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Exploring the Nexus Between Birth Rates, Female Employment, and Economic Growth: A Turkish Perspective (1999–2022)

Doğum Oranları, Kadın İstihdamı ve Ekonomik Büyüme Arasındaki Bağlantının Araştırılması: Türkiye Perspektifi (1999-2022)

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ABSTRACT

This study investigates the relationship between birth rates and key economic and social factors, including the female employment rate, gender inequality index, and per capita GDP, in Turkey from 1999 to 2022. Using Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests, the stationarity properties of the variables were examined, followed by the Breitung and Candelon frequency domain causality test to explore causal relationships in the short, medium, and long term. The results reveal that female employment exerts a significant positive impact on birth rates in the long run, indicating that women’s integration into the labor market can harmonize with demographic sustainability when supported by inclusive policies. In contrast, the gender inequality index was found to have a limited but negative influence on birth rates, highlighting the importance of gender equality in shaping economic and demographic outcomes. Additionally, per capita GDP significantly influences birth rates, reflecting the dynamic interplay between economic growth and demographic trends. These findings emphasize the need for targeted policies that address the interconnected nature of demographic and economic factors.

This research provides valuable insights into the role of gender equality and employment policies in promoting sustainable development. By demonstrating the causal links between these variables, the study contributes to the broader literature on demographic economics and emphasizes the critical importance of creating policy frameworks that support women’s labor force participation while fostering demographic and economic balance

Keywords: Birth rates, female employment, gender inequality, frequency domain causality

ÖZET

Bu çalışma, 1999-2022 dönemi Türkiye’sinde doğum oranları ile kadın istihdam oranı, cinsiyet eşitsizliği endeksi ve kişi başına düşen GSYİH arasındaki ilişkileri incelemektedir. Augmented Dickey-Fuller (ADF) ve Phillips-Perron (PP) birim kök testleri ile değişkenlerin durağanlık özellikleri analiz edilmiş, ardından kısa, orta ve uzun vadeli nedensellik ilişkilerini incelemek üzere Breitung ve Candelon frekans alanı nedensellik testi uygulanmıştır. Sonuçlar, kadın istihdamının uzun vadede doğum oranları üzerinde anlamlı ve pozitif bir etkiye sahip olduğunu göstermektedir. Bu bulgu, kadınların iş gücüne katılımının, kapsayıcı politikalarla desteklendiğinde, demografik sürdürülebilirlik ile uyum sağlayabileceğini ortaya koymaktadır. Buna karşın, cinsiyet eşitsizliği endeksinin doğum oranları üzerindeki etkisi sınırlı, ancak negatif yöndedir. Bu durum, toplumsal cinsiyet eşitliğinin ekonomik ve demografik sonuçlar üzerindeki önemini vurgulamaktadır. Ayrıca, kişi başına düşen GSYİH’nin doğum oranlarını önemli ölçüde etkilediği, ekonomik büyüme ve demografik eğilimler arasındaki dinamik etkileşimi yansıttığı belirlenmiştir. Bu bulgular, demografik ve ekonomik faktörlerin birbiriyle bağlantılı doğasını ele alan hedefe yönelik politikaların gerekliliğini vurgulamaktadır.

Bu araştırma, toplumsal cinsiyet eşitliği ve istihdam politikalarının sürdürülebilir kalkınmayı teşvik etmedeki rolüne dair değerli içgörüler sunmaktadır. Söz konusu değişkenler arasındaki nedensel bağlantıları ortaya koyarak, demografik ekonomi literatürüne katkıda bulunmakta ve kadın iş gücüne katılımı destekleyen, demografik ve ekonomik dengeyi teşvik eden politika çerçevelerinin önemini vurgulamaktadır.

Anahtar Kelimeler: Doğum oranları, kadın istihdamı, cinsiyet eşitsizliği, frekans alanı nedenselliği

1. INTRODUCTION

Birth rates are a crucial indication that intricately influences a nation's demographic composition, social dynamics, and economic capacity. The examination of this indicator influences existing population strategies and facilitates the sustainable design of future economic and social frameworks. In nations experiencing economic and social upheaval, such as Turkey, a comprehensive analysis of the determinants influencing birth rates is crucial for the development of strategic initiatives.

This study aims to examine the relationship between birth rates in Turkey and economic and social factors such as the female employment rate, per capita gross domestic product (GDP), and the gender inequality index. In this context, the impact of economic welfare levels and gender equality on birth rates will be examined in detail.

The main objective of the study is to identify the effects of economic and social factors on birth rates and to draw conclusions on how these dynamics can be managed from a policy perspective. The study will provide

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both a theoretical framework and systematically present the findings obtained from the literature for this purpose.

2. THEORETICAL FRAMEWORK

Studies examining the impact of variables such as GDP per capita, female employment rates, and the gender inequality index on birth rates are of great importance in evaluating the effectiveness of economic development and gender equality policies. Santos Silva and Klasen (2021) emphasize the obstructive role of gender inequality on economic growth, highlighting the critical importance of women's fertility decisions and human capital investments in this process (Santos Silva & Klasen, 2021, p. 582). In this context, reducing gender inequality and increasing women's participation in the workforce are seen as fundamental elements in achieving sustainable economic growth goals.

The impact of the increase in women's labor force participation and education levels on the relationship between birth rates and economic development is also widely discussed in the literature. Schmitz and Gabel (2023) state that the increase in women's education and labor force participation are fundamental factors in achieving gender equality and the sustainability of economic growth (Schmitz & Gabel, 2023, p. 360). Additionally, it is emphasized that the dynamics between these variables should be addressed considering the differences between countries and cultural contexts.

The relationship between women's participation in the workforce and birth rates is a complex issue that lies at the intersection of economic and social dynamics. Current research shows that the increase in women's participation in the workforce has various effects on birth rates. For example, Liao and colleagues (2021) state in a global study they conducted that the widespread availability of childcare services has increased women's employment and that this situation is related to birth rates (Liao, Kong, & Zhou, 2021, p. 5). This finding indicates that childcare services affect both women's participation in the workforce and their fertility decisions. From an economic perspective, the relationship between women's labor force participation and birth rates can vary according to the level of economic development of the countries. Moosavian (2022), in his study examining the impact of parental status on labor force participation, states that motherhood negatively affects women's labor force participation, while fatherhood increases men's labor force participation (Moosavian, 2022, p. 15). This situation reveals the impact of gender roles and economic structures on women's fertility and employment decisions.

In other words, birth rates have a complex relationship with economic growth. On the one hand, high fertility rates can create a young and dynamic population, increasing the labor supply. However, this situation will also lead to an increase in social expenditures such as education and healthcare. Women's participation in the workforce is another factor that directly affects birth rates. For example, a study conducted in Sweden and the USA found that the increase in women's participation in the workforce was positively correlated with fertility rates (Liao et al., 2021, p. 7; Yeşilkaya, 2022, p. 333).

The connection between economic growth and fertility can vary depending on the level of development of the countries. In developed countries, the increase in women's education and labor force participation has been a factor stabilizing fertility rates. In contrast, a more complex relationship between women's labor force participation and fertility is observed in developing countries. In the case of Turkey, it has been noted that birth rates have been declining since the 1990s and that this is related to economic and social transformation processes (Bernhardt, 1993, p. 26; Koç & Şahpaz, 2020, p. 510).

The involvement of women in the workforce can directly demonstrate its influence on economic growth via childbearing rates.. In civilizations with a higher participation of women in the workforce, a decline in birth rates and an augmentation in GDP per capita have been noted.. This situation both increases economic prosperity and makes human capital investments more efficient. However, it is also emphasized that low fertility rates can lead to economic problems such as an aging population in the long term (Akın & Aytun, 2016, p. 5; McDonald, 2000, p. 428).

Gender inequality is another important factor that similarly affects women's participation in the workforce and their fertility decisions. High gender inequality indirectly affects fertility rates by limiting women's access to education and economic opportunities. For example, in a comparison between the European Union and Turkey, it has been observed that countries performing better on the gender inequality index have more balanced fertility rates (Santos Silva & Klasen, 2021, p. 582).

Birth rates are a crucial indication that intricately influences a nation's demographic composition, social dynamics, and economic capacity. The examination of this indicator influences existing population strategies and facilitates the sustainable design of future economic and social frameworks. In nations experiencing economic and social upheaval, such as Turkey, a comprehensive analysis of the determinants influencing birth rates is crucial for the development of strategic initiatives.

3. LITERATURE SUMMARY

The relationship between women's labor force participation, fertility rates, and economic growth has been examined from different perspectives in the literature, and the effects of various variables on these dynamics have been studied in detail. The effects of gender equality policies on labor force participation are an important focal point in this context.

Korkmaz and Alacahan (2013) found that the increase in female employment raises GDP per capita, while Ustabaş and Gülsoy (2017) demonstrated that the participation rate of female labor in the service and industrial sectors supports economic growth. Demirtaş and Yayla (2017) stated that global integration has positive effects on women's employment in OECD countries, but this effect is limited in developing countries.

Kılıç and Öztürk (2012) determined that the level of education plays a decisive role in women's participation in the workforce in Turkey, especially in urban areas. Koç and Şahpaz (2020) stated that per capita income, education level, and divorce rates have a positive impact on women's labor force participation, while the increase in male unemployment rates negatively affects this participation.

Thaddeus and colleagues (2022) stated that women's labor force participation in Sub-Saharan Africa negatively affects economic growth in the long term. Lo Bue and colleagues (2022) have shown that in developing countries, women's rates of vulnerable employment are higher than men's and that this is related to socioeconomic factors such as marriage and parenthood.

examined the impact of legal reforms related to gender equality on women's labor force participation and GDP per capita, finding that these reforms increased women's labor force participation by 6% and GDP per capita by 1%. López-Marmolejo and Rodríguez-Caballero (2023) examined the impact of legal reforms related to gender equality on women's labor force participation and GDP per capita, finding that these reforms increased women's labor force participation by 6% and GDP per capita by 1%. Similarly, Tunçsiper (2023), in her study within the context of the European Union and Turkey, has shown that legal reforms support women's participation in economic life and economic growth. Tokal and colleagues (2023) emphasized that in emerging market economies, the level of education and economic freedom reduce gender inequality, but the level of education has a stronger impact.

In conclusion, the literature reveals that the relationship between women's labor force participation, fertility, and economic growth varies according to regional and socioeconomic contexts, and these dynamics should be supported by gender equality policies. The effective implementation of education, economic freedom, and gender equality policies can not only increase women's participation in economic life but also yield positive results on fertility decisions and economic growth.

4. DATA AND METHODOLOGY

In this study, birth rates (DGMO) were designated as the dependent variable, while the independent variables included the gender inequality index (GII), per capita gross domestic product (GDPP), and female employment rate (KDNIST). The analysis utilized annual data covering the period from 1999 to 2022. The gender inequality index data were sourced from the "Our World in Data" platform, whereas data for the other variables were obtained from the World Bank database. To ensure data compatibility, the natural logarithm of gross domestic product (GDP) was applied.

The stationarity characteristics of the series were evaluated utilizing the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests. The Breitung and Candelon frequency domain causality test was subsequently applied to examine the causal linkages between birth rates and the independent variables in the frequency domain. This approach enabled a detailed examination of the short-term, medium-term, and long-term dynamics underlying the relationships among the variables. Descriptive information about the variables is provided in Table 1;

Table 1. Descriptive Information on Variables

Variable	Notation	Definition	Transformation	Source
DGMO	DGMO	Fertility rate, total (births per woman) (%)	-	WORLD BANK (WDI)
KDNIST	KDNIST	Employment to population ratio, 15+, female (%) (modeled ILO estimate)	-	WDI
CEI	CEI	Gender Inequality Index	-	Our World in Data
GDPP	LNGDPP	GDP per capita (constant 2010 US$)	Logarithmic	WDI

The GDPP variable underwent a natural logarithmic transformation to standardize observation values with varying units, ensuring they express equivalent meanings. The "ln" notation indicates that the logarithm of the series has been computed. The model being examined is presented in equation (1);

$$DGMO_t = \beta_0 + \beta_1 KDNIST_t + \beta_2 CEI_t + \beta_3 LNGDPP_t + \varepsilon_t \quad (1)$$

In the econometric model given in Equation (1), the notations β_0 and ε_t represent the constant and error term, respectively.The parameters from β_0 to β_3 are the coefficients of the explanatory variables contained in the function.

4.1 Traditional Unit Root Tests ADF and PP

This study employed the ADF and PP unit root tests, which are conventional methods, to assess the unit root and stationarity of the series. Stationarity is characterized by a time series exhibiting a consistent mean, variance, and autocorrelation structure throughout time (Enders & Granger, 1998).

The Dickey-Fuller (1981) stationarity test evaluates a first-order autoregressive (AR) process. The Augmented Dickey-Fuller (1981) test operates on the AR(p) model with a lag order of p, assessing the null hypothesis as an ARIMA(p,1,0) autoregressive integrated moving average process, and the alternative hypothesis as a stationary ARIMA(p+1,0,0) model (Cheung & Lai, 1995). The test presumes that the error terms are independently and identically distributed [ε_t ~WN(0,σ^2)]. In the test, it is assumed that the error terms are independently and identically distributed [ε_t ~WN(0,σ^2)].

$$\Delta y_t = \gamma y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-1+1} + \varepsilon_t \quad (2)$$

$$\Delta y_t = c + \gamma y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t \quad (3)$$

$$\Delta y_t = c + \gamma y_{t-1} + \delta_2 t + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t \quad (4)$$

The initial model (Model 1) possesses a regression framework devoid of a constant term and trend variable. The second model (Model 2) comprises of the constant term, excluding the trend variable. The third model (Model 3) integrates both the constant term and the trend. In these models, the coefficient of the prior period value of the dependent variable, y_{t-1}, denoted as " γ ", is tested to determine whether it is less than one. The acceptance of the alternative hypothesis leads to the conclusion that the series is stationary.

The Dickey-Fuller test assumes constant variances and independent error terms, presuming no autocorrelation is present. Phillips & Perron (1988) reevaluated the assumptions of the Dickey & Fuller (1979) test and proposed an alternative method to address random shocks (Sevüktekin & Nargeleçekenler, 2010). This novel methodology provides more adaptable solutions, especially for instances of autocorrelation and heteroscedasticity. The equations delineating the constant and constant-trend models employed in the PP test are as follows:

$$Y_t = \alpha_0 + \beta_1 Y_{t-1} + \varepsilon_t \quad (5)$$

$$Y_t = \alpha_0 + \beta_1 Y_{t-1} + \beta_2 \left(t - \frac{T}{2}\right) + \varepsilon_t \quad (6)$$

Equations (4) and (5) described above denote models that encompass the constant term and those that integrate both the constant term and the trend, respectively. In these models, Y_t signifies the dependent variable, α_0 indicates the constant term, t represents the trend, and T specifies the number of observations, while the error term encapsulates the model's uncertainty component. The coefficient estimation is performed using this method. In the Augmented Dickey-Fuller (ADF) test, the results are evaluated against MacKinnon crucial values to ascertain the stationarity of the series (Tarı, 2010).

4.2. Breitung and Candelon (2006) Frequency Domain Causality Test

Granger (1969) developed the idea of causality, which pertains to the incorporation of the lagged values of one variable into the equation of another variable. A variety of causality tests have been established in the literature to investigate causal links among variables. These conventional tests function inside the temporal domain, yielding a test statistic that assesses causality between variables in a singular time dimension(Aydın, 2020).

Granger (1969), Geweke (1982), and Hosoya (1991) are significant contributors to the advancement of frequency-based causality tests and their methodological applications in the literature. Geweke and Hosoya proposed a causality measurement in the frequency domain by partitioning spectral density functions into designated frequency intervals. Breitung & Candelon (2006) advanced these methodologies by proposing a Vector Autoregression (VAR) model, illustrated in Equations (7) and (8), to assess probable causal linkages in their frequency-based causality test.

$$Y_t = \theta_{11,1}Y_{t-1} + \theta_{11,2}Y_{t-2}, \dots, +\theta_{11,p}Y_{t-p} + \theta_{12,1}X_{t-1} + \theta_{12,2}X_{t-2}, \dots, \theta_{12,p}X_{t-p} \quad (7)$$

$$X_t = \theta_{21,1}Y_{t-1} + \theta_{21,2}Y_{t-2}, \dots, \theta_{21,p}Y_{t-p} + \theta_{22,1}X_{t-1} + \theta_{22,2}X_{t-2}, \dots, \theta_{22,p}X_{t-p} \quad (8)$$

The model presented in Equations (7) and (8) is expressed in matrix form using the lag operator (L) as follows:

$$\varphi(L) = \begin{pmatrix} Y_t \\ X_t \end{pmatrix} = \begin{pmatrix} \varphi_{11}(L) & \varphi_{12}(L) \\ \varphi_{21}(L) & \varphi_{21}(L) \end{pmatrix} \begin{pmatrix} X_t \\ Y_t \end{pmatrix} = \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} \quad (9)$$

$\varphi(L) = I - \varphi_1 L - \varphi_2 L^2 - \dots - \varphi_p L^p$ represents the 2x2 lag polynomial, while denotes $\varphi_1 - \varphi_2 - \varphi_3 - \dots - \varphi_p$ the 2x2 autoregressive parameter matrix. Breitung & Candelon (2006) specified that ε_{1t} and ε_{2t} represent the error vector, which corresponds to white noise. The moving average representation of the VAR model, shown through Cholesky decomposition, is:

$$\begin{pmatrix} Y_t \\ X_t \end{pmatrix} = \psi(L)\eta_t = \begin{pmatrix} \psi_{11}(L) & \psi_{12}(L) \\ \psi_{21}(L) & \psi_{22}(L) \end{pmatrix} \begin{pmatrix} \eta_{1t} \\ \eta_{2t} \end{pmatrix} \quad (10)$$

$\psi(L) = \varphi(L)^{-1}G^{-1}, E(\eta_t, \eta_t) = I$ ve $\eta_t = G\varepsilon_t$ represents. Based on this equation, the spectral density function of x_t is expressed as follows:

$$f_x(\omega) = \frac{1}{2\pi}\left\{\left|\psi_{11}(e^{-i\omega})\right|^2 + \left|\psi_{12}(e^{-i\omega})\right|^2\right\} \quad (11)$$

The causality measure proposed in the studies of Geweke (1982) and Hosoya (1991) has been reformulated as shown in Equation (12):

$$M_{x\rightarrow y}(\omega) = \log\left[1 + \frac{\left|\psi_{12}(e^{-i\omega})\right|^2}{\left|\psi_{11}(e^{-i\omega})\right|^2}\right] \quad (12)$$

In Equation (12), the test examines whether Y_t is not the Granger cause of X_t at frequency ω. The approach by Breitung and Candelon (2006) is expressed with the following linear restrictions:

$$\sum_{k=1}^{p} \theta_{12,k}\cos(k\omega) = 0, \sum_{k=1}^{p} \theta_{12,k}\sin(k\omega) = 0 \quad (13)$$

In accordance with these limitations, a standard F-test can be conducted to test the null hypothesis, which implies the absence of Granger causality at frequency ω. The F-statistic is distributed as F(2,T−2p) where $\omega \in (0,\pi)$ representing 2 restrictions. T denotes the number of observations, while p represents the order of the VAR model.

5. FINDINGS

Time series graphs of the variables are provided in Figure 1;

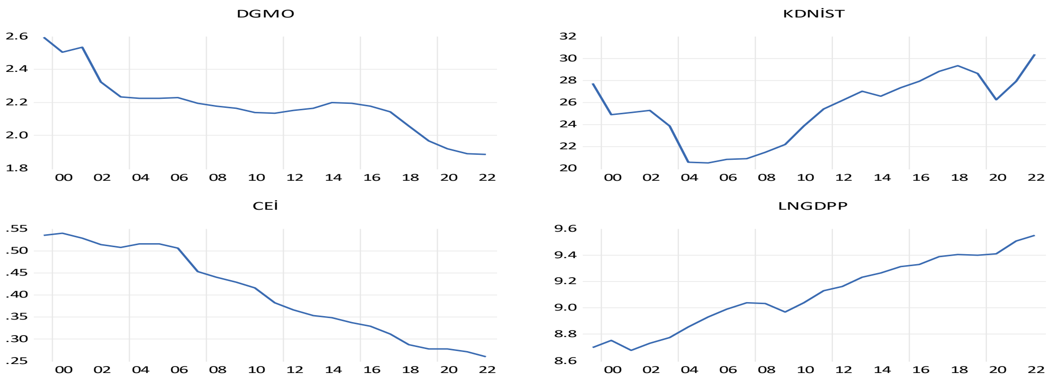


Figure 1. Time Series Graphs of Variables

Upon examining the time series plots of the variables in Figure 1, it is seen that birth rates and the gender inequality index demonstrate a declining trend, while the female employment rate and per capita gross domestic product reveal an ascending trend.

The study utilized classic unit root tests, specifically the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests, to assess the stationarity of the series. Table 2 displays the outcomes of the Augmented Dickey-Fuller and Phillips-Perron unit root tests.

Table 2. Augmented Dickey Fuller ve Phillips-Perron Unit Root Test Results

UNIT ROOT TEST TABLE (PP)					
At Level					
		DGMO	**KDNIST**	**CEI**	**LNGDPP**
With Constant	t-Statistic	-1.711	-0.641	0.027	0.004
	Prob.	***0.412***	***0.842***	***0.951***	***0.949***
With Constant & Trend	t-Statistic	-2.230	-2.592	-2.402	-2.883
	Prob.	***0.451***	***0.286***	***0.368***	***0.185***
At First Difference					
		d(DGMO)	**d(KDNIST)**	**d(CEI)**	**d(LNGDPP)**
With Constant	t-Statistic	-3.835***	-3.399**	-4.001***	-4.299***
	Prob.	***0.008***	***0.022***	***0.005***	***0.003***
With Constant & Trend	t-Statistic	-3.734**	-3.526*	-3.834**	-4.233**
	Prob.	***0.041***	***0.061***	***0.033***	***0.015***
UNIT ROOT TEST TABLE (ADF)					
At Level					
		DGMO	**KDNIST**	**CEI**	**LNGDPP**
With Constant	t-Statistic	-2.522	-0.654	0.048	-0.096
	Prob.	***0.124***	***0.838***	***0.954***	***0.938***
With Constant & Trend	t-Statistic	-2.165	-1.936	-2.427	-3.777
	Prob.	***0.484***	***0.602***	***0.356***	***0.037***
At First Difference					
		d(DGMO)	**d(KDNIST)**	**d(CEI)**	**d(LNGDPP)**
With Constant	t-Statistic	-3.819***	-3.441**	-4.008***	-4.307***
	Prob.	***0.008***	***0.020***	***0.005***	***0.003***
With Constant & Trend	t-Statistic	-3.734**	-3.569*	-3.874**	-4.236**
	Prob.	***0.041***	***0.056***	***0.031***	***0.015***

*MacKinnon (1996) one-sided p-values. Notes: (*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1%. and (no) Not Significant

The stationarity of the variables was assessed using the Phillips-Perron (PP) and Augmented Dickey-Fuller (ADF) tests.

The PP test findings indicate that, in the model with a constant term, none of the variables were statistically significant. The p-values were notably elevated, with DGMO at 0.412, KDNIST at 0.842, CEI at 0.951, and LNGDPP at 0.949. In the model incorporating both a constant and a trend term, all variables were determined to be non-stationary, exhibiting p-values between 0.185 and 0.451.

Upon calculating the first differences, certain variables attained significance in the PP test. In the model with a constant factor, DGMO, CEI, and LNGDPP were determined to be stationary at the 1% significance level. Concurrently, KDNIST was determined to be stationary at the 5% significance threshold. In the model incorporating a constant and trend factor, DGMO and CEI exhibited stationarity at the 5% significance level, whereas KDNIST demonstrated stationarity at the 10% significance level, and LNGDPP was stationary at the 5% significance level.

The ADF test findings indicate that, in the model with a constant term, none of the variables exhibited stationarity at the 1%, 5%, or 10% significant levels. The p-values were elevated, with DGMO at 0.124, KDNIST at 0.838, CEI at 0.954, and LNGDPP at 0.938. In the model incorporating both a constant and a trend term, only LNGDPP was identified as stationary at the 5% significance level, whilst the remaining variables were non-stationary.

Upon using initial differences in the ADF test, the model with a constant component indicated that DGMO, CEI, and LNGDPP attained stationarity at the 1% significant level. Simultaneously, KDNIST was determined to be stationary at the 5% significance threshold. In the model incorporating a constant and trend factor, DGMO and CEI exhibited stationarity at the 5% significance level, but KDNIST demonstrated stationarity at the 10% significance level, and LNGDPP was stationary at the 5% significance level.

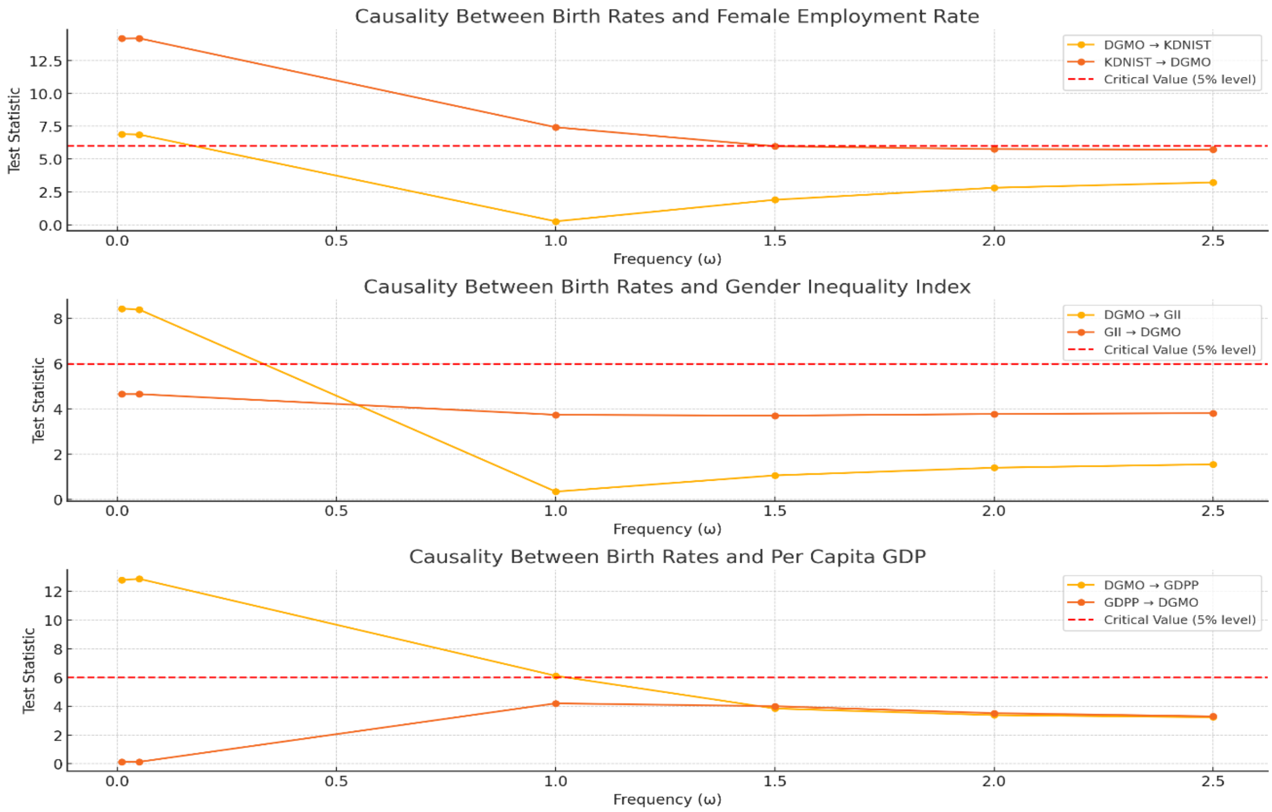
All variables were determined to be non-stationary at their level values, signifying the presence of unit roots and adherence to an I(1) process. Subsequently, after computing the first differences, all variables exhibited stationarity. DGMO, CEI, and LNGDPP exhibited stationarity at the 1% significance level, whereas KDNIST demonstrated stationarity at the 5% significance level. The results indicate that the first differences of the variables ought to be employed for analyses based on stationarity.

The frequency domain causality test facilitates the disaggregation of causal links among variables into transitory and permanent components. In this context, test statistics are computed for both elevated (ω=2.5) and diminished (ω=0.5) frequencies. Short-term causality analyses are performed with high-frequency statistics (ω=2.5), while long-term causality linkages are assessed using low-frequency statistics (ω=0.5). The table illustrates the statistical representation of the frequency domain causality test together with its corresponding frequency graph.

Table 3. Breitung and Candelon (2006) Frequency Domain Causality Test

	Long Term (Permanent)		Medium Term		Short Term (Temporary)	
Variables	ω= 0.01	ω= 0.05	ω= 1.00	ω= 1.50	ω= 2.00	ω= 2.50
DGMO≠>KDNİST	6.8963** (0.0318)	6.8606** (0.0324)	0.2485 (0.8831)	1.8918 (0.3883)	2.8079 (0.2456)	3.2166 (0.2002)
KDNİST ≠> DGMO	14.1758*** (0.0008)	14.1943*** (0.0008)	7.4168** (0.0245)	5.9693* (0.0506)	5.7543* (0.0563)	5.7112* (0.0575)
DGMO ≠>CEİ	8.4285** (0.0148)	8.3831** (0.0151)	0.3416 (0.8430)	1.0585 (0.5890)	1.3981 (0.4971)	1.5485 (0.4610)
CEİ ≠> DGMO	4.6504* (0.0978)	4.6494* (0.0978)	3.7354 (0.1545)	3.6990 (0.1573)	3.7712 (0.1517)	3.8106 (0.1488)
DGMO ≠>LNGDPP	12.7623*** (0.0017)	12.8415*** (0.0016)	6.1071** (0.0472)	3.8370 (0.1468)	3.3763 (0.1849)	3.2306 (0.1988)
LNGDPP ≠> DGMO	0.1305 (0.9368)	0.1327 (0.9358)	4.1959 (0.1227)	3.9960 (0.1356)	3.5133 (0.1726)	3.2931 (0.1927)

Note: For ω (frequency) between 0 and π ω∈(0,π) with degrees of freedom (2, T-2p), the F table value is approximately 2.49 at the 10% significance level. * indicates that the null hypothesis is rejected at the 10% significance level. The values in parentheses represent the p-values of the F statistics.



The above graphs illustrate the causality relationships between birth rates (DGMO) and female employment rate (KDNIST), gender inequality index (GII), and per capita gross domestic product (GDPP) across different frequencies. The red dashed line represents the critical value at the 5% significance level (5.991). Causality is considered significant when the test statistics exceed this threshold.

The frequency domain causality test results indicate a bidirectional causal relationship between birth rates (DGMO) and the female employment rate (KDNIST). A statistically significant causal relationship is identified between birth rates and the female employment rate in the long term ($p < 0.05$). Nevertheless, this influence is not substantial in the medium and short durations. The relationship from the female employment rate to birth rates is statistically significant across all time frames. The association is notably robust in the long run ($p < 0.01$), although the level of significance diminishes marginally in the medium and short ranges ($p = 0.05$). The data demonstrate that the female employment rate consistently influences birth rates throughout all eras, but the impact of birth rates on female employment is observable only in the long run.

Analysis of the causal association between birth rates (DGMO) and the gender inequality index (GII) reveals a statistically significant long-term effect of birth rates on gender inequality ($p < 0.05$). Nonetheless, this association lacks significance in both the medium and short timescales. A minor causal relationship from gender disparity to birth rates is observed in the long run ($p = 0.10$), although this association lacks statistical significance in the medium and short terms. The findings indicate that birth rates may exert long-term effects on gender inequality, but the influence of gender inequality on birth rates seems to be more constrained.

An analysis of the correlation between birth rates (DGMO) and per capita gross domestic product (GDPP) indicates a significant causal association from birth rates to per capita income levels in both the long and medium terms ($p < 0.01$ and $p < 0.05$, respectively). This link lacks significance in the short run. No statistically significant causality is observed from per capita income to birth rates over any time period ($p > 0.05$). The findings indicate that birth rates may substantially affect per capita income as a measure of economic growth in the long and medium terms, whereas per capita income does not considerably influence birth rates.

In summary, birth rates exert a significant long-term influence on economic and social factors, although their short-term effects are comparatively constrained. The female employment rate is identified as the most critical factor influencing birth rates among the factors examined. The correlations between birth rates and gender inequality or per capita income become particularly significant over the long term. This signifies that the impact of demographic indicators on economic and social processes fluctuates over time, highlighting the necessity of incorporating these dynamics into long-term planning initiatives.

6. CONCLUSION AND IMPLICATIONS

In this study, the relationships between birth rates, women's employment rates, the gender inequality index, and GDP per capita in Turkey during the period 1999–2022 were empirically examined. The stationarity properties of the variables were analyzed using ADF and PP unit root tests, and short, medium, and long-term relationships were evaluated using the Breitung and Candelon frequency domain causality test. The results of the study show that birth rates are deeply influenced by economic and social factors.

The findings obtained have revealed that the increase in women's employment has positive effects on birth rates in the long term. This suggests that if women's participation in the workforce is increased, the positive effects of economic and social policies on fertility could become more pronounced. However, although the impact of the gender inequality index on fertility is limited, it is understood that it negatively affects women's employment and overall economic well-being. In this context, it has been determined that GDP per capita, used as an indicator of the level of economic welfare, has a direct effect on fertility rates, and that this relationship plays an important role in shaping economic growth and demographic structure.

It has been understood that policies aimed at increasing women's employment should be supported by measures such as the widespread provision of childcare services, the implementation of flexible working arrangements, and the enhancement of maternity leave options. Such measures can facilitate the integration of women into the workforce, contributing to the balancing of fertility rates and the enhancement of social welfare. Additionally, the implementation of economic regulations and tax incentives that promote the employment of women in workplaces can enable women to play a more active role in economic life.

In order to reduce gender inequality, the importance of structural reforms that provide equal opportunities in education and employment is becoming evident. Practical training programs and economic development projects should be developed to enable women to improve their professional skills. Education and vocational training policies will not only increase women's employment but also contribute to achieving gender equality.

In conclusion, the complex relationship between birth rates, women's employment, and economic growth requires a holistic and long-term policy approach. In developing countries like Turkey, policies that support the integration of women into economic and social life will contribute not only to achieving gender equality but also to economic growth and sustainable development. This study emphasizes the necessity of an approach that addresses economic and demographic goals together.

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