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# Time Statistical Analysis in the Study of Population Change Process

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**Abstract**

*The optimal population and the right political approach to achieving it are today a big concern of governments, especially developing countries. The uncontrolled increase in population can pose a variety of challenges for any country. In the meantime, unlike educational and health restrictions, one of the most important issues on which population change can be problematic is the economic path. Iraq will be a developing country due to the war and the problems it has faced in recent decades. So in this article, we examined the impact of population age structure on economic growth and in the period 2019-2021. The time series was used to do this research. The results of this study indicate that the ratio of population dependence, which indicates the state of population structure, has a negative and significant impact on economic growth.*

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## Introduction

The economic growth of countries is undoubtedly closely related to the welfare state of society. In economic schools and growth models, factors influencing economic growth have been examined; the theorists of Keynesian, neokinetic, neoclassical and intrinsic growth analyze the role of population in growth. Among these theories, the focus of endogenous growth is on developments within the economic system that determine population growth, and unlike other theories, population growth is considered an endogenous variable. In this attitude the growth of technology human capital the growth of ideas which is often explained by the intrinsic model are considered a direct function of population growth، In this view, the channels that influence population on economic growth are both negative and positive, the factor of economic growth and the barrier to economic growth.

In neoclassical growth theory, it is assumed that the population growth rate is constant and does not take into account the demographic impact. In this context, some studies, which have used cross-sectional data, prove that population growth has not had a significant impact on economic growth. On the other hand, researchers such as Bloom (2001), Bloom and Williamson (2001) and

Preskouts and others (2004) believe that models that consider only the growth rate of the entire population among the population structure variables to explain economic growth are not complete models. They may not explain the economic growth rate. They believe that focusing on population growth hides important elements of demographic statistics, which have variable effects on economic growth.

In contrast, they showed that if the changes in the age structure of the population are taken into account and the implicit assumption of the consistency of the population composition is excluded, a meaningful and positive relationship between the working-age population and the economic growth rate will be found. In this study, focusing on Iraq, we have tried to analyze statistical time analyses of the study of the changing population of Iraq. For this purpose, taking into account that many unobservable factors such as institutional variables are effective on economic growth and technology is an unobservable factor but very effective on economic growth and because technology and other institutional variables change over time.

Therefore, key variables must also be included in the growth model. To this end, the structural time series and structural attitude (Harvey (1985)) have been used in economic growth modeling to conduct research, which is the innovation and distinction between this article and other previous studies in the field of the impact of population structure on economic growth. The important and significant advantage of this modeling is the attention to the dynamics and changes of invisible variables on economic growth. This article uses this approach and given the demographic structure of the country and the life expectancy index to try to provide a more accurate and so-called less detailed explanation of the previous models of economic growth in Iraq so that the role of non-observable factors can be explained alongside the more visible factors on economic growth.

## 1. Theoretical Foundations

### The Role of Demographic Variables in Economic Growth

As mentioned, in the past, studies of economic growth were only about the population growth of countries, but recently the importance of population structure in the economic growth of countries has been considered. Theoretical discussion of the role of demographic variables in growth can be explained by the dynamics of the population and its age structure. The impact of demographic structure on economic growth can be expressed in two ways:

1. Life cycle model, savings and investment
2. Demographic transition and the window of economic opportunity

### 1.1. Life Cycle Model, Savings and Investment

Fisher (1930) noted the changes in the life cycle to people's productivity, and argued that people smooth their consumption by changing their savings throughout their lives. Therefore, people of different ages have different savings in order to have a smooth consumer trend, so the age structure of society affects the amount of savings in the country. This view was expanded by Ando and Modigliani (1957) with the theory of the bicycle.

### Ando - Modigliani life cycle theory

According to this theory, people have low incomes in early and late life and earn the highest incomes in middle age. Assuming that there is no inheritance, people are pure borrowers at the beginning of their life, and in the middle and middle years of life, where their income exceeds their consumption, they save some of their income to spend their life in old age and have positive savings. In fact, the savings from early life and late life are negative and the middle age is positive. Given that high-income groups are in middle age, they have a moderate desire for low consumption $(\frac{C}{y})$ and a moderate desire for high savings $(\frac{S}{y})$. For further explanation، Suppose the consumption function of the individual i is considered as $C_t^i = K^i i\,(P_t^i V)$ where PV is the current value of future income and $K^i$ is the number of PV that the individual i tends to consume at the time of t. If the age and income distribution of the population is relatively constant and people's taste for current and future consumption over time is stable and the term PV is adaptable to realities and practical currents، In this theory total income can be separated from income from work and income from property (1).

$$PV_0 = \sum_{t=0}^{T} \frac{y_t^L}{(1+r)^t} + \sum_{t=0}^{T} \frac{y_t^P}{(1+r)^t} \quad (1)$$

$$\sum_{t=0}^{T} \frac{y_t^P}{(1+r)^t} = \alpha_0 \quad (2)$$

$$\sum_{t=0}^{T} \frac{y_t^P}{(1+r)^t} = \alpha_0 \quad (3)$$

It is assumed that at zero time, there will be a modest income from work $(y_0^e)$.

$$y_0^e = \frac{1}{T-1} \sum_{t=0}^{T} \frac{y_t^L}{(1+r)^t} \quad (4)$$

$(T-1)$ is the average expected residual life of the population.

$$\sum_{t=0}^{T} \frac{y_t^L}{(1+r)^t} = (T-1) y_0^e$$

$$PV_0 = y_0^L + \beta(T-1) y_0^L + \alpha_0 \quad (5)$$

α represents a person's true wealth.

$$PV_0 = [1 + \beta(T-1)] y_0^L + \alpha_0$$

$$C_0 = K[1 + \beta(T-1)] y_0^L + K\alpha_0$$

Hence the savings function is equal to:

$$S_0 = 1 - K[1 + \beta(T-1)] y_0^L + K\alpha_0$$

The function emphasizes the impact of demographic tissue on long-term trends in savings patterns. Therefore, if on average there are a large number of middle-aged people, higher and higher incomes in the community will lead to a positive rate of savings. In a growing economy because younger populations live in boom times. They save more than the negative savings of the older segments, and the interest rate will be positive. Also, lower population growth, due to reduced savings incentives for retirement, may lead to lower savings growth (Modigliani and Endo, 1957). On the other hand, increasing savings plays a major role in the investment and economic growth of countries. Therefore, the population structure affects the economic growth of countries.

**1.2. Demographic transition and the window of economic opportunity**

How population structure affects economic growth can be explained by population transfer. In demographic transition, the changes in the demographic structure of the country are studied, which involve several stages. The first phase of the population transition begins with a high rate of birth and death, and then leads to a decrease in death rates and an increase in younger groups. The decline in mortality rates is due to the advancement of public health, treatment and medical knowledge. This phase has been accelerated since the end of World War II in developing countries (Bloom and others, 2003). The next phase of the demographic transition is a dramatic reduction in fertility. Increasing the chances of children surviving reduced births and made the optimal number of births more real. The time interval between the decline in mortality and birth rates causes a dramatic population growth. So, the demographic transition, at first, accelerates population growth, then decreases, and probably returns to a constant level (before the transition) when the transition is complete. This transition is accompanied by the transformation of society from a rural population to an urban population. According to the standard demographic transition scenario, child mortality is initially reduced, but fertility and childbearing decline begins with a time-out. As a result, demographic transition is initially a barrier to economic growth, as population growth rates increase faster than working-age population growth rates. Then by reducing fertility, the population transition causes a "demographic benefit" because the population growth at working age is faster than the total population growth. The important difference between the two groups of developed and undeveloped countries is the speed at which the transition occurs. In developed countries, demographic change occurs gradually, while in underdeveloped countries, the transition is rapid and sudden. A population window is a phenomenon created by the process of population transfer. The population window is a period when the population grows at the working age and the young and young population decreases. At this time, the old crowd is still small. Older and younger demographic groups impose relatively low costs on society, but the presence of a large working-age group creates an opportunity to increase per capita income. The increase in per capita income from the population window is called the population benefit (Bloom and Wilson, 1998; Bloom and others, 2001 & Mason, 2001). The aging population is likely to reduce the share of the population in the working age, and the demographic benefit is a temporary phenomenon. As can be seen in the standard population Transition scenario, child mortality decreases in the early stage, but fertility and childbearing decline begins with a time-out. As a result, population growth is initially a barrier to economic growth, as the rate of population growth increases faster than the rate of population growth at the working age. Then by reducing fertility, because population growth is faster at working age than overall population growth, population transition causes demographic "benefit". Demographic benefit may be due to productivity, which is the result of combining a large working-age population with a lower proportion of resources. In other words, children and the elderly consume much more than they produce, and the working-age group produces on average more than they consume, so society can invest resources in the care and education of children and the care of the elderly (Mason, 2005). The faster the population increases in working age than the population of the whole country, the same benefit or gift of the population is expressed. Increasing the population share of the work age is associated with a decrease in dependence. In the period of the population window (opportunity), the underage population (under 15 years of age) and the elderly population (65 years of age and older) decrease compared to the working-age population. In this connection, Bloom and Williamson (1998) explain the demographic benefits of per capita income growth opportunities in two ways: first, the existence of accounting effects that arise from an increase in the proportion of the population in the working age to the total population, in which the proportion of "producers" to "consumers" increases. As a result, it has positive effects on economic growth. Increasing the proportion of the working-age population to the total population reduces the proportion of dependence (burden of dependence), and reducing the proportion of dependence (burden of dependence) may increase savings and thus economic growth (Kelly, 1996). Second, the existence of "behavioral effects" is on per capita income growth. Increasing the rate of population growth in working age dilutes capital, which means reducing the ratio of capital to population in working age, and thus affects economic growth. As a result, changes in demographic structure may have significant effects on economic performance as they change labor supply and savings rates throughout the life cycle. In addition, a decrease in fertility will increase the supply of women's labor. Also, available resources from demographic structure changes can be used to invest in health and education (Bloom et al., 2007). Increasing savings, productivity and investment are driving the economic growth of society.

## 2. Research model and method of estimation

### 2.1. Specification of the model

**Statistical data:**

For the experimental test, the annual Time series data between 2019 and 2021 were extracted from the Iraqi Statistical Center. In order to model the effect of life expectancy and demographic structure on economic growth, the modified Prescott et al (2007) model has been used:

$$\mathrm{Gr}_t = \alpha_0 + \alpha_1 \ln \mathrm{LE}_t + \alpha_2 \ln \mathrm{LY}_t + \alpha_3 \,\mathrm{G\,LE}_t + \alpha_4 \,\mathrm{G\,K}_t + \alpha_5 \mathrm{D_u m}_t + \varepsilon_t \qquad (6)$$

Where $Gr_t$ economic growth (based on GDP per capita), $LnLE_t$ logarithm exponential life expectancy at birth, $LnY_t$ logarithm of the population dependence ratio (population ratio between 15 and 64 years old to the population of the whole country), $GL_t$ growth rate of the working population, GL growth rate of investment or growth of gross fixed capital formation, $Dum_t$ is the virtual variable and $\varepsilon_t$ is the regression error. Given that many invisible factors such as institutional variables affect economic growth, and technology is an invisible but highly influential factor in economic growth, and because technology and other institutional variables vary over time, these key variables need to be included in the growth model. To this end, he completed the model using the Harvey structural time series (1985) and considering the width of the model's origin in a variable and random manner as a representative of the technology factor. The Harvey structural time series model is designed to model invisible but effective factors on the dependent variable. So the evolved form of the model changes with a structural approach as follows:

$$Gr_t = \beta_t + \alpha_1 \ln LE_t + \alpha_2 \ln LY_t + \alpha_3 \, G\,LE_t + \alpha_4 \, G\,K_t + \alpha_5 D_u m_t + \varepsilon_t$$
$$\beta_t = \beta_{t-1} + \varphi_{t-1} + \vartheta_t$$
$$\varphi_t = \varphi_{t-1} + \varphi_{t-1} + \omega_t$$
$$\vartheta_t \approx NID(0, \sigma_\vartheta^2)$$
$$\omega_t \approx NID(0, \sigma_\vartheta^2) \qquad (7)$$

Where $B_t$ represents all the factors that influence and invisible economic growth, one of the most important components of which is the technology factor, which is assumed to be a random variable over time, because the advancement of technology is not a factor that is predetermined and changes over time, so it should be considered a random variable. Other factors affecting economic growth, including institutional and qualitative variables that are not effective and visible, are also found in the random variable factor. For example, work culture, consumption culture, quality of community institutions, and other factors can be called implicit trends in the $B_t$ variable affecting knowledge. Therefore, due to the importance of invisible variables in determining economic growth and in order to prevent torque, it is better to use Harvey's structural explanation in linear growth models, in which the role of these factors in modeling is not considered.

In the apparatus of Equations (2), two equations for the implicit trend variable are assumed that the first equation represents the level of the implicit trend and the second equation represents the slope of the implicit trend. The above equations, respectively, represent the level and slope of the process. The above process can be described as the trend in a period equal to the trend in the previous period plus the growth component and some unpredictable factors, which are the growth component of the same slope that varies over time.

The variances $\sigma_\vartheta^2$ and $\sigma_\omega^2$ are called 2 times the parameter, which play a very important role in determining the nature of the process. If these two variances are zero, the above regression model will become the normal regression model with a given linear trend. Depending on whether the super parameters are zero in the process, and whether they have a slope or a surface, different regression models will be formed. The Shape of the implicit process is determined by super parameters such as slope variance and surface variance and irregular residue variance. Super parameters and other model parameters are estimated with a combination of maximum accuracy and a Kalman filter algorithm. The waste equation and a set of auxiliary waste are also estimated so that the model can be properly evaluated. Auxiliary residues include the evaluation of irregular residues (model disturbances) and the evaluation of surface residues (surface disturbance component) and the evaluation of slope residues (slope disturbance component). To maintain the normality of auxiliary waste, some irregular interventions, surfaces and slopes are identified. Capman and colleagues (2010) generally study these information interventions about important failures and structural changes at certain times during the period. Because these interventions have a temporary effect on the process, irregular interventions can be described as pulse effects (shocks that have very short-term and sudden effects on the function). Short-term responses to such shocks, which have a temporary effect, are chosen. Although surface and slope interventions have permanent effects on the estimated trend and their effects last longer, in economic growth modeling these interventions portray structural changes that may have been caused by a variety of reasons, and these changes are displayed in the estimated trend variable. Harvey believes that in structural time series models, there is no need to examine the efficiency of model variables, and that is another important feature of structural time series models. The optimal estimations of the trend in the entire sample period are calculated with the smoothing algorithm of the Kalman filter, by means of which it is possible to follow the evolution of the trend. A time series is a set of observations ordered by time: data obtained and sorted from the observation of a phenomenon over time. It is an important strategic issue when it comes to the implementation of successive treaties, independent of neatened. We use the autocorrelation function (acf) and partial autocorrelation (pacf) to check this dependence of values. If the correlation coefficient decreases relatively slowly in the values of the correlation coefficient, it indicates instability. The box-Pierce test shows that it is used in the use of the serialization techniques and the serial regression model.

$H_0 = \rho_1 = \rho_2 \ldots = \rho_m = 0,$

The test statistics for this hypothesis are as follows.

$$Q = T \sum_{k=1}^{m} \hat{\rho}_k^2. \tag{8}$$

A series of trends is actually an unstable series. To predict, it's often useful to draw a trend curve to its observations and extrusion. Using less regression, one-line squares can be applied to observations. A linear regression model can be written as follows:

$$y_i = f(x_i ; \beta) + \varepsilon_i \quad i = 1, 2, \ldots, n \tag{9}$$

Where $f(x_i ; \beta)$ is a linear function of the $\beta$ parameter vector. Sometimes we assume that the sentence of the error is $\varepsilon_i$ with a normal distribution of $N(0, \sigma^2)$. The form of multi-sentence model and Fourier model is as follows:

$$f(x_i ; \beta) = \beta_0 + \beta_1 x_i + \beta_2 x_i^2 + \ldots + \beta n x_i^k + \varepsilon_i , \tag{10}$$

The estimator of the parameters (3) can be obtained using the less squares method and we search for some $\hat{\beta}$ to minimize the following statements in two models (3) and (4) respectively:

$$Q(\hat{\beta}) = \sum_{i=1}^{n} [y_i - f(x_i - f(x_i; \hat{\beta}))]^2,$$

$$Q(\hat{\beta}_0, \hat{\beta}_1, \hat{\beta}_2) = \sum_{i=1}^{n} [y_i - \beta_0 - \beta_1 \cos(wx_i) - \beta_2 \sin(wx_i) ]^2,$$

In any mathematical model, the prediction quality of the model should be taken into consideration first of all. The exact address of the bishpen Dasht Bazaar is quite acceptable. This accuracy can be tested with statistical methods, including (Root Mean Square Erro RMSE). The sum of squared error is a measure that expresses the degree of uncertainty or error in predicting y by $\hat{y}$ of the regression model. How to take a photo of the accounting department:

$$SSE = \sum_{i=1}^{n} (y_i - \hat{y}_i)^2 = \sum_{i=1}^{n} \hat{\varepsilon}_i^2 \tag{11}$$

The Closer the SSE is to zero, the greater the doubts or errors in the Y predicate after it is used as a regression model. The closer the SSE is to zero, the greater the uncertainty or error in predicting y after it is used in the regression model. Corresponding to equation (5), we can define the mean square error and root mean square error (RMSE).

$$MSE = \frac{SSE}{n-2}, \qquad RMSE = \sqrt{\frac{SSE}{n-2}}$$

In this article, Time is considered an independent variable, and it is assumed that the trend of population change over time moves according to the established pattern. According to the charts below, the data show a specific annual cycle, although they do not have a simple sinusoidal shape. However, the dominant part of the annual cycle is expected to be presented in the form of $s_t = \mu + A\cos 2\pi ft + B\sin 2\pi f$. in which the frequency is 1.12 periods per month. That the data $\{x_1, x_2, \ldots, x_{n-1}\}$ are modeled according to relation (4).

### 2.2. Analysis of the results of the estimate

In this section, we will examine the results of the model estimation in the time frame 2019-2021. The results of the structural model estimation are reported in Table 1.

**Table 1: Results of the Structural Model Estimation**

| Variable | Coefficient | P-Value |
|---|---|---|
| Implicit trend slope | -3/99 | 0/01 |
| Implicit trend slope | -0/02 | 0/01 |
| Exponential logarithm of the life expectancy index | 1/11 | 0/01 |
| | | |
| Exponential logarithm of the population dependence index | -0/028 | 0/02 |
| Population growth | 0/27 | 0/74 |
| Gross fixed capital formation growth | 0/22 | 0/00 |
| Virtual variable | | 0/07 |
| The logarithm is correct | 94/38 | |

The results of the research model estimation can be summarized as follows:
The population dependence index has a negative and significant impact on economic growth. More precisely, a one percent increase in the population dependence index leads to a 0.28 percent decline in economic growth. Population dependence change means population structure change because the population dependence index shows the ratio of the population under 15 and over 65 to the population of 15 to 65 years, so the negative effect of this index was expected to decrease. The higher the index, the higher the burden of society, the lower the proportion of people involved in the production of goods and services, and the opposite is the demographic benefit, which has a negative impact on economic growth. The life expectancy index has a positive and meaningful impact on economic growth. More precisely, every one percent increase in the life expectancy index leads to a 1.11 percent increase in economic growth. Many factors, including literacy, nutrition, health care, and other institutional variables, including culture, affect the life expectancy index. The improvement of this index may indicate the improvement of these factors, or at least some of these factors in the country. For example, improving health also leads to improved workforce performance because healthier employees have a more creative and prepared mind, and therefore can contribute to the production of goods and services more efficiently, and community health may have a positive impact on economic growth. Also, the higher the literacy level of society, the higher the level of human capital and even social capital in society, and from this point of view, it is an influential factor in economic growth. The level and slope of the implicit trend has had a significant impact on economic growth. In other words, with other factors that are not visible in the model, such as institutional-structural variables, as well as technology, the changes in economic growth can be partially explained. To understand more about this, let's look at the implicit trend and economic growth in Figure 2. As you can see, the movement of the implicit trend variable, which indicates the impact of invisible factors on economic growth, is in sync with the economic growth variable. For example, technological change is one of the determinants of growth that is an invisible variable.
Also, variables such as work culture and consumption which are unobservable, There may be factors influencing economic growth that lie in the implicit trend variable.

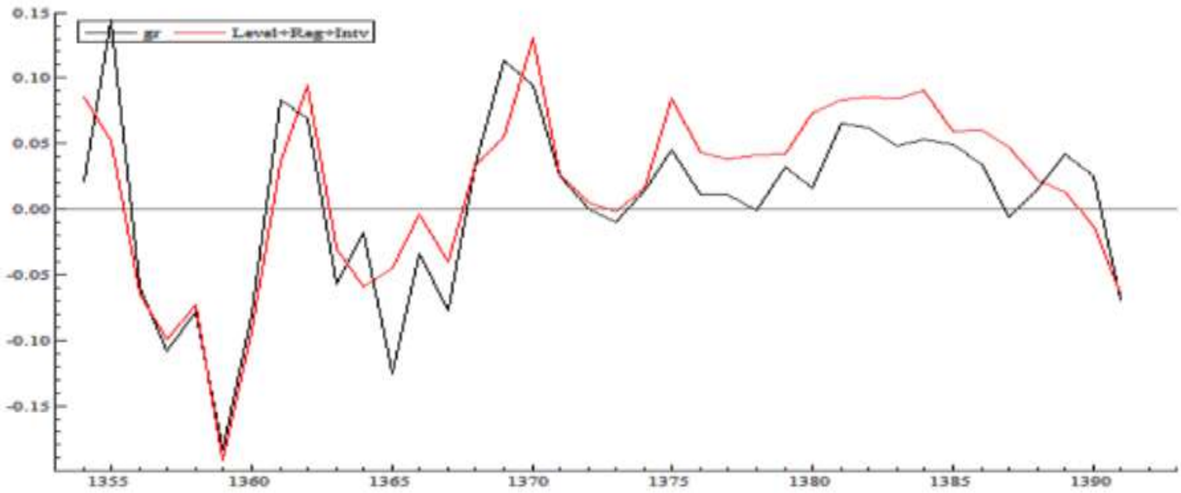


**Figure 1: Graph of Changes in Implicit Trends and Economic Growth**

Although the growth rate of the working population is positive, this variable at the 0/5 level has not had a significant impact on economic growth.

The growth of gross fixed capital has had a positive and significant impact on economic growth. More precisely, each one percent increase in gross fixed capital growth leads to a 0/22 percent increase in economic growth. The positive impact of this variable is also expected, so the growth rate of capital formation, or the growth of investment in growth models, is a key factor in economic growth. The CUSUM graphical test, which shows the stability of the estimated regression coefficients, was used to check the stability of the regression coefficients. The results in Figure 3 indicate the stability of the regression coefficients.

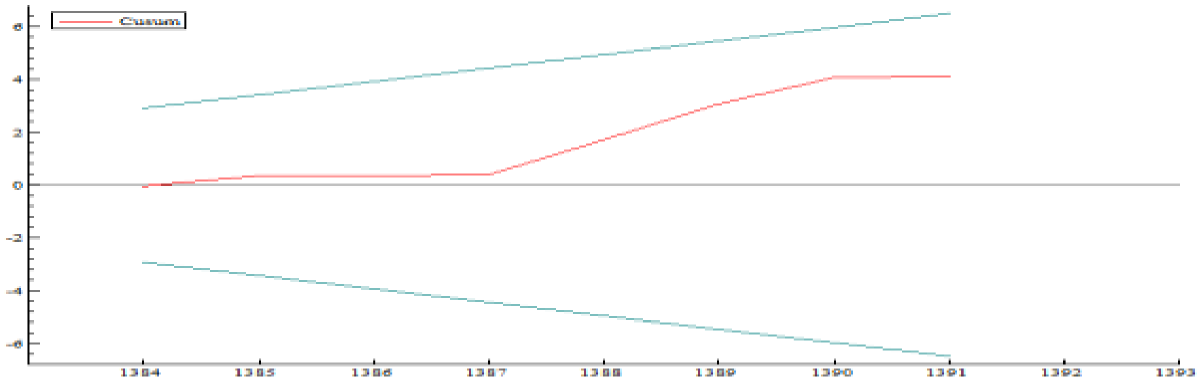


**Figure 2: CUSUM Test for the Stability of Estimated Regression Coefficients**

The graph of the ACF self-correlation function for regression errors is also drawn in graph 4, which indicates the absence of self-correlation between the components of the regression error.

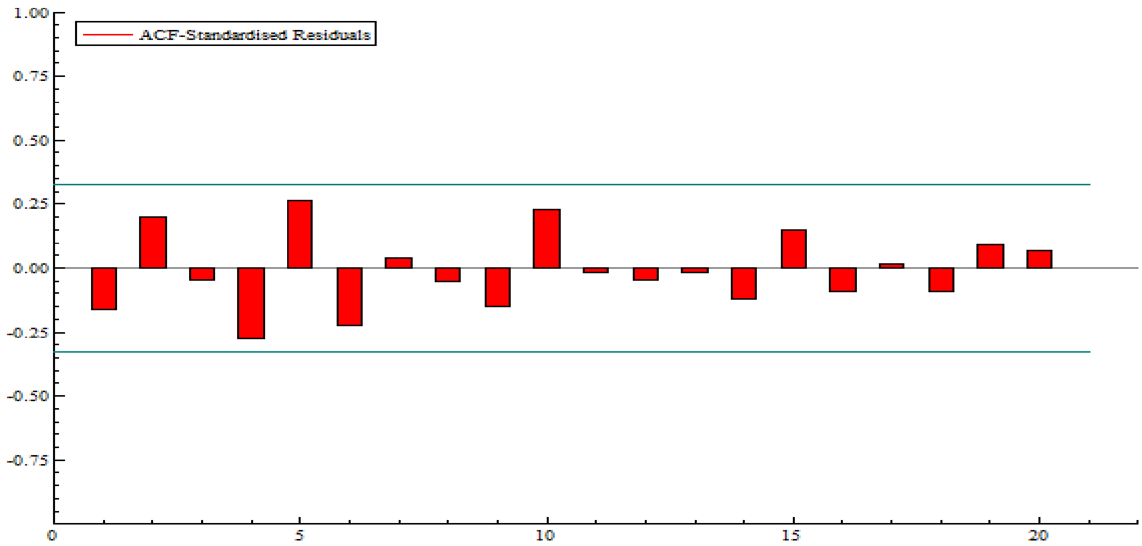


**Figure 3: Diagram of the ACF self-correlation function regression errors**

Multi-sentence models are used in situations where the analyst is aware of the presence of curvilinear effects in the actual response function. These models are also used as an approximating function for complex nonlinear relationships or unknown relationships. The Fourier model (price, 1985) basically deals with approximating a function with the sum of the sinusoidal and cosine sentences called the Fourier series. In order to apply Fourier analysis in the case of discrete time series, it is necessary to consider the representation of the Fourier series $f(t)$ only when $f(t)$ is defined by the correct numbers $1, 2, \ldots, N$. Suppose the function $f(t)$ is defined on $\{\pi, \pi\}$ in this case $f(t)$ can be defined by the Fourier series $\frac{a_0}{2} + \sum_{r=1}^{k}(ar\cos rt + b_b \sin rt)$ to approximate. The population change data are fragmented due to the way of collection. Therefore, we can try to fit the Fourier model for them. As the trend of population change clearly shows the downward sinusoidal structure. The diagnostic criteria for the optimization of the model are that the Fourier 8 model is the most optimized for the data. The diverse age composition impact data was adopted from 2019 to 2021. Optimization of the model are that the Fourier 8 model is the most optimized for the data.

**Table 2: Estimates of the population of Iraq by governorate, environment, and gender**

| Estimates of the population of Iraq by governorate, environment, and gender for the year 2021 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Governorate | Urban | | | Rural | | | Total | | |
| | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| Dohuk | 517,657 | 516,458 | 1,034,115 | 182,103 | 180,262 | 362,365 | 699,760 | 696,720 | 1,396,480 |
| Nineveh | 1,251,327 | 1,192,534 | 2,443,861 | 807,323 | 778,822 | 1,586,145 | 2,058,650 | 1,971,356 | 4,030,006 |
| Sulaymaniyah | 988,411 | 991,065 | 1,979,476 | 180,260 | 176,455 | 356,715 | 1,168,671 | 1,167,520 | 2,336,191 |
| Kirkuk | 641,118 | 634,996 | 1,276,114 | 227,945 | 222,350 | 450,295 | 869,063 | 857,346 | 1,726,409 |
| Erbil | 843,573 | 824,708 | 1,668,281 | 168,125 | 167,557 | 335,682 | 1,011,698 | 992,265 | 2,003,963 |
| Diyala | 437,140 | 433,186 | 870,326 | 456,435 | 442,159 | 898,594 | 893,575 | 875,345 | 1,768,920 |
| Anbar | 492,725 | 464,668 | 957,393 | 490,661 | 466,111 | 956,772 | 983,386 | 930,779 | 1,914,165 |
| Baghdad | 3,889,652 | 3,792,484 | 7,682,136 | 565,658 | 532,628 | 1,098,286 | 4,455,310 | 4,325,112 | 8,780,422 |
| Babylon | 541,805 | 535,259 | 1,077,064 | 585,548 | 568,524 | 1,154,072 | 1,127,353 | 1,103,783 | 2,231,136 |
| Karbala | 443,438 | 436,967 | 880,405 | 220,808 | 215,537 | 436,345 | 664,246 | 652,504 | 1,316,750 |
| Wasit | 452,743 | 443,793 | 896,536 | 299,274 | 293,821 | 593,095 | 752,017 | 737,614 | 1,489,631 |
| Salahaddin | 391,667 | 385,533 | 777,200 | 478,950 | 467,396 | 946,346 | 870,617 | 852,929 | 1,723,546 |
| Najaf | 566,366 | 569,135 | 1,135,501 | 230,807 | 223,653 | 454,460 | 797,173 | 792,788 | 1,589,961 |
| Al-Qadisiyah | 402,325 | 396,756 | 799,081 | 300,719 | 295,085 | 595,804 | 703,044 | 691,841 | 1,394,885 |
| ALMUthanna | 207,406 | 201,247 | 408,653 | 234,738 | 236,483 | 471,221 | 442,144 | 437,730 | 879,874 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Dhi Qar** | 728,409 | 724,565 | 1,452,974 | 407,809 | 402,912 | 810,721 | 1,136,218 | 1,127,477 | 2,263,695 |
| **Maysan** | 444,288 | 443,672 | 887,960 | 154,608 | 159,607 | 314,215 | 598,896 | 603,279 | 1,202,175 |
| **Basra** | 1,284,035 | 1,268,090 | 2,552,125 | 294,623 | 295,701 | 590,324 | 1,578,658 | 1,563,791 | 3,142,449 |
| **Total** | 14,524,085 | 14,255,116 | 28,779,201 | 6,286,394 | 6,125,063 | 12,411,457 | 20,810,479 | 20,380,179 | 41,190,658 |

**Estimates of the population of Iraq by governorate, environment, and gender for the year 2020**

| Governorate | Urban | | | Rural | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| **Dohuk** | 504,582 | 503,415 | 1,007,997 | 177,507 | 175,707 | 353,214 | 682,089 | 679,122 | 1,361,211 |
| **Nineveh** | 1,219,718 | 1,162,414 | 2,382,132 | 786,933 | 759,150 | 1,546,083 | 2,006,651 | 1,921,564 | 3,928,215 |
| **Sulaymaniyah** | 963,440 | 966,025 | 1,929,465 | 175,713 | 171,993 | 347,706 | 1,139,153 | 1,138,018 | 2,277,171 |
| **Kirkuk** | 624,926 | 618,955 | 1,243,881 | 222,194 | 216,734 | 438,928 | 847,120 | 835,689 | 1,682,809 |
| **Erbil** | 822,265 | 803,875 | 1,626,140 | 163,884 | 163,317 | 327,201 | 986,149 | 967,192 | 1,953,341 |
| **Diyala** | 426,098 | 422,252 | 848,350 | 444,901 | 430,987 | 875,888 | 870,999 | 853,239 | 1,724,238 |
| **Anbar** | 480,279 | 452,938 | 933,217 | 478,264 | 454,337 | 932,601 | 958,543 | 907,275 | 1,865,818 |
| **Baghdad** | 3,791,401 | 3,696,686 | 7,488,087 | 551,365 | 519,173 | 1,070,538 | 4,342,766 | 4,215,859 | 8,558,625 |
| **Babylon** | 528,117 | 521,739 | 1,049,856 | 570,767 | 554,160 | 1,124,927 | 1,098,884 | 1,075,899 | 2,174,783 |
| **Karbala** | 432,241 | 425,930 | 858,171 | 215,221 | 210,092 | 425,313 | 647,462 | 636,022 | 1,283,484 |
| **Wasit** | 441,302 | 432,582 | 873,884 | 291,719 | 286,404 | 578,123 | 733,021 | 718,986 | 1,452,007 |
| **Salahaddin** | 381,775 | 375,792 | 757,567 | 466,860 | 455,588 | 922,448 | 848,635 | 831,380 | 1,680,015 |
| **Najaf** | 552,058 | 554,753 | 1,106,811 | 224,976 | 218,001 | 442,977 | 777,034 | 772,754 | 1,549,788 |
| **Al-Qadisiyah** | 392,165 | 386,736 | 778,901 | 293,115 | 287,626 | 580,741 | 685,280 | 674,362 | 1,359,642 |
| **ALMUthanna** | 202,170 | 196,164 | 398,334 | 228,807 | 230,511 | 459,318 | 430,977 | 426,675 | 857,652 |
| **Dhi Qar** | 710,010 | 706,261 | 1,416,271 | 397,511 | 392,732 | 790,243 | 1,107,521 | 1,098,993 | 2,206,514 |
| **Maysan** | 433,066 | 432,464 | 865,530 | 150,700 | 155,572 | 306,272 | 583,766 | 588,036 | 1,171,802 |
| **Basra** | 1,251,600 | 1,236,058 | 2,487,658 | 287,173 | 288,228 | 575,401 | 1,538,773 | 1,524,286 | 3,063,059 |
| **Total** | 14,157,213 | 13,895,039 | 28,052,252 | 6,127,610 | 5,970,312 | 12,097,922 | 20,284,823 | 19,865,351 | 40,150,174 |

**Estimates of the population of Iraq by governorate, environment, and gender for the year 2019**

| Governorate | Urban | | | Rural | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| **Dohuk** | 491,738 | 490,602 | 982,340 | 172,987 | 171,235 | 344,222 | 664,725 | 661,837 | 1,326,562 |
| **Nineveh** | 1,188,663 | 1,132,816 | 2,321,479 | 766,896 | 739,822 | 1,506,718 | 1,955,559 | 1,872,638 | 3,828,197 |
| **Sulaymaniyah** | 938,909 | 941,433 | 1,880,342 | 171,236 | 167,616 | 338,852 | 1,110,145 | 1,109,049 | 2,219,194 |
| **Kirkuk** | 609,016 | 603,194 | 1,212,210 | 216,533 | 211,210 | 427,743 | 825,549 | 814,404 | 1,639,953 |
| **Erbil** | 801,330 | 783,412 | 1,584,742 | 159,705 | 159,161 | 318,866 | 961,035 | 942,573 | 1,903,608 |
| **Diyala** | 415,248 | 411,497 | 826,745 | 433,572 | 420,011 | 853,583 | 848,820 | 831,508 | 1,680,328 |
| **Anbar** | 468,055 | 441,403 | 909,458 | 466,089 | 442,771 | 908,860 | 934,144 | 884,174 | 1,818,318 |
| **Baghdad** | 3,694,868 | 3,602,564 | 7,297,432 | 537,328 | 505,951 | 1,043,279 | 4,232,196 | 4,108,515 | 8,340,711 |
| **Babylon** | 514,669 | 508,454 | 1,023,123 | 556,228 | 540,052 | 1,096,280 | 1,070,897 | 1,048,506 | 2,119,403 |
| **Karbala** | 421,227 | 415,089 | 836,316 | 209,748 | 204,742 | 414,490 | 630,975 | 619,831 | 1,250,806 |
| **Wasit** | 430,065 | 421,563 | 851,628 | 284,293 | 279,113 | 563,406 | 714,358 | 700,676 | 1,415,034 |
| **Salahaddin** | 372,053 | 366,221 | 738,274 | 454,972 | 443,986 | 898,958 | 827,025 | 810,207 | 1,637,232 |
| **Najaf** | 538,005 | 540,633 | 1,078,638 | 219,242 | 212,458 | 431,700 | 757,247 | 753,091 | 1,510,338 |
| **Al-Qadisiyah** | 382,178 | 376,893 | 759,071 | 285,657 | 280,303 | 565,960 | 667,835 | 657,196 | 1,325,031 |
| **ALMUthanna** | 197,013 | 191,163 | 388,176 | 222,979 | 224,642 | 447,621 | 419,992 | 415,805 | 835,797 |
| **Dhi Qar** | 691,934 | 688,282 | 1,380,216 | 387,388 | 382,734 | 770,122 | 1,079,322 | 1,071,016 | 2,150,338 |
| **Maysan** | 422,036 | 421,458 | 843,494 | 146,867 | 151,605 | 298,472 | 568,903 | 573,063 | 1,141,966 |
| **Basra** | 1,219,735 | 1,204,586 | 2,424,321 | 279,862 | 280,890 | 560,752 | 1,499,597 | 1,485,476 | 2,985,073 |
| **Total** | 13,796,742 | 13,541,263 | 27,338,005 | 5,971,582 | 5,818,302 | 11,789,884 | 19,768,324 | 19,359,565 | 39,127,889 |

**Table 3: Summary of the Results of the Regression Model**

| Model name | Equation | Parameter estimation |
|---|---|---|
| Linear model | $f(t) = \beta_0 + \beta_1 t$ | $\beta_0 = 133400, \quad \beta_1 = -321{,}1$ |
| Grade 2 polynomial model | $f(t) = \beta_0 + \beta_1 t + \beta_2 t^2$ | $\beta_0 = 11700, \quad \beta_1 = 818{,}9$<br>$\beta_2 = -13{,}4$ |
| Grade 3 polynomial model | $f(x) = \beta + \beta t + \beta t + \beta t$ | $\beta = \quad , \quad \beta = \quad \beta = -$<br>$\beta = -$ |
| Fourier model (1) | $f(t)$<br>$= a$<br>$+ a\cos(tw) + b\sin(tw)$ | $a - \quad e+ \quad , \quad a = \quad e +$<br>$b = \quad e +$ |
| Fourier model (8) | $f(t)$<br>$= a$<br>$+ a\cos(tw) + b\sin(tw)$<br>$+ a\cos(tw) + b\sin(tw)$<br>$+ a\cos(tw) + b\sin(tw)$<br>$+ a\cos(tw) + b\sin(tw)$<br>$+ a\cos(tw) + b\sin(tw)$<br>$+ a\cos(tw) + b\sin(tw)$<br>$+ a\cos(tw) + b\sin(tw)$<br>$+ a\cos(tw) + b\sin(tw)$ | $a = \quad , \quad a = -1 \quad , b = 0 \quad ,$<br>$a = - \quad , \quad b = \quad ,$<br>$a = - \quad , \quad b = \quad ,$<br>$a = - \quad , \quad b = \quad ,$<br>$a = - \quad , \quad b = / \quad ,$<br>$a = - \quad , \quad b = / \quad ,$<br>$a = - \quad , \quad b = \quad ,$<br>$a = \quad , \quad b = - \quad , w = 0 \quad ,$ |

Table 3) the value of the root of the mean squares of the error at the time of t indicates the suitability of the Fourier model (8) in terms of population change data if the RMSE is generally small, this model is good. Also, the coefficient of determination of the Fourier model (8) is acceptable among other models.

**Table 4: Summary of the results of the model**

| N | Model | $R^2$ | RMSE | $\hat{I}_{1399}$ |
|---|---|---|---|---|
| 1 | Linear model | 0.3715 | 10090 | 1252085 |
| 2 | Grade 2 polynomial model | 0.6899 | 7171 | 974633 |
| 3 | Grade 3 polynomial model | 0.6900 | 7215 | 967269 |
| 4 | Fourier model (1) | 0.6899 | 7215 | 1250368 |
| 5 | Fourier model (8) | 0.8191 | 6068 | 1072131 |

## 3. Conclusions and suggestions

The study of factors influencing economic growth has always been one of the most important and interesting issues for economists and economic policy makers in countries. So different researchers have looked at economic growth and the factors that influence it from different angles. This article attempts to consider economic growth from the perspective of demographic structure and life expectancy index.after reviewing the experimental and theoretical literature of the research, the modified model of Prescott and others (2007) was used to examine the factors influencing the economic growth of Iraq. This article uses the Harvey structural regression method (1985), which is an important and significant advantage of this modeling to pay attention to the dynamics and changes of invisible variables on economic growth. Given that invisible variables such as institutional variables and technological changes affect economic growth, these variables, along with their dynamics and developments over time, need to be considered in modeling, which Harvey's structural regression approach has this important feature. In this article, we used this approach and given the population structure of the country and the life expectancy index to try to provide a more accurate and so-called low-level explanation of economic growth in Iraq than previous models so that we can explain the role of non-observable factors alongside visible factors in economic growth.

The results of the study prove that according to the expectation of an increase in the population dependence index, it has had a negative and significant effect on economic growth, which intensifies the burden of dependence and reduces the rate of economic participation and therefore the rate of economic growth in Iraq, which is associated with various research by Bloom and et al (1998, 1999, 2007, 2010 and... Prescott et al. (2004), Manson (2001) and golly (2013) and... It's consistent. The results of the study also prove that the index of hope and growth in gross fixed capital formation had a positive and meaningful impact on economic growth.

Another important result of the study is the invisible factors in the model such as institutional-structural variables as well as technology, which allow to explain the changes in economic growth to some extent, so that the results of the implicit trend estimation proved that the movement of the implicit trend variable, which indicates the impact of the invisible factors on economic growth, was synchronized with the economic growth variable, which is the effect of the invisible factors on economic growth.co-movement of its kind is interesting and shows the undeniable impact of institutions and other invisible variables, including technological developments, on economic growth in Iraq.

It is an accurate, timely and confidential analysis with a very detailed and detailed article by the author of the article. The death of nusanat rakhdad means the change of the Iraqi society, according to which it is a good description of growth. By fitting different models to population change data, the Fourier model (8) with the lowest RMSE is the most optimal model for fitting and forecasting. This structural model shows a decreasing sinusoid. By using this model, the birth rate will continue to decrease in the coming years. Due to the increase in errors in the implementation of the model for more distant years and due to the fact that the release of the birth data is done regularly, the calculations of the model can be repeated at the beginning of each year. Also, in order to reach more accurate values and also to observe the differences in reproductive behavior, the model calculations can be done by separating the provinces. If you have access to more reliable data, you can also check the accuracy of the model's performance for years to predict the change in the population of Iraqis.

The research proposals can be summarized as follows:

1. Given the positive impact of the life expectancy index on economic growth, it is necessary for the government to pay more attention to the discussion of extensive, quality and cheap health and healthcare services in its expenditures, as well as improving the quality of public education for the unity of society.
2. Given the significant impact of invisible factors on growth such as institutional variables and technological changes, it is essential that the country's economic policymakers in development programs pay special attention to strengthening institutional variables such as work and effort culture, optimal consumption culture, strengthening social capital, promoting the spirit of participatory work and greater empathy in society.

## References


**[1]** Anderson, Bjorn (2001), "Scandinavian Evidence on Growth and Age structure", Regional Studies, Vol35, No 5, pp377-390.

**[2]** Ando, A. and Modigliani, F. (1963), The "'life cycle' hypothesis of savings: aggregate implication and tests", American Economic Review, Vol. 53, No. 103, pp55-84.

**[3]** Bloom, D. E, J. G. Williamson. (1998). Demographic Transitions and Economic Miracles in Emerging Asia. World Bank Economic Review, 12(3), pp419-455.

**[4]** Bloom, D. E., & Finlay, J. E. (1999). "Demographic change and economic growth in Asia". Asian Economic Policy Review, 4(1), pp45-64.

**[5]** Bloom, D. E., Canning, D., & Finlay, J. E. (2010). Population aging and economic growth in Asia. In The Economic Consequences of Demographic Change in East Asia, NBER-EASE Volume 19 (pp. 61-89). University of Chicago Press.

**[6]** Bloom, D. E., Canning, D., Fink, G., & Finlay, J. E. (2007). "Does age structure forecast economic growth?" International Journal of Forecasting, 23(4), pp569-585.

**[7]** Cervellati, M., & Sunde, U. (2011)." Life expectancy and economic growth: the role of the demographic transition". Journal of Economic Growth, 16(2), pp99-133.

**[8]** Fang, C., & Dewen, W. (2016). “Demographic transition and economic growth in China”. Institute of Population and Labor Economics, Chinese Academy of Social Sciences, Beijing, China.

**[9]** Harvey, A. C. (1985).” Trends and cycles in macroeconomic time series”. Journal of Business & Economic Statistics, 3(3), pp216-227.

**[10]** Harvey, A. C., & Forecasting, S. T. S. M. (2021). The Kalman filter.

**[11]** Harvey, A. C., & Koopman, S. J. (1992). Diagnostic checking of unobserved-components time series models. Journal of Business & Economic Statistics, 10(4), pp377-389.

**[12]** Kelley, A. C., & Schmidt, R. M. (1996). Saving, dependency and development .Journal of Population Economics, 9(4).pp365-386.

**[13]** Koopman, S. J., Mallee, M. I., & Van der Wel, M. (2010). Analyzing the term structure of interest rates using the dynamic Nelson–Siegel model with time-varying parameters. Journal of Business & Economic Statistics, 28(3), pp329-343.

**[14]** Lindh, T. (1999). Age structure and economic policy: The case of saving and growth. Population Research and Policy Review, 18(3), pp261-277.

**[15]** Navaneetham, K. (2020). Age structural transition and economic growth: evidence from South and Southeast Asia. Available at SSRN 1629748.

**[16]** Prskawetz, A., Kögel, T., Sanderson, W. C., & Scherbov, S. (2007). Theeffects of age structure on economic growth: An application of probabilistic forecasting to India .International Journal of Forecasting, 23(4), pp587-602.

**[17]** vanDerVen, R., & Smits, J. (2011). The demographic window of opportunity: Age structure and sub-national economic growth in developing countries. Nijmegen Center for Economics (NİCE), İnstitute for Management Research, pp11-102.

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# التحليل الإحصائي الزمني في دراسة عملية التغير السكاني

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**المستخلص**

إن العدد الأمثل للسكان والنهج السياسي الصحيح لتحقيقه يشكل اليوم مصدر قلق كبير للحكومات، وخاصة البلدان النامية. يمكن أن تشكل الزيادة غير المنضبطة في عدد السكان مجموعة متنوعة من التحديات لأي بلد. في غضون ذلك، وعلى النقيض من القيود التعليمية والصحية، فإن إحدى القضايا الأكثر أهمية التي يمكن أن يسبب التغير السكاني فيها مشكلة هي المسار الاقتصادي. وسيكون العراق دولة نامية بسبب الحرب والمشاكل التي واجهها في العقود الأخيرة. لذا قمنا في هذا المقال بدراسة تأثير التركيبة العمرية للسكان على النمو الاقتصادي وفي الفترة 2019-2021. تم استخدام السلسلة الزمنية لإجراء هذا البحث. وتشير نتائج هذه الدراسة إلى أن نسبة الاعتماد السكاني التي تدل على حالة التركيبة السكانية لها تأثير سلبي وكبير على النمو الاقتصادي.

**معلومات البحث**

**تواريخ البحث:**

تاريخ تقديم البحث:20/2/2024
تاريخ قبول البحث:12/4/2024
تاريخ رفع البحث على الموقع: 31/12/2024

**الكلمات المفتاحية:**

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