REPUBLIC OF AZERBAIJAN

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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

ECONOMETRIC MODELING OF THE EFFECT OF SOLAR ACTIVITY ON DEMOGRAPHIC AND ECONOMIC INDICATORS

Speciality: 5302.01 - "Econometrics, Economic Statistics"

Field of science: Economic sciences

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BAKU – 2022

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GENERAL CHARACTERISTICS OF RESEARCH WORK

The relevance of the topic: The complex natural and economic processes that occur in today's globalized world have a diverse range of effects on Azerbaijan's economy, which must be incorporated into the global economy. At a time when natural resources are depleting, the environment is polluted, and globalization is underway, global demographic and economic processes, as well as these processes in Azerbaijan must be closely monitored, and the quantities that determine these indicators must be prioritized.

The elements that influence demographic processes, as well as the amount of their impact, should be identified in this respect. Natural, political, and economic forces all have an impact on demographic and economic dynamics, thus there are many factors to consider. Nature and biological organisms are both affected by the solar system. Solar activity is one of the most important markers of the solar system. The different indications that characterize the solar system and its activity are known to science. These features have a mixed impact on the environment, human health, and the economy. Econometric models have been used to investigate the effect of Wolf's number on demographic and economic indicators that characterize solar activity, which is a natural factor in the dissertation.

The Earth was formed as a result of an explosion, with the minerals in the dust cloud rotating and merging in the solar system. We must understand that the sun is one of the primary causes for the earth's existence. If this is the case, then it is vital to investigate the impact of the sun on the earth's operations. The goal of the dissertation's econometric modelling of the impact of solar activity on demographic and economic processes is to reflect the complex processes and trends of demographic and economic development in the world, as well as in Azerbaijan, in the form of econometric models, so that different scenarios can be studied and effective decisions can be made. To achieve all of these objectives, econometric modelling of the impact of solar activity on demographic and economic processes is required. From this perspective, the topic's importance stems from the

fact that the studied and constructed models will allow us to follow and forecast processes to some extent.

The depth of the investigation into the problem: In general, a variety of studies on the impact of solar activity on biological creatures and economic processes are being done in modern times. Foreign scholars such as C. Juglar, A. Madison, M.M. Caldwell, L.O. Bjorn, J.F. Bornman, A. Pakhalov, A.L. Chijevski, A.D.Chertkov, V.N. Obridko, V.N. Orayevski, A.D. Sitinski, T. Rakitaki, V.Belkin researched the subject. Scholars in economics including A. Muradov, N. Hajiyev, R.A. Musayev, Y.H. Hasanli, and M.H.Najafli carried out a wide variety of study on the subject in our country.

The effect of the Wolf number, which in the dissertation characterizes solar activity, on population, births, deaths, natural disasters, marriages, divorces, and investment in economic indicators, as well as the world's population, and GDP, which are demographic indicators in Azerbaijan were evaluated using an econometric model. Conclusions were drawn after analyzing the models.

Goals and objectives of the study: The goal of the research is to use econometric models to investigate the effect of the Wolf number, which characterizes solar activity, on demographic indicators such as birth, mortality, natural increase, marriage, and divorce, as well as economic indicators such as GDP and investment.

The main objectives of the study to achieve the set goal are the followings:

- Calculate average ages, modes, medians, quartiles, quintiles, and decimals by year using algebraic mean and structural average values on the basis of age group statistics between 1959 and 2020;
- Analysis of time series of data such as Azerbaijan's population, life expectancy, marriages, and divorces;
- Construction of econometric regression models of the interaction of the average age, life expectancy and life expectancy at birth of the Azerbaijani population;
- Establishment of econometric regression models between life expectancy at birth and life expectancy and divorce with average age of the Azerbaijani population;

- Study the impact of solar activity on birth, mortality, natural increase, marriage, divorce, GDP, and investment in Azerbaijan using econometric regression models;
- Statistical examination of time series of birth, death, natural increase, and GDP as well as investment in solar activity around the world;

Object of research work: Solar activity's impact on Azerbaijan's and the world's demographic and economic indicators.

Subject of research is an econometric analysis of the impact of solar activity on global and Azerbaijani demographic and economic processes.

Theoretical and methodological basis of the research: The research's theoretical and methodological foundations are studies in this subject, foreign country experience, systematic analysis, grouping and generalization, comparison, statistical and econometric approaches in the research process.

Research database: The main information base of the research include the Solar Activity (Wolf Number) indicator from 1700 to 2020, statistical data on demographic and economic indicators in the world from 1959 to 2020, as well as in Azerbaijan. For analytical analysis and modelling, data from the State Statistical Committee of Azerbaijan, the Central Bank, and the World Bank as well as data from the official website of the information provider Quandl have been used.

The study employed empirical, statistical distribution, econometric and comparative analysis methodologies.

Scientific originality of the research: The scientific novelty of the research is as follows:

- The effect of solar activity on the primary indicators of demographic processes in Azerbaijan (natural increase, birth, and death) was examined using econometric models based on long-term statistics. Increased solar activity in Azerbaijan raises (decreases) the Wolf number, increases (decreases) the number of natural births, and decreases (increases) the number of deaths, according to the findings. The Wolf number has a higher impact on births than it does on deaths, according to our findings;

- Econometric models have been used to estimate the impact of solar activity on GDP and investment in Azerbaijan. Solar activity has a beneficial impact on GDP growth and investment;
- Econometric models were used to analyze the impact of the Wolf number, indicator of solar activity on marriages and divorces in Azerbaijan. Our findings show that an increase in the Wolf numbers has a good impact on the number of marriages and decreases the number of divorces.
- From an econometric standpoint, the impact of the Solar activity indicator Wolf number on the world population, death, births, natural growth dynamics, as well as the impact of GDP and investments has been studied. The effects' numerical value was determined, and existing econometric models were applied to forecast global population;
- The effect of the Wolf number on global investment, including the time factor, was studied using an econometric model. The model revealed that the rise in solar activity, as well as the annual change in the time factor, has resulted in an increase in global investment.
- The influence of the Wolf number on global real GDP per capita, including the time factor, has been studied using an econometric model. The model revealed that a rise in solar activity, as well as a shift in the time factor each year, has resulted in an increase in global Real GDP per capita.
- An econometric model was developed by examining the effect of the Wolf number, Solar Activity Indicator on Real GDP per capita worldwide, including the time factor. It is determined from the established model that the increase in the solar activity indicator Wolf number and time trend increases the world's GDP. However, the COVID-19 pandemic has led to a decline in the world GDP.

Theoretical and practical significance of the research: Government agencies can benefit from the research in terms of formulating and implementing demographic, social, and economic policies based on econometric models of their impact on births, deaths, natural growth, marriages and divorces, GDP, and investment, given that the Wolf number has a periodicity of 11.1 years.

Approbation and practical implementation of research work: Basic theoretical and practical results of the research have been presented in the following conferences.

1. «Fundamental and applied research, development and application of high technologies in industry and economy», St. Petersburg, Russia, December 4-5, 2014. 2014..

2. T.R.Trakya University. 16th International Econometrics, Applied Research and Statistical Symposium, 7-12 May 2015, Edirne, Turkey.

3. Ecomod Conference, July 15, 2015 - July 17, 2015, Boston College, United States.

It was discussed at the International Scientific Conference.

Publication of the main results of the research: The dissertation's main points and findings were published in 12 scholarly papers, journals, and theses.

The structure of the dissertation: An introduction (14675 symbols), three chapters (I chapters – 45183 symbols, II chapters – 58296 symbols, III chapters – 33058 symbols), results (4400 symbols), used literature, and appendices, as well as 152 computer pages, make up the dissertation. There are 36 illustrations, 3 tables, and 140 bibliographies in the dissertation.

MAIN CONTENT OF THE STUDY

The introduction establishes the topic's relevance, the problem's level of study, the object and subject of research, theoretical and methodological foundations, methods of analysis, source of information, scientific novelty, practical significance, and explains the goals and objectives, as well as their approval and structure.

The dissertation's **first chapter** is called "Theoretical and methodological elements of solar activity's impact on demographic and economic indicators". This chapter delves into the statistical study of age group dynamics, solar activity and its characteristics, theoretical and methodological issues, and the key components of econometric assessments of solar activity's impact on demographic and economic indicators.

Data on the entire population of the Republic of Azerbaijan for 1959-2020 by age and age groups was taken from the Statistical Committee's statistical collection entitled "Demographic Indicators" and evaluated using statistical methods in this chapter. In this analysis, the numbers of the structural average quantities of the age groups of the population (*mode, median, quartile, quintile, decile*), decile coefficient characterizing the income differentiation of the population (K_D), an ordered starting moment that coincides with the algebraic mean (k=1), sigma, m_3, a_3 (asymmetry), m_4, a_4 (kurtosis) was calculated and analyzed.

The study of solar activity has piqued the interest of scientists for a long time. The reason for this is that the sun has a significant impact on the world and human life. Increased solar activity excites the earth's magnetic surface, which has an impact on not just gadgets (which might cause technical accidents), but also people's physical and mental health. The number of persons who commit themselves at the peak of solar activity, for example, is on the rise. Crop yields, death, birth, and other activities are all affected by solar activity.

For man, the space has always been enigmatic and fascinating. Man has attempted to explore this endless space, and his efforts are still ongoing. Many people still believe in the absolute effect of space processes on earthly processes. To further understand this, the

question “Do events in the space effect happenings on Earth?” must be answered. Before we get to this point, it is important to look at how the universe (galaxies), the Earth, and the other planets in the solar system came to be and how old they are. The answers to these questions help to clarify the answer to the first question to some extent.

The universe is about 12-14 million years old, and the Earth and other planets in the solar system are about 4.7 million years old. The spinning and compression of gas clouds resulted in the formation of these planets. The explosion of nearby stars was most likely the main force behind this event.

Droplets occurred as a result of nuclear explosion reactions, attracting dusty substances in the environment under the effect of the shock wave travelling from the centre and the gravitational field. The centre regions of the clouds with the highest density have, of course, turned into protons. High-intensity and various wavelength radiation energy was emitted as the value of gravitational pressure in the droplets reduced and the atomic nuclear moved closer together as a result of powerful nuclear reactions. The proton star blazed brightly, and the true star was called “Sun”. The sun at its youngest age was in the centre, surrounded by a cloud of dust and gas created by the explosion. Small mineral particles began to develop as the cloud cooled.

Other planets develop compactly around the sun after a period of time. Planets created from high-density matter approach the sun closer, while planets formed from low-density gaseous stuff orbit the sun at a greater distance. These gaseous planets began to shrink under the effect of gravity during a two-million-year period, resulting in the formation of around ten planets in the solar system.

Neutrons, protons, electrons, and their nuclear have all gathered in the environment as a result of this massive explosion.

The sun has a mass of 330,000 times that of the earth. The Earth is 149.6 million kilometres away from the Sun. The sun has a radius of 696,000 kilometres, which is 109 times that of our planet. The sun is made up of 73 percent hydrogen, 25% helium, and 2% heavier components. The sun is sufficiently massive under the influence of gravity that nuclear processes turn hydrogen atoms into helium atoms.

A considerable amount of energy is released in this instance. Radiation and subsequently convection are used to release this energy to the outside surface. The high-density outer layer of the sun serves as a protective layer that regulates nuclear reactions. The sun's nucleus, which acts as a massive thermonuclear reactor, illuminates and heats the solar system's planets, including the earth. The solar nucleus achieves a temperature of 15 million degrees Celsius. The photosphere is the visible surface of the sun. Because of the resulting magnetic field, the photosphere is continually changing. Nuclear particles generate solar "spots" in the photosphere, the visible component of the sun, which fade away over time due to polarization.

Space particles spiral to form a strong electric current between the earth's north and south poles along the equator. This elliptical electric current, in turn, induces a magnetic field that grows stronger as it approaches the poles.

The earth's magnetic field becomes stronger as the magnetic field of the "spots" generated in the sun becomes stronger. This field, formed by particles from the sun, reduces the earth's magnetic field when it is in the opposite direction, and increases it when it is in the same direction. The Earth's rotation around the sun follows an elliptical path. The epileptic plane is the plane that cuts this ellipse. Because the earth circles about its own axis and the sun at different rotational speeds, there is summer on the side facing the sun and winter on the other throughout its travel in the new orbit. The sun appears at its zenith at the equator during the summer and fall equinoxes. This corresponds to the spring equinox on March 20-21 and the autumn equinox on September 22-23 (Equinox in the fall). The sun is at its peak in the northern tropics on the summer solstice (June 22-23), hence it is summer in the northern hemisphere and winter in the southern hemisphere. The sun is at its peak in the southern tropics on the winter solstice (December 21-22), resulting in winter in the northern hemisphere and summer in the southern hemisphere. Magnetic "storms" occur on Earth during 11.1-year cycles of solar activity, depending on the period of rotation of the sun. Magnetic winds are at their strongest around February-April and October-December. This is due to the earth's rotation bringing it closer to the sun.

When solar activity peaks, the amount of particles (electrons, protons, gamma quanta, and other particles) entering the Earth's atmosphere from space increases, causing changes in living creatures' biological and physiological parameters. The resilience of erythrocytes in the blood to external impacts reduces with solar activity, as does the 21-component value of the blood. The rate of blood flow fluctuates over time as a result of changes in blood pressure. Adrenaline secretion, hemoglobin concentration, blood oxygen capacity, and erythrocyte sedimentation rate are all affected to some extent by solar activity. Rhythmic processes occur in all living species in the natural world. Biological rhythm is a peculiar phenomenon as well as an inseparable internal property of living beings. About 600 morphophysiological markers in the human body alter during biorhythms, according to research.

In the cell, the size and quantity of internal organelles, the rate of metabolic activities (protein production, enzyme and hormone activity), and the rate of cell division all fluctuate on a regular basis. All organs and organ systems have biorhythms. Changes in the frequency of organs operating at different frequencies are likewise affected by biorhythms. The frequency of biorhythms is even affected by the organism's geographic location. As a result, the physical coordinate system of time and space has an impact on biorhythms. When living things go into space, the application of Einstein's general theory of relativity expresses itself in the shift of biorhythms.

Biorhythms are a universal physiological parameter that can be found across the biosphere. Biorhythms are the patterns that biological processes or events follow across time. Biorhythms are a self-contained, self-sustaining mechanism. Endogenous rhythms are influenced by exogenous rhythms. The nature and speed of messages conveyed to organisms are affected by solar activity. These occurrences are influenced by the frequency of the electromagnetic and gravitational fields, as well as their intensity. The solar system has an evident impact on nature and living organisms.

Light quanta that fall on the organs of vision and pass through the labour affect the activity of the pineal gland in the brain. It is well

known that the synthesis of melaton, a neurotransmitter produced by the pineal gland, increases during night and decreases throughout the day. A group of neurosecretory cells that form suprahasmatic nuclei on the right and left sides of the hypothalamus surface govern the manufacturing of the hormone melotone. These nuclei are found above the point where the optic nerves meet. The visual organs provide information about night and day to these nuclear. Melotonin secretion is synchronized with biorhythms on a daily basis. The bioactivity of these nuclei changes cyclically 10 times in 24 hours and 19 minutes, according to rat studies. It was discovered that when metabolic activities in the body diminish at night, the activity of neurons reduces and the release of the hormone melotonin increases by infusing tagged radioactive dioxyl glucose into the body. During the day, on the other hand, metabolic activities in the body become more intense, and neuron activity rises, reducing melotonin release. Biorhythm is simultaneously tied to rhythmic fluctuations in melotonin levels. Supraxasmatic nuclei play the role of both controllers and pacemakers in the control of biorhythms in the body. Under the influence of cosmic rays, the activity of neurons in the supraxasmatic nuclei of the hypothalamus appears to vary. In addition to these markers, melotanin is the body's strongest antioxidant, protecting DNA and other cell structures from damage by neutralizing chemical radicals. This feature of melotanin can be used to help extend the lives of living organisms by strengthening their immune systems.

All physical and chemical processes in the sun and galaxy have a significant impact on the Earth and other planets, we conclude. Small amounts of radiation, UV rays, visible light rays, and high and low frequency electromagnetic waves, for example, have a unique influence on Earth's living organisms. External-exogenous variables have an impact on living organisms' internal-autonomous rhythms, which may be seen in all spheres of tissue and cell structure elements. Depending on the intensity of the particles generated by the magnetic field and shock waves caused by different reactions in the solar system, different cataclysms occur in nature.

Changes in solar activity generate changes in a number of indicators that reflect population development on a regular basis (natural growth,

migration, marriages, divorces, life expectancy at birth, etc.). On the other hand, the natural environment, as well as the solar element, has a significant impact on the demographic process, particularly population increase, in addition to national and socioeconomic considerations. Clement Juglar, a nineteenth-century French physician, concluded that there were regularities, or rather periodicity, in the statistics of births, deaths, and marriages across time. Other socio-economic processes have ups and downs as a result of periodicity (increases and declines) in demographic processes. Solar activity has a substantial impact on demographic dynamics. Science is already aware of the solar activity's periodicity (11-12 years).

Following that, theoretical and methodological issues relating to the impact of the Wolf number on human health and the economy, as well as theoretical issues of econometric modelling in this direction, were investigated, providing information about the solar system and indicators describing its activity. Rudolf Wolf (July 7, 1816 – December 6, 1893) was a well-known Swedish astronomer and mathematician who specialized in sunspot study.

Wolf made extensive use of Schwab's findings, not only making observations but also collecting possible data on sun spot activity until 1610, calculating an 11.1-year periodic period. He proposed a method for measuring the activity of sunspots in 1848. Wolf numbers, as they are now known, continue to be utilized. The sun's "spots" are caused by powerful nuclear reactions and explosions. Elementary particles and radiation are discharged into the environment as a result of the intensity of these "spots". Temperature changes in the sun convey radiation of various wavelengths via the atmosphere to the galaxy, including the Earth, and have a significant impact on radio, telephone, and transmission stations, affecting extra, circular currents on Earth. Protuberances are another type of solar activity. Protuberances are types that comprises of huge goose-shaped loops and threads. Protuberances are gaseous particles that are emitted by a source. Solar "spots" are regular and are formed in accordance with 11.1; 23; 600; 1800; 5400 years. Figure 1.5 shows a graph of periodic changes in solar activity between 1700 and 2020.

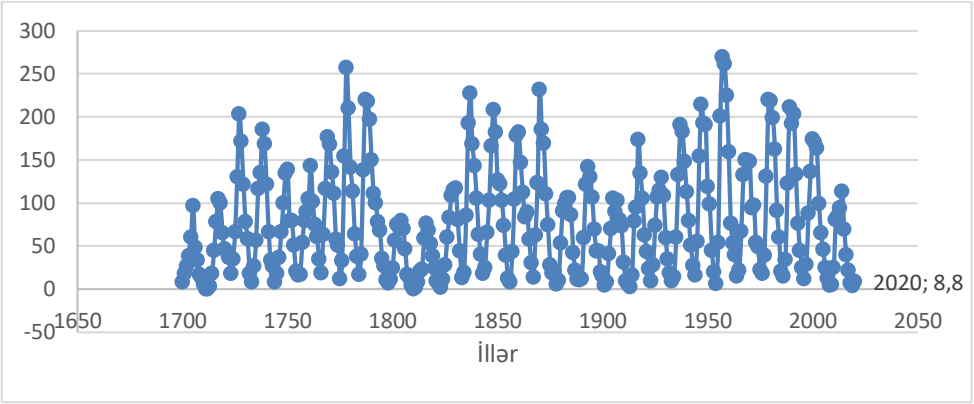

Figure 1: Dynamics of solar activity, with Wolf's number (1700-2020)

The intensity of radiation and other wavelengths entering the Earth changes on a regular basis, according to this action. Every 7,500 years, the Earth's magnetic poles reverse orientation.

Wolf's number peaked in 1958, as shown in Figure 1, with a frequency of roughly 11.1 years.

In light of the foregoing, econometric models of the impact of solar activity on the dynamics of Azerbaijan's population through time, including the number of deaths, births, natural increases, marriages, and divorces, have been developed. Furthermore, the interrelationships between indicators such as average age, life expectancy, life expectancy at birth, and the number of divorces per thousand individuals have been reflected in econometric models. In the dissertation, the following forms are frequently employed in econometric modelling. In theory, four versions of the regression equation specification are extensively employed in econometric modelling. To put it another way, regression models can take the following shapes:

$$Y=C(1)+C(2)*X+u\ , \qquad \textit{(Linearly shaped)}$$

Here, Y- explained variable, X- explanatory variable, u- random limit, C(1) and C(2) -parameters. C (1) - is a constant factor, characterizes the effect of *C (2)*- explanatory variable (X) to explained

variable. In other words, the unit change of X changes the explained variable (Y) to the unit C (2).

$$Ln(Y) = C(1)+C(2)*X+u\ , \qquad \textit{(Logarithmic-linear)},$$

Here, C (2) the coefficient is interpreted as follows: Indicates that the unit variable of X (in its own unit) changes the explanatory variable (Y) to C (2)*100 percent. Note that this interpretation is true at very small values of the coefficient C (2). Otherwise, EXP (C (2)) needs to be calculated and interpreted.

$$Y=C(1)+C(2)*Ln(X)+u\ , \qquad \textit{(Linear-logarithmic)}$$

Here, C (2) the coefficient is interpreted as follows: Shows the change in the 1% change in X from the explained (Y) variable to C (2) / 100 (with the unit Y).

$$Ln(Y) = C(1)+C(2)*Ln(X)+u\ , \qquad \textit{(Logarithmic-logarithmic)}$$

Here, C (2) the coefficient is interpreted as follows: The explanatory 1% change of X indicates the C (2) percentage change of Y, which is explained.

Note that all four of the above are nonlinear with respect to the variable (except for the first form) but linear with respect to the parameters. Therefore, it can be easily parameterized by the Ordinary Minimum Squares Method.

The impact of the Solar Activity (Wolf Number) indicator on births, deaths, natural increase, number of marriages and divorces, world population, births, deaths, natural increase, which are demographic indicators in Azerbaijan, between 1700 and 2020, is the research's main data source. Simultaneously, econometric models based on the impact of real GDP, investment, world GDP, and investment, all of which are economic indicators in Azerbaijan, have been developed. Furthermore, econometric models of the relationship between the dynamics of Azerbaijan's population over time and

average age, life expectancy at birth, and the number of divorces have been established and investigated.

$$DOG = c(1) + c(2) * GA + u\,, \quad (1)$$
$$OLEN = c(1) + c(2) * t + c(3) * GA + u\,, \quad (2)$$
$$TA = c(1) + c(2) * GA + u\,, \quad (3)$$
$$MNS = c(1) + c(2) * GA + u\,, \quad (4)$$
$$MBS = c(1) + c(2) * LOG(GA) + u\,, \quad (5)$$
$$LOG(RUDM) = C(1) + C(2) * LOG\big(GA(-11)\big) + C(3) * @TREND\,, \quad (6)$$
$$LOG(IN) = C(1) + C(2) * LOG(GA(-11)) + C(3) * @TREND\,, \quad (7)$$
$$LOG(DE) = C(1) + C(2) * LOG(GA) + C(3) * @TREND\,, \quad (8)$$
$$LOG(DEDS) = C(1) + C(2) * LOG(GA)\,, \quad (9)$$
$$LOG(DEOS) = C(1) + C(2) * LOG(GA)\,, \quad (10)$$
$$DETA = C(1) + C(2) * GA\,, \quad (11)$$
$$LOG(D\_UDM) = C(1) + C(2) * LOG\big(GA(-11)\big) + \\ +C(3) * COVID19 + C(4) * @TREND\,, \quad (12)$$
$$LOG(D\_IN) = C(1) + C(2) * LOG(GA(-10)) + C(3) * @TREND, \quad (13)$$
$$LOG(ABRDUDM2015) = C(1) + \\ +C(2) * GA(11) + C(3) * @\mathrm{TREND} + u, \quad (14)$$

Here, GA - solar activity (W*olf number*), DOG – Number of births per thousand people in Azerbaijan, $OLEN$ - The number of deaths per thousand people in Azerbaijan, TA - Natural increase of the population of Azerbaijan per thousand people, MNS - the number of marriages per thousand people, MBS - the number of divorces per thousand people, $RUDM$ – Real GDP in Azerbaijan, IN – Investment in Azerbaijan, DE - world population, $DEDS$ - the number of births per thousand people in the world, $DEOS$ - the number of deaths per thousand people in the world,$DETA$ – natural increase per thousand people in the world, D_UDM – world GDP, $COVID19$ - Covid-19 pandemic, D_IN – world investment, $ABRDUDM2015$ – Real Gross Domestic Product per capita around the world (With stable prices in 2015), $@TREND$ – time indicator, LOG - The logarithm based on the of the corresponding indicator in the Eviews system, u - shows random deviations. Given the 11.1-year periodicity of the Wolf number, the

Wolf number is included in models such as GA (-11). $C(1)$, $C(2)$, $C(3)$ and $C(4)$ are parameters of the model.

Our aim in this dissertation work is to conduct as well as establish of theoretically based econometric models that reflect the interaction between the above-named indicators in Azerbaijan, and the suitability of the models. The following tests were applied for the analysis and forecasting in the dissertation: (Determination coefficient (R-squared), Determined coefficient of determination (Adjusted R-squared), the cost of Fisher statistics (F-statistic), Durbin-Watson (Durbin-Watson stat), standard errors in parameters, t-statistics). The models studied in the dissertation were constructed in the form of linear regression equations and the parameters were determined.

The dissertation's **second chapter** is called "Econometric examination of the impact of solar activity on a range of demographic and economic indicators". The impact of solar activity on the dynamics of mortality, birth, natural increase, marriage, and divorce, as well as the impact on economic indicators like GDP and investment, were econometrically analyzed in this chapter.

The following are the findings of using relevant data to implement solar activity dynamics, econometric models of the dynamics of indicators characterizing the number of births, deaths, natural increase, marriages, and divorces in Azerbaijan in the Eviews 9 Application Program Package (TPP).

Solar activity (GA) dynamics of birth in Azerbaijan (DOG), death (OLEN), natural growth (TA) Econometric models of the impact on the dynamics:

$$DOG = 22.45739 + 0.017466*GA, \quad (15)$$

s.s. (5.426844) (0.009064)
t-test: (4.138205) (1.926984)
p-probability: (0.0001) (0.0577)
R-squared=0.925959, DW=1.993346

$$OLEN=19.3933171582-0.0969047828163*@TREND-0.00991038731796*GA, \quad (16)$$

s.s. (1.553202) (0.012809)(0.004331)
R-squared=0.836420, DW=1.542197

$$TA = 15.28974 + 0.026611*GA, \quad (17)$$

s.s. (3.668396) (0.013654)

R-squared=0.827836, DW=1.959713

Here, @TREND – shows the tradition (trend) of the time. The numbers in parentheses under the parameters are the standard error of the values found in the parameters, respectively (s.s.), student's t-test and probabilities. R-squared-determination coefficient, DW- The first is the Darbin-Watson statistic, which shows the autocorrelation of residues.

(15-17) The main statistical characteristics of regression equations and other relevant tests have shown that (15) - (17) econometric models are adequate.

Thus, in Azerbaijan, solar activity (Wolf number) has a favourable impact on the number of births and natural increases per 1,000 people, but a negative impact on the number of deaths. Every year, the number of deaths due to the passage of time, or rather the passing of tradition decreases by about ten people per thousand.

The dynamics of solar activity in Azerbaijan per thousand people (MNS) and econometric models of the impact on the dynamics of divorce (MBS):

$$MNS = 7.953629 + 0.006611*GA, \quad (18)$$

s.s. (0.841826) (0.002793)

t-test: (9.448072) (2.367215)

p-probability: (0.0000) (0.0204)

R-squared=0.781682, DW=1.550351

$$MBS = 0.138364430025*LOG(GA), \quad (19)$$

s.s.(0.036948)

t-test: (3.744843)

p-probability: (0.0004)

R-squared=0.563530, DW=1.185525.

(18) - (19) According to the results of econometric models, a one-unit increase in the number of Wolf increases the number of weddings and divorces per 1,000 inhabitants in Azerbaijan by around 0.007 and 0.0014 units, respectively. The number of weddings per 10,000 people in Azerbaijan increases by around 7 units, and the number of divorces

per 100,000 people increases by roughly 14 units, when the number of Wolf, which characterizes solar activity, increases by 10 units.

Solar activity and time dependence econometric model of Real GDP in Azerbaijan:

$$LOG(RUDM) = -18.659 + 0.09*LOG(GA(-11)) + 0.09*@TREND + [AR(8)=-0.67] \quad (20)$$

s.s. (2.204)(0.054440)(0.006654)(0.158152)
t-test: (-8.463)(1.653090)(13.43995)(-4.260149)
p-probability: (0.0000)(0.1113)(0.0000)(0.0003)
R-squared=0.934981, Adjusted R-squared=0.924145, DW=0.578748.

To achieve adequacy, the 8th order autoregression factor (AR (8)) is incorporated in model (20). The Wolf number is included in the model as GA because of its 11.1-year periodicity (-11). The results of model (20) reveal that a 1% increase in the Wolf number raises real GDP by 0.09 percent in Azerbaijan, while real GDP rises by 9% over time.

Econometric model of investment (IN) Solar activity and time dependence in Azerbaijan:

$$LOG(IN) = -24.8752049 + 0.102876555*LOG(GA(-11)) + 0.109335*@TREND \quad (21)$$

s.s.(3.073785)(0.043089)(0.009619)
t-test: (-8.092696)(2.387542)(11.36603)
p-probability: (0.0000)(0.0306)(0.0000)
R-squared=0.902312, Adjusted R-squared=0.889287, DW=0.939249.

(21) According to the model, a 1% increase in the number of Wolfs will result in a 0.1 percent rise in the volume of investments in Azerbaijan, while actual investment will increase by 10.9 percent over time. The Wolf number is included in the model as GA because of its 11.1-year periodicity (-11).

The third chapter of the dissertation is called "Econometric modelling of the impact of solar activity on a range of demographic and economic indicators around the world". The impact of solar activity dynamics on global population, mortality, birth, natural growth dynamics, and the impact of economic indicators on GDP and investment have all been econometrically analyzed in this chapter, with the following results using the Eviews 9 Application Program Package (TPP).

Econometric model of the impact of solar activity on the dynamics of the world population (DE):

LOG (DE) = 10.60772+0.0087611552*LOG(GA)+0.0165480*@TREND, (22)
(S.S): (0.063572) (0.003764) (0.000200)
t-test: (166.8615) (2.327443) (82.59003)
p-probability: (0.0000) (0.0229) (0.0000)
R-squared=0.990890; Adjusted R-squared=0.990622

Birth in the world of solar activity dynamics (DEDS), death (DEOS), natural growth (DETA) Econometric models of the impact on the dynamics:

LOG (DEDS) = 3.05399105887 + 0.0571038640911*LOG (GA(11)),(23)
(S.S.): (0.085391) (0.057104)
t-test: (35.76469) (2.741035)
P-probability: (0.0000) (0.0086)
R-squared=0.135342; Adjusted R-squared=0.117328

LOG (DEOS) = 2.12472977633 + 0.0502892761531*LOG(GA(11)) , (24)
(S.S.): (0.094151) (0.022970)
t-test: (22.56722) (2.189334)
p-probability: (0.0000) (0.0335)
R-squared=0.090792; Adjusted R-squared=0.071850

DETA=12.9682456191+0.030905239834*GA(11)+[AR(11)=0.736670658934], (25)
(S.S.): (1.050034) (0.008366) (0.162912)
t-test: (12.35031) (3.694164) (4.521890)
p-probability: (0.0000) (0.0007) (0.0001)
R-squared=0.520036

The armament of Wolf number also raises the number of births, deaths, and natural rises per capita around the planet, according to models (23) - (25) Natural growth, on the other hand, had a beneficial impact on the number of births since it had a greater impact on the number of deaths than the number of births. The Wolf number is included in the model as GA because of its 11.1-year periodicity (11).

World GDP (D_UDM) Solar activity, COVİD19 econometric model of pandemic and time dependence:

LOG(D_UDM)=-6.898+0.037*LOG(GA(-11))-0.164*COVID19+0.057*@TREND , (26)
s.s. (0.493248)(0.018091)(0.116888)(0.001541)
t-test: (-13.98425)(2.042291)(-1.400499)(37.25908)
p-ehtimal: (0.0000)(0.0481)(0.1695)(0.0000)

R-squared=0.975764, Adjusted R-squared=0.973851, DW=0.373146.

(26) Reveals that a 1% increase in the Wolf number raises global GDP by 0.0375 percent and the time trend by 0.057%. The COVID-19 pandemic, on the other hand, has resulted in a 16.4% drop in global GDP.

Investments around the world (D_IN) Econometric model of solar activity and time dependence:

LOG(D_IN) = -24.105021 + 0.2114291*LOG(GA(-10)) + 0.1215169*@TREND , (27)
s.s.(1.327297)(0.060602)(0.004240)
t-test: (-18.16098)(3.488810)(28.65653)
p-ehtimal: (0.0000)(0.0011)(0.0000)
R-squared=0.946353, Adjusted R-squared=0.944070, DW=0.486641.

(27) According to the model, a 1% increase in Wolf raises global investment by 0.2114291 percent, while the time trend increases by 12.2 percent.

Real Gross Domestic Product per capita around the world (ABRDUDM2015) Econometric model of the effect of solar activity:

LOG(ABRDUDM2015)=3.843574 + 0.000167*GA(11) + 0.017069*@TREND , (28)

(S.S.):	(0.102681)	(0.00007)	(0.000363)
t-test:	(37.43228)	(2.113222)	(47.05663)
p-probability:	(0.0000)	(0.0402)	(0.0000)

R-squared=0.981554; Adjusted R-squared=0.979915
F-statistic=598.6528; Prob (F-statistic)= 0.000000

Model (28) reveals that a 1% increase in the Wolf number raises global per capita GDP by 0.000167%, while the time trend rises by 1.7 percent.

The main results obtained in the dissertation are as follows:

1. In Azerbaijan, each unit increase in solar activity (Wolf number) raises the number of births per 1,000 people by 0.017466. To put it another way, the number of births per million people rises by around 17 persons.
2. Time and solar activity are negatively related to the number of deaths per 1,000 people. The number of deaths per 100,000 people lowers every year.
3. Each unit increase in solar activity boosts natural population by around 27 individuals per million. Increased or decreased solar

activity has a significant impact on the number of births, deaths, and natural population growth per 1,000 people.

4. An increase of 10 units in the number of wolves, which is a measure of solar activity, results in an increase of around 7 units in the number of weddings per 10,000 people in Azerbaijan. Even in the absence of solar activity, the minimum number of weddings per 1,000 people is 7.9.
5. An increase of one percent in solar activity raises the number of divorces by roughly 14 per 100,000 individuals.
6. A 1% array of wolf numbers increases real GDP by 0.09 percent in Azerbaijan, whereas real GDP increases by 9% over time.
7. A 1% rise in Wolf numbers increases investment by 0.1 percent in Azerbaijan, whereas investment security increases by 11% over time.
8. A 1% decrease in the number of wolves increases the global population by around 0.009%, while the time factor increases by 1.1 percent per year.
9. An increase of one percent in the number of wolves increases the number of births per 1,000 people by 0.059 percent, or in other words, an increase of one hundred percent in the number of wolves increases the number of births per 1,000 people by 5.88 percent.
10. A rise of one percent in the number of wolves, a solar activity indicator, increases the number of deaths per 1,000 people globally by around 0.052 percent. To put it another way, a 100 percent rise in the number of Wolfs increases the global death rate by around 5.2 percent per thousand people.
11. Each unit of solar activity increases 0.03 units to the natural increase in the world's population per 1,000 people. In other words, a 100-unit rise in Wolf equals a natural increase of 3 individuals per 100,000.
12. A 1% decrease in solar activity increases global GDP by 0.037 percent, while the time factor increases global GDP by 5.7 percent annually. Since 2019, the COVID-19 pandemic has resulted in a 16.4 percent drop in global GDP.
13. A 1% decrease in solar activity increases worldwide investment by 0.21 percent, while the time factor increases global investment by 12.1% each year.

14. A 1% decrease in solar activity increases Real GDP per capita by 0.0167 percent, whereas the time factor increases Real GDP per capita by 1.7 percent each year.

The main content of the dissertation was published in the following works:

1. Yadulla Həsənli, Nizami İsmayılov "Azərbaycanda Demoqrafik Proseslərə (Təbii Artim, Doğum, Ölüm) Günəş intensivliyinin Təsirinin Ekonometrik Modelləşdiilməsi". Əmək və sosial problemlər, Elmi əsərlər toplusu, №3(11), 2012, səh.24-32.
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AMEA-nın Xəbərləri “İqtisadiyyat” seriyası 2015-1 (yanvar-fevral). Bakı 2015, səh.11-16.
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The defense will be held *on "20" may 2022* at FD 1.11 Dissertation council of Supreme Attestation Commission under the President of the Republic of Azerbaijan operating at Azerbaijan State University of Economics.

Address: AZ 1001, Baku, Istiglaliyat street 6

The dissertation is accessible at the Azerbaijan State University of Economics Library.

Electron versions of dissertation and its abstract are available on the official website of the Azerbaijan State University of Economics.

Abstract was sent to the required addresses on *"19" april 2022.*

Signed for print: 16.04.2022
Paper format: 60x84 1/16.
Volume: 17/04. Number of hard copies: 20
(33897 Symbols)

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