working Paper* No. 5.

Çuhadar, P. & R. Cafrı-Açcı (2021), "An Empirical Investigation on the Socioeconomic Determinants of Divorce Rates in CEE Countries", *Dicle Üniversitesi İİBF Dergisi*, 11(21), 30-56.

Daliri, H. (2019), "Identifying the Effective Economic Variables on Divorce in Iran", *Quarterly Journal of Women's Studies Sociological and Psychological*, 17(2), 35-62.

Doiron, D. & S. Mendolia (2011), "The Impact of Job Loss and Family Dissolution", *Journal of Population Economics*, 25(1), 367-398.

Eğilmez, M. (2017), *Endüstri 4.0*, <mahfiegilmez.com>, 03.01.2022.

Eichenberg, C. et al. (2017), "From Online Dating to Online Divorce: An Overview of Couple and Family Relationships Shaped Through Digital Media", *Contemp Fam Ther*, 39, 249-260.

Elder's, G.H. (1974), *Children of the Great Depression: Social Change in Life Experience*, Westview Press: Boulder, CO.

Enders, W. & J. Lee, (2012), "A Unit Root Test Using a Fourier Series to Approximate Smooth Breaks", *Oxford Bulletin of Economics and Statistics*, 74(4), 574-599.

Ersoy, A.R. (2016), *On the Way to Industry 4.0: Digital Enterprise*, <https://www.mmo.org.tr/sites/default/files/gonderi_dosya_ekleri/4Oturum-AliRizaErsoy-DijitallesmeYolundaEndustri40.pdf>, 03.01.2022.

EUROSTAT (2020), *International Digital Economy and Society Index 2020 Final Report*, EU Report.

Ezell, S.J. (2016), *A Policymaker's Guide to Smart Manufacturing, Information Technology & Innovation Foundation Report*, A Policymaker's Guide to Smart Manufacturing | ITIF.

Fodranová, I. & M. Antalová (2021), "How Can Digital Sharing Economy Reduce Unemployment?", *Journal of Technology Management & Innovation*,16(1), 51-57.

Fossen, F. & A. Sorgner (2019), "Mapping the Future of Occupations: Transformative and Destructive Effects of New Digital Technologies on Jobs", *Foresight and STI Governance*, 13(2), 10-18.

Freddi, D. (2018), "Digitalisation and Employment in Manufacturing", *AI & Society*, 33(3), 393-403.

González-Val, R. & M. Marcén (2017), "Divorce and the Business Cycle: A Cross-Country Analysis", *Rev Econ Household*, 15, 879-904.

González-Val, R. & M. Marcén (2017), "Unemployment, Marriage and Divorce", *Applied Economics*, 50(13), 1495-1508.

Granger, C.W.G. (1969), "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods", *Econometrica,* 37(3), 424-438.

Gürtzen, N. et al. (2021), "Do Digital Information Technologies Help Unemployed Job Seekers Find A Job? Evidence from the Broadband Internet Expansion in Germany", *European Economic Review*, 132, 103657.

Hall, B.H. et al. (2008), "Employment, Innovation, and Productivity: Evidence from Italian Microdata", *Industrial and Corporate Change*, 17(4), 813-839.

Harman, J. (2021), "Does Employment Lead to the Breakdown of a Marriage? Evidence from the Slovak Republic", *Review of Economic & Business Studies*, 14(2),9-40.

Harrison, R. et al. (2008), "Does Innovation Stimulate Employment? A Firm-Level Analysis Using Comparable Micro-Data from Four European Countries", *ZEW Discussion Papers,* No. 111.

Haykal, S.H. & M. Makki (2022), "The Impact of Digitalization on Unemployment During Covid-19 Pandemic", in: T. Bach et al. (eds), *Digital Economy. Emerging Technologies and Business Innovation*, Springer, Cham.

Hellerstein, J.K. et al. (2013), "Business Cycles and Divorce: Evidence from Microdata", *Economic Letter*, 118(1), 68-70.

Hewitt, B. (2021), "The Dynamics of Family Formation and Dissolution", *The Australian Economic Review*, 54(4), 506-517.

Hoffman, S. (1977), "Marital Instability and the Economic Status of Women", *Demography*, 14, 67-76.

Igdeli, A. & M. Ay (2021), "Socio-Economic Determinants of Divorce: Regional Panel Data Analysis for Turkey", *Sivas Cumhuriyet University Journal of Economics and Administrative Sciences*, 22(1), 1-22.

Ireland National Skills Council (2018), "Digital Transformation: Assessing the Impact of Digitalisation on Ireland's Workforce", *Expert Group on Future Skills Needs Report.*

Jensen, P. & N. Smith (1990), "Unemployment and Marital Dissolution, *Journal of Population Economics*, 3(2), 215-229.

Kalkınma Bakanlığı (2018), "Sanayide Dijitalleşme", *Çalışma Grubu Raporu*.

Katsoulacos, Y.S. (1986), *The Employment Effect of Technical Change: A Theoretical Study of New Technology and the Labour Market*, Lincoln: University of Nebraska Press.

Kersbergen, K.V. & B. Vis (2022), "Digitalization as a Policy Response to Social Acceleration Comparing Democratic Problem Solving in Denmark and the Netherlands", *Government Information Quarterly*, 39, 101707.

Keynes, J.M. (1930), *Economic Possibilities for our Grandchildren*, <https://www.aspeninstitute.org/wp-content/uploads/files/content/upload/Intro_Session1.pdf>, 01.08.2022.

Komarovsky, M. (1940), *The Unemployed Man and His Family*, Newyork: Dreyden Press.

KPMG (2021), *Dijitalleşme Yolunda Türkiye 2021*, <https://assets.kpmg.com/content/dam/kpmg/tr/pdf/2021/04/dijitallesme-yolunda-turkiye-raporu-2021.pdf>, 19.01.2022.

Lecerf, M. & A. Dobreva (2019), "The Fight Against Unemployment", *EPRS Briefing*, PE 630-274.

Lederman, D. & M. Zouaidi (2022), "Incidence of the Digital Economy and Frictional Unemployment: International Evidence", *Applied Economics*, 54, 5873-5888.

Magwentshu, N. et al. (2019), "The Future of Work in South Africa: Digitisation, Productivity and Job Creation", *McKinsey & Company Report*.

Marx, K. (1867), *Das Capital*, Hamburg: Verlongvon Otto Meissnor.

Mokyr, J. (2003), *The Second Industrial Revolution, 1870-1914*, Northwestern University.

Nallo, A.D. et al. (2021), "The Effect of Unemployment on Couples Separating in Germany and the UK", *Journal of Marriage and Family*, 84(1), 310-329.

Nazlioglu, S. et al. (2016), "Oil Prices and Real Estate Investment Trusts (REITs): Gradual-Shift Causality and Volatility Transmission Analysis", *Energy Economics*, 60(C), 168-175.

OECD (2008), *Growing Unequal? Income Distribution and Poverty in OECD Countries*, Sweden: OECD.

OECD (2008), *Handbook On Constructing Composite Indicators: Methodology and User Guide*, Sweden: OECD.

Peterson, R.R. (1996), "Reevaluation of the Economic Consequence of Divorce", *American Sociological Review*, 61, 528-536.

Piva, M. & M. Vivarelli (2018), "Is Innovation Destroying Jobs? Firm Level Evidence from the EU", *Sustainability*, 10, 1279-1296.

Prisecaru, P. (2016), "Challenges of the Fourth Industrial Revolution", *Knowledge Horizons-Economics*, 8(1), 57-62.

Ricardo, D. (1817), *On the Principles of Political Economy and Taxation*, London: John Murray, Albemarle-Street.

Roy, S. (2011), "Unemployment Rate and Divorce", *Economic Record*, 87, 56-79.

Sandalcılar, A.R. (2012), "İşsizlik Boşanmayı Etkiliyor mu? Bölgesel Panel Nedensellik", *Ege Akademik Bakış*, 12(2), 225-238.

Schaller, J. (2013), "For Richer, if Not for Poorer? Marriage and Divorce over the Business Cycle", *Journal of Population Economics*, 26, 1007-1033.

Schumpeter, J. (1942), *Capitalism, Socialism, and Democracy*, New York: Harper & Bros.

Shapiro, A.P. & F.S. Mandelman (2021), "Digital Adoption, Automation, and Labor Markets in Developing Countries", *Journal of Development Economics*, 151, 102656.

Smock, P.J. et al. (1999), "The Effect of Marriage and Divorce on Women's Economic Well-Being", *American Sociological Review*, 64, 794-812.

Solow, R.M. (1957), "Technical Change and the Aggregate Production Function", *The Review of Economics and Statistics*, 39(3), 312-320.

South, S. (1985), "Economic Conditions and the Divorce Rate: A Time-Series Analysis of the Postwar United States", *Journal of Marriage and Family*, 47(1), 31-41.

Toda, H.Y. & T. Yamamoto (1995), "Statistical Inferences in Vector Autoregressions With Possibly Integrated Processes", *Journal of Econometrics*, 66, 225-250.

Topbaş, F. & S. Kurt (2007), "İşsizlik ve Boşanma İlişkisi:1970-2005 VAR Analizi", *Journal of Management and Economics Research*, 5(7), 30-43.

TURKSTAT (2021), *Türk Aile Yapısı Araştırması*, <tuik.gov.tr>, 10.21.2023.

Valenzuela, S. et al. (2014), "Social Network Sites, Marriage Well-Being and Divorce: Survey and State-Level Evidence from The United States", *Computers in Human Behaviour*, 36, 94-101.

Van Reenen, J. (1997), "Employment and Technological Innovation: Evidence from U. K. Manufacturing Firms", *Journal of Labor Economics*, 15(2), 255-284.

Vernon, R. (1966), "International Investment and International Trade in the Product Cycle", *The Quarterly Journal of Economics*, 80(2), 190-207.

Veronika, H. & R. Werner (2018), "Digitalization and Development Cooperation: An Assessment of the Debate and Its Implications for Policy", ECONSTOR *Research Report*.

Virgolino, A. et al. (2022), "Lost in Transition: A Systematic Review of The Association Between Unemployment and Mental Health", *Journal of Mental Health,* 31(3), 432-444.

Walwei, U. (2016), "Digitalization and Structural Labor Market Problems: The Case of Germany", ILO *Research Paper*, 17.

Wyrwicka, M.K. & B. Mrugalska (2017), "Industry 4.0-Towards Opportunities and Challenges of Implementation", *24th International Conference on Production Research* (ICPR 2017), 382-387.

Yıldırım, N. (2004), "Türkiye'de Boşanma ve Sebepleri", *Bilig*, 28, 59-81.

Yılmaz, K.Ç. (2022), "The Relation Between Divorce and Woman Labor Force, Savings and Male Unemployment: Evidence from Turkey", *Journal of Emerging Economies and Policy*, 7(1), 56-63.

Zaitov, E.K. & D.M. Teshayev (2022), "Family Conflict and Divorce as A Social Problem", *Eurasian Journal Humanities and Social Sciences*, 5, 827-831.

Zemtsov, S. (2020), "New Technologies, Potential Unemployment and 'Nescience Economy' during and after the 2020economic Crisis", Regional *Science Policy and Practice*, 12, 723-743.

Zhang, J. et al. (2018), "Does Mobile Phone Penetration Affect Divorce Rate? Evidence from China", *Sustainability*, 10(10), 3701.