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Research Article

The impact of economic and social factors on birth numbers: A panel data approach

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ABSTRACT

This study examines the impact of urbanization, entrepreneurship, and education on the number of births across Turkish provinces from 2010 to 2023. Utilizing annual provincial-level data and applying the Common Correlated Effects (CCE) estimator to account for cross-sectional dependence and heterogeneity, the analysis yields insightful findings. Results show that an increase in the urbanization rate contributes to a rise in the number of births, challenging the conventional view that urban living suppresses fertility. In contrast, a higher number of entrepreneurs and an increase in university graduates are both associated with a decline in birth rates. These findings suggest that individuals engaged in entrepreneurship or higher education may prioritize career and economic goals over family formation, leading to delayed or reduced fertility. The divergent effects of these variables underscore the need for nuanced demographic policies that support fertility while also accounting for socioeconomic transformations such as urban growth, entrepreneurial activity, and educational attainment.

Keywords: Urbanisation, Education, Number of Births

1. Introduction

Fertility is not merely a demographic variable shaped by individual preferences, but also a phenomenon closely linked to socioeconomic structures. Particularly, the classical microeconomic theory of fertility developed by Becker (1960) argues that individuals make childbearing decisions within a cost-benefit framework. According to this approach, having children entails both direct costs (such as nutrition, education, and care) and indirect costs (especially the opportunity costs for women in the labor market) (Becker, 1960; Becker, 1992). Therefore, rising education levels, increased labor market opportunities, and engagement in entrepreneurial activities can elevate the opportunity cost of having children, thereby exerting a suppressive effect on fertility. This study examines the effects of urbanization, entrepreneurship, and the number of higher education graduates on birth numbers using annual provincial-level data from Turkey over the 2010–2023 period. The analysis aims to provide empirical evidence consistent with theoretical foundations on how fertility decisions are shaped by economic conditions. The main objective of this study is to identify the socioeconomic factors influencing fertility rates in Turkey and to empirically analyze their impact on the number of births. Specifically, it investigates the direction and magnitude of the effects of urbanization, entrepreneurship, and educational attainment on fertility. In doing so, the study aims to offer evidence-based insights for policymakers to design sustainable demographic policies.

It is observed that birth rates in Turkey have been decreasing over the years. This situation is shaped by economic, social and demographic factors. In particular, increasing urbanisation, higher education level and higher participation of women in the labour force play a decisive role on birth rates. As seen in Figure 1, according to TURKSTAT data, there are significant differences among provinces in terms of the number of births. While Istanbul (156,708), Şanlıurfa (54,452) and Ankara (54,264) stand out as the provinces with the highest number of births,

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Bayburt (847), Tunceli (784) and Ardahan (943) are among the provinces with the lowest number of births. These data show that birth rates are higher in metropolises and more economically developed regions, while they remain low in rural and low-populated regions. It is noteworthy that Istanbul has the highest number of births, while birth numbers in eastern provinces such as Şanlıurfa and Diyarbakır are also relatively high. However, the general trend shows that birth rates are decreasing in the long term.

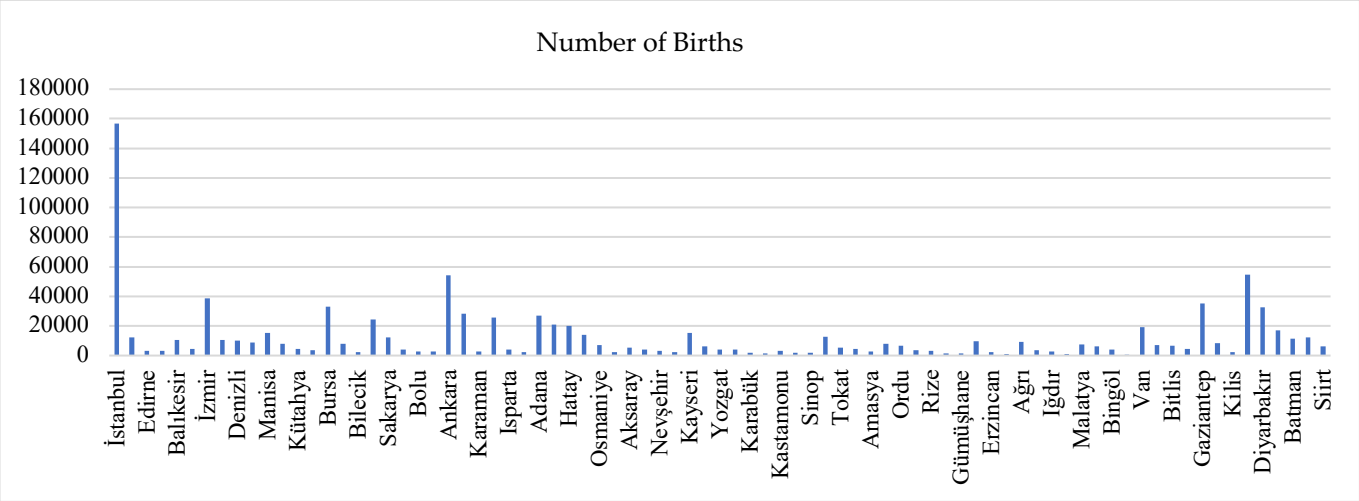

Figure 1. Number of Births by Provinces in 2023

Source: Turkish Statistical Institute (TURKSTAT, 2024)

Birth rates in Turkey are closely related to economic and social factors such as urbanisation, entrepreneurship and education level. Urbanisation plays a decisive role in demographic dynamics by increasing individuals' living standards and access to social opportunities. The process of urbanisation can stimulate birth rates as it improves access to infrastructure and health services. Individuals, especially those living in big cities, benefit from better education and health services and can make more informed decisions about having children with the support provided by social security mechanisms.

On the other hand, although entrepreneurship is seen as one of the main drivers of economic growth and innovation, it may have a dampening effect on birth rates. Entrepreneurs may postpone having children due to busy work schedules, financial risks and career-oriented lifestyles. Although it increases economic independence, entrepreneurship may negatively affect family planning decisions, leading to lower birth numbers.

The level of education also significantly affects the fertility decisions of individuals. The increase in the number of higher education graduates leads individuals to receive education for longer periods and adopt a career-oriented lifestyle. Especially the increase in the level of education of women may lead to a shift in the age of birth to later years and a decrease in total birth rates. Education improves the economic and social status of individuals and makes their decisions on having children more rational.

In conclusion, birth rates in Turkey are shaped by the complex interactions of factors such as urbanisation, entrepreneurship and education level. While the urbanisation process has an increasing effect on birth rates, the increase in entrepreneurship and educational attainment may cause individuals to postpone their decision to have children. Therefore, it is of great importance to address these factors in a balanced manner in the formulation of population policies. In order for Turkey to have a sustainable population structure, economic stability should be ensured, urbanisation processes should be supported and education policies should be designed by taking into account their effects on fertility.

In line with the theoretical background and literature reviewed, this study proposes the following hypotheses:

H1: The increase in the urbanization rate is expected to have a positive effect on the number of births.

H2: The increase in the number of entrepreneurs is expected to have a negative effect on the number of births.

H3: The increase in the number of higher education graduates is expected to have a negative effect on the number of births.

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2. Literature Summary

It is widely acknowledged in the literature that changes in birth numbers are closely linked to economic, social, and cultural dynamics. In both developed and developing countries, declining birth rates are frequently attributed to factors such as increased educational attainment among women, higher labor force participation rates, urbanization, improved living standards, and transformations in family structures. Moreover, the implications of declining birth rates on economic growth, labor markets, innovation, and entrepreneurship have received increasing attention. Within this framework, examining how fertility interacts with socio-economic indicators such as the number of entrepreneurs, the number of higher education graduates, and GDP per capita offers a promising avenue for understanding broader demographic and economic trends.

A considerable body of research has explored the determinants and consequences of declining fertility. For example, Bongaarts (2001) found that social and economic modernization, especially women's education and urbanization, played central roles in fertility reduction. This is consistent with McDonald (2006), who emphasized that rising female labor force participation, economic uncertainty, and cultural shifts are key contributors to low fertility, while also highlighting the importance of state policies such as childcare support and work-family balance mechanisms.

Further reinforcing the role of socio-economic factors, Morgan and Taylor (2006) argued that declining birth rates, once considered a regional issue, have become a global phenomenon. Similarly, Adsera (2011) provided empirical evidence linking higher unemployment rates to lower second birth probabilities in EU countries, thereby illustrating the influence of economic instability on fertility decisions. In parallel, Lutz and Skirbekk (2013) and Matysiak and Vignoli (2013) demonstrated that women's educational attainment and employment status have a negative effect on fertility across European contexts, underscoring how career goals and labor force integration shape family planning.

The literature also includes studies focusing on population policies and macro-level events. Demir (2016) offered a comparative analysis of Turkey, China, and France, illustrating how different state-led population strategies, whether pro-natalist, quality-oriented, or restrictive, affected national birth trends. Similarly, Comolli (2017) and Comolli and Vignoli (2021) emphasized how economic shocks such as the 2008 and 2011 crises negatively impacted birth rates in Europe and the United States. Zeman et al. (2018) further differentiated regional fertility trends by identifying distinct drivers of first and second birth declines across Europe and East Asia.

In the Turkish context, recent studies have begun to address local and cohort-specific dynamics. Eroğlu et al. (2021) identified traditional and cultural determinants of high fertility in Şanlıurfa, including early marriage, low education, and son preference. Keskin and Çavlin (2023) analyzed fertility patterns among Turkish women born between 1949 and 1978, highlighting the role of education and urbanization in shifting toward a two-child norm. Yılmaz (2024a, 2024b) contributed further insights by examining the effects of urbanization, education, and natural disasters such as the earthquake on fertility declines in Ağrı and nationwide, respectively.

While these studies have significantly advanced our understanding of fertility behavior and demographic change, relatively few have examined the bidirectional relationship between fertility and economic outcomes such as entrepreneurship and human capital accumulation. In this regard, existing research often overlooks the interplay between birth rates and indicators of innovation potential, such as the number of entrepreneurs or master's degree holders.

This study aims to fill this gap by focusing specifically on Türkiye, exploring how fertility trends relate to the number of entrepreneurs, the number of master's degree graduates, and GDP per capita. By integrating demographic and economic indicators in a unified analytical framework, the study offers a novel contribution to the literature on the socio-economic consequences of declining fertility.

3. Dataset, Econometric Methodology and Model

3.1. Dataset

In this study, data from all 81 provinces of Turkey for the period 2010 to 2023 are used to analyze the key determinants of birth rates. This specific timeframe is chosen based on the availability of the most recent and consistent data across all provinces. The dependent variable is the number of births, while the main explanatory variables include the urbanization rate, the number of entrepreneurs, and the number of higher education graduates.

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The dataset is compiled from various statistical sources published by the TURKSTAT, covering provincial-level data on births, population, entrepreneurship, and education.

The number of births represents the total annual births in each province and serves as a key indicator for analyzing demographic trends. The urbanization rate, defined as the proportion of the population living in urban areas, is examined for its impact on fertility. Urbanization can influence birth rates through factors such as lifestyle changes, economic opportunities, and access to infrastructure services.

The number of entrepreneurs reflects the count of new businesses established in each province and is used as a measure of economic dynamism and job creation. Increased entrepreneurship may affect fertility decisions by influencing labor market participation and economic stability.

The number of higher education graduates refers to individuals with at least a bachelor's degree in each province. Higher education levels, particularly among women, are often associated with delayed childbearing and lower birth numbers, as individuals may prioritize career development over starting a family.

By analyzing these variables at the provincial level, the study aims to uncover how socioeconomic factors shape birth rates in Turkey. The dataset is suitable for panel data analysis, enabling a detailed examination of the effects of time-varying regional and economic factors on fertility.

3.2. Econometric Methodology

The data set used in the study has been analysed comprehensively in terms of homogeneity and horizontal cross-section dependence. The stationarity properties of the variables have been analysed by means of unit root tests and in line with the findings obtained, it has been determined that the data set has a heterogeneous structure and contains horizontal cross-section dependence. In addition, it is determined that the dependent variable is stationary when the first difference is taken, while the independent variables are stationary at different levels.

Accordingly, in order to estimate the long-run cointegration relationship in a statistically reliable and consistent manner, the Common Correlated Effects (CCE) method proposed by Pesaran (2006) was preferred. The CCE method takes into account the cross-sectional dependence between variables and minimises the bias arising from this dependence through common factors, thus providing more reliable estimates. In addition, the flexibility of the method to estimate different coefficients for each horizontal cross-section unit by taking into account the heterogeneity of the model contributes to the results of the study to be more comprehensive and realistic (Yerdelen Tatoğlu, 2018: 299). In this framework, the CCE estimator was used in the analysis process in a way to take into account both short and long run relationships and the consistency of the results was evaluated with various additional tests. Thus, it has become possible to improve the accuracy of the model and to interpret the dynamic relationships between economic variables in a more reliable way.

3.3. Model

The empirical model developed in line with the econometric analyses conducted in the study is expressed mathematically as follows:

$$lnbirth_{i,t} = \alpha + \beta_1 lneducation_{i,t} + \beta_2 lnenterprise_{i,t} + \beta_3 lnurbanisation_{i,t} + \varepsilon_{i,t}$$

The dependent variable $lnbirth_{i,t}$ in the above equation represents the number of newborn children. Among the independent variables $\beta_1 lneducation_{i,t}$ represents the number of higher education graduates, $lnurbanisation_{i,t}$represents the total population ratio of provinces and districts and $\beta_2 lnenterprise_{i,t}$ epresents the number of entrepreneurs. Subscripts i and t in the equation denote region and year respectively. Moreover, β denotes the elasticity coefficients of the variables, α denotes the model constant, ln denotes the natural logarithm and ε denotes the error terms.

4. Findings

In panel data analysis, unlike time series analysis, it is essential to carefully evaluate the dataset in terms of homogeneity and cross-sectional dependence to minimize the risk of biased and inconsistent estimators and to ensure reliable results. In this regard, analyzing the stationarity and cointegration properties of the dataset used in

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this study is of critical importance. These analyses serve as a fundamental step in understanding the structure of the panel dataset and determining the appropriate econometric methodologies.

The econometric analyses conducted in this study, along with the findings derived from these analyses, are presented in detail in the subsequent sections. These findings provide significant insights into the relationship between the number of births and key variables such as the urbanization rate, the number of entrepreneurs, and the number of higher education graduates. By addressing these aspects, the study contributes to a deeper understanding of the socioeconomic factors influencing fertility trends.

4.1. Descriptive Statistics

Table 1. Descriptive Statistics

Variables	Variable. Description	Obs. Num.	Mean	Stan. Deviat.	Min.	Max.	Exp. Effect
Dependent Variables							
Birth	Number of newborn babies	1.134	8.991	1.047	6.664	12.400	
Independent Variables							
Urbanisation	Share of province and district population in total population (%)	1.134	4.293	0.251	3.464	4.605	Negative
Education	Number of higher education graduates	1.134	8.187	1.265	4.997	12.924	Negative
Enterprise	Number of entrepr.	1.134	10.024	1.056	7.902	13.976	Negative

Source: (TURKSTAT, 2024)

In the estimation model, the natural logarithms of all variables were taken in order to normalise the distribution of variables and to minimise problems such as changing variance and cross-sectional dependence. According to the data in the table, among the independent variables, the average number of entrepreneurs (10.024) and the standard deviation of the education factor (1.265) contain higher variance than the other variables. This suggests that there is considerable heterogeneity among provinces in terms of entrepreneurial activity and educational attainment. The relatively high standard deviation in education also indicates uneven distribution of university graduates across provinces, which may influence regional fertility behaviors differently. Furthermore, while the expected effects of urbanization, education, and entrepreneurship on birth rates are negative based on theoretical assumptions, the actual impact may vary depending on local socioeconomic dynamics and policy interventions.

4.2. Panel Homogeneity Test

Delta test was applied to determine whether the cointegration slope coefficients are homogeneous or heterogeneous. According to the results presented in Table 2, Delta Tilde (Δ) and Adjusted Delta Tilde (Δ_adj) test statistics calculated for each model are statistically significant at 5% significance level. This finding led to the rejection of the null hypothesis (H_0) that the variables are homogeneous and the acceptance of the alternative hypothesis (H_a) that the cointegration slope coefficients are heterogeneous (Pesaran et al, 2008). Therefore, it is concluded that the slope coefficients differ across regions in the analysed models.

Table 2. Homogeneity (Delta) Test Results

Model	Delta ve Delta (adj)	p- value
	19.463	0.000
	24.275	0.000

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4.3. Cross-Section Dependence Test

In the study, the Pesaran CDLM test, developed by Pesaran (2004), was applied to detect cross-section dependence (CSD). This test can be used for both homogeneous and heterogeneous panel data sets and remains valid in both T>N and N>T cases. According to the test results presented in Table 3, the p-values for all variables were found to be less than 0.05. Therefore, the null hypothesis (H_0), which assumes no cross-section dependence, was rejected. Consequently, it was concluded that there is cross-section dependence among the units in the panel (Pesaran, 2004).

Table 3. Cross-Section Dependence Test Results

Variable	Pesaran CD_{LM}	p-değeri
Birth	177.911***	0.000
Urbanisation	163.951***	0.000
Enterprise	197.807***	0.000
Education	211.462***	0.000

Those in parentheses indicate t-statistics. *< 0.10, **< 0.05, ***< 0.01

4.4. Panel Unit Root Test

Since horizontal cross-section dependence is detected in this study, CIPS test is preferred as a unit root test. The CIPS test is based on CADF test statistics and was developed by Pesaran (2004). The CADF test was developed by taking into account cross-sectional dependence and provides reliable results in both T>N and N>T cases in panel data analyses involving horizontal cross-sectional dependence (Küçükaksoy and Akalın, 2017: 27).

Table 4. CIPS Test Results

	Level		Differenced Series	
Variable	**Constant (-2.19)**	**Trend (-2.74)**	**Constant (-2.19)**	**Trend (-2.74)**
Birth	-2.030	-2.477	-3.698***	-3.701***
Urbanisation	-2.164***	-2.382		
Enterprise	-1.564	-1.646	-2.549***	-2.757***
Education	-1.902	-1.813	-3.008***	-3.242***

Those in parentheses indicate t-statistics. *< 0.10, **< 0.05, ***< 0.01

Note: Values in parentheses denote critical values at 1% significance level. In the application of unit root tests, lag values are determined according to the Akaike Information Criterion.

According to the results presented in Table 4, all variables except the urbanisation variable contain unit root at level, but become stationary when first differences are taken in both fixed and trended models. This finding indicates that the variables are non-stationary at level values but become stationary when first differences are taken. On the other hand, the urbanisation variable is found to be stationary at level under the constant model, which indicates that it exhibits a different dynamic than the other variables.

4.5. Cointegration Test

In addition to the heterogeneity and cross-sectional dependence of the data set, the fact that the dependent variable is first difference stationary [I(1)] and the independent variables have different degrees of stationarity (but none of them are [I(2)]) poses significant methodological challenges for panel data analysis. In such cases, appropriate tests are required to accurately identify the cointegration properties of time series and panel data models. In this context, the Durbin-Hausman Panel Co-integration Test developed by Westerlund (2008) is preferred to produce bias-free and consistent estimators. The most important advantage of the Westerlund (2008) test is that it can take heterogeneous and horizontal cross-section dependence into account and provide reliable results for independent variables with different degrees of stationarity. The test is suitable for analysing both short-term and long-term relationships and is used to assess whether cointegration conditions hold for the entire panel data. This method is a powerful tool to investigate the existence of long-run equilibrium relationships between the first difference stationary [I(1)] dependent variable and independent variables with different degrees of stationarity in the panel (Westerlund, 2008).

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Table 5. Durbin-Hausman Cointegration Test Results

	DHg		DHp	
	Test statistic	Probability Value	Test statistic	Probability Value
Model	-4.029	0.000	-2.793	0.002

Since the probability value in Table 5 is less than 0.10, the null hypothesis stating that there is no cointegration relationship between the variables is rejected at 10% significance level. This indicates that there is a long-run cointegration relationship between the variables and this relationship is statistically significant.

4.6. Estimation of Long Run Co-integration Coefficients

In addition to the heterogeneity and cross-sectional dependence of the data set, in case the dependent variable is stationary [I(1)] at the first difference level and the independent variables have different degrees of stationarity, estimations are made using the Common Correlated Effect (CCE) Method developed by Pesaran (2006), a method that produces statistically robust and consistent estimators (Ağır and Türkmen, 2020: 847). This method allows variables with different levels of stationarity to be evaluated together by taking heterogeneity and horizontal cross-section dependence into account in panel data analyses. The CCE Method is a preferred approach to increase the reliability of the model, especially when the independent variables have different stationarity levels and the dependent variable is stationary at the first difference level.

Table 6. CCE Analysis Results

Variable	Katsayı	Olasılık Değeri
Enterprise	-0.754***	0.000
Urbanisation	0.697***	0.000
Education	-0.050**	0.015

Those in parentheses indicate t-statistics. *< 0.10, **< 0.05, ***< 0.01

According to the results of the analysis, there are statistically significant relationships between the number of births and the variables of entrepreneurship, urbanisation, and education. Specifically, a 1% increase in the number of entrepreneurs leads to a 0.754% decrease in the number of births, holding other factors constant. This finding suggests that as entrepreneurial activity intensifies, individuals—particularly in reproductive age groups—may prioritize career development and economic goals over family planning, which could result in postponed or reduced childbearing. Therefore, rising entrepreneurship may bring unintended demographic consequences, such as declining birth numbers, which should be considered in population and family support policies.

Similarly, a 1% increase in the urbanisation rate increases the number of births by approximately 0.697%. This outcome challenges the conventional view that urbanisation reduces fertility and indicates that urban environments in Turkey may currently offer more supportive conditions for raising children, such as better access to healthcare, education, and employment opportunities for women. Urban policy strategies aiming to manage population dynamics should account for these localized effects.

Lastly, a 1% increase in the level of higher education attainment leads to a 0.050% decrease in the number of births. This reflects well-established patterns in the demographic literature, where higher educational attainment—particularly among women—is associated with delayed marriage and childbirth. The result emphasizes the need to harmonize education and family policies to alleviate potential trade-offs between educational aspirations and fertility intentions.

These findings show that the number of births is significantly affected by economic and social factors. Increased entrepreneurship may cause individuals to lead a career-oriented life and postpone their decision to have children due to economic concerns. This result is consistent with Bloom et al. (2009) and Del Boca (2002).

Higher levels of urbanisation may increase birth rates due to factors such as improved living standards with urbanisation and expansion of health and infrastructure services. This result is consistent with Shapiro & Tambashe (1999) and Dyson (2011). Increasing the level of education may increase the level of awareness of individuals and cause them to be more cautious about family planning and decrease birth numbers. These results reveal that variables such as entrepreneurship, urbanisation and education play determinant roles in fertility decisions. This result is consistent with Kravdal (2002) and Martin (1995).

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5. Conclusion

The results of the analysis reveal that birth numbers in Türkiye are shaped by the complex interplay of economic and social dynamics. Urbanization presents a dual mechanism in relation to fertility, offering both opportunities and constraints. This nuanced result partially supports Hypothesis 1 (H1). On one hand, urban living enhances access to healthcare services, childcare facilities, education, and employment opportunities, all of which may facilitate childbearing. On the other hand, advanced urbanization may suppress fertility due to high living costs, housing constraints, time pressures, and increasingly individualistic lifestyles. As such, the impact of urbanization on fertility is context-dependent and should not be classified as uniformly positive or negative. Pro-natalist population policies should therefore be integrated with family-friendly urban planning, including affordable housing projects, walkable neighborhoods, and expanded access to early childhood education and care (ECEC) services in metropolitan areas.

One of the key determinants, entrepreneurship, appears to have a negative effect on fertility, supporting Hypothesis 2 (H2). The findings suggest that increased entrepreneurial activity leads individuals, particularly women, to focus on career development, business ventures, and financial independence. These priorities often result in postponing or forgoing childbearing. This highlights a critical policy implication: while policies that support entrepreneurship contribute to economic growth, they may also lead to unintended demographic consequences. Therefore, entrepreneurship-supporting policies should be balanced with fertility-promoting measures. For example, female entrepreneurs could be supported through targeted initiatives such as subsidized childcare, parental leave programs tailored to self-employed individuals, and flexible tax incentives that encourage work-life balance.

Education, particularly at the tertiary level, shows a significant and negative relationship with fertility, providing strong evidence for Hypothesis 3 (H3). Higher education attainment among women is associated with delayed marriage, postponed childbirth, and fewer total births. These outcomes are not only the result of personal preferences but also reflect broader structural factors such as labor market participation, shifting gender roles, and professional aspirations. Therefore, educational advancement policies should be accompanied by structural supports that allow women to reconcile career ambitions with family life. These could include campus-based childcare services, extended parental leave for graduate students and academic staff, and awareness campaigns on fertility timelines and reproductive health.

Taken together, these findings underline the importance of designing population policies that are multidimensional, evidence-based, and context-sensitive. While economic empowerment, urban development, and educational expansion are key drivers of societal progress, they also create demographic trade-offs that must be acknowledged. One-size-fits-all approaches are unlikely to yield effective outcomes in the long term. Instead, governments should develop integrated strategies that align pro-natalist objectives with the realities of modern economic life.

In this context, the following policy recommendations are proposed: align entrepreneurship incentives with family support by offering targeted tax benefits and child-related subsidies to self-employed parents.Develop urban planning frameworks that encourage family life by expanding affordable housing and childcare infrastructure in cities.Design flexible education and career pathways that incorporate fertility awareness and enable young adults, especially women, to make informed reproductive choices.Support dual-earner families through work-life balance legislation, including flexible working hours and equal parental leave for both genders.

In conclusion, the analysis supports the study's hypotheses. First, urbanization exerts both enabling and constraining effects on fertility, which partially supports Hypothesis 1 (H1). Second, entrepreneurship appears to reduce fertility, thus supporting Hypothesis 2 (H2). Third, higher education contributes to delayed fertility and lower birth rates, supporting Hypothesis 3 (H3). These multifaceted findings call for targeted and balanced policy responses that incorporate the demographic implications of Türkiye's socio-economic transformation.

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ETHICAL AND SCIENTIFIC PRINCIPLES STATEMENT OF RESPONSIBILITY

The authors declare that ethical rules and scientific citation principles were complied with throughout the preparation process of this study.

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1st author contribution rate: %100