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Identifying Regional Foci of Potential Geopolitical Activity on the Basis of Demographic Scale Effect

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Abstract. Within the framework of the article, we assess regions and countries that in the future may become new foci of economic and civilizational activity. This issue is relevant because many countries are now witnessing the exhaustion of demographic growth opportunities, which in turn will hinder intensive economic growth in them. To address the issue, we propose a two-stage econometric modeling procedure. The first econometric dependence links population growth rate with total fertility rate, and the second dependence reveals the impact of economic, institutional and cultural factors on fertility rate. Empirical testing of models was performed for a sample of 15 countries (Russia, Ukraine, Kazakhstan, Kyrgyzstan, France, Germany, Iran, Japan, China, Mexico, Egypt, Great Britain, USA, Canada and Australia) and showed high productivity and invariance of the proposed model scheme. Based on the constructed models, we put forward several quantitative characteristics of national demographic regimes. The most important

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of them is the long-term demographic effect of scale, taking into account the reaction of the population to the growth of per capita welfare. Applied calculations show that the U.S. still has the potential to maintain its growth regime for quite a long time, while China, Japan and Germany have almost exhausted this resource. The most likely foci of a new round of development of human civilization may be Russia, Kazakhstan and Iran, which, taking into account neighboring countries, form a kind of regional cluster in the center of Eurasia. It is in this area of the planet that we should expect the greatest economic and political activity in the next two to three decades.

Key words: economic growth, demographic regime, birth rate, econometric model.

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Introduction

The year 2022 witnessed the onset of an active phase of de-globalization with its inherent geopolitical turbulence. During this period, many countries that are more or less under pressure exerted by the world hegemon (the United States) are beginning to use the increasing uncertainty for defending their political sovereignty and strengthening their geopolitical and economic positions. The world's former monocentricity is being replaced by multipolarity, as new regional centers of power are emerging. The countries that will manage to "ride" the wave of changes will later exit the periphery and semi-periphery and join a group of states at the core of the world economic system. And vice versa – some core countries may find themselves on the sidelines of world history. In this regard, new national geopolitical strategies based on available civilizational advantages in the context of international confrontation are becoming particularly relevant. Russia, which finds itself in the epicenter of global events, is facing the most urgent need for a new geopolitical course.

The unfolding events highlight with unprecedented clarity the importance of the size of countries, because only large ones will be able to take a worthy position on the world stage. In turn, the size of the country is traditionally expressed by two parameters –territory and population. All other economic indicators are derived from these two, so there emerges a new round of competition for two fundamental parameters. Today, the old consensus on national borders is already being denied and processes are being launched to revise them. This has happened in Iraq, Syria, Georgia, Armenia and Azerbaijan, it is happening in Ukraine; many Eastern European nation-states engage in covert fighting for part of western Ukraine, Transdniestria and even Moldova. On the other hand, the demographic factor has already fully manifested itself: the most populated territories – China, India and the USA – are the most powerful countries. It is already quite clear that in the future the increase in a country's power will largely be determined by its reserves in the development of the territory and population growth. However, the situation is complicated by the fact that in relation to the first and second factors, many countries have already completely or almost completely exhausted their potential. At this point of analysis lies a research intrigue: which countries and which regions of the world still retain the potential of demographic and economic activity. In this regard, the goal set in the article is to identify regional foci and countries that

preserve civilizational development potential. The methodology of our study is based on constructing econometric models of population growth, determining reproduction regimes established in different countries, and assessing the demographic scale effect indicator designed for these purposes.

The aim of the study involves solving the following tasks: formally determine the demographic effect of scale using econometric models; construct indicators of demographic regimes based on the constructed models; carry out applied calculations using the models based on data for 15 countries; determine the potential of future economic growth for the counties under consideration.

Review of the literature and key ideas

The volume of literature on demography is truly limitless; therefore we will focus only on certain milestones of this scientific direction.

Apparently, the first step in the creation of the population theory was the historical work of Th. Malthus (Malthus, 1992), according to which the supply of income decreases due to delaying marriage (preventive checks) and increasing the death rate (positive checks) due to lower wages. However, the simplest Malthusian model poorly described the real course of subsequent events, and the next milestone in the description of economic growth was R. Solow's neoclassical model (1956), in which the role of regulator of economic activity shifted to capital and the rate of accumulation. Despite the differences in the initial assumptions of the Malthusian and neoclassical models, the mechanisms they describe are very similar. G. Becker showed quite clearly that in the above models there is a kind of symmetry of the mechanisms that restore economic equilibrium: if in the neoclassical model the capital ratio exceeds the equilibrium level, then the rate of return decreases and weakens the incentives to invest, thereby contributing to the return of capital ratio to its original equilibrium; if in the Malthusian model wages exceed the equilibrium level, then this stimulates population growth, which, in turn, causes a shortage of investments and restores the initial wage and capital endowment (Becker, 1988). Subsequently, the population theory was enriched with the concept of human capital, which became a new milestone in the study of economic dynamics (Becker, 1988).

A different line in the study of population dynamics can be seen in the works of S.P. Kapitsa, who built a phenomenological theory of human growth based on a simple dependence of population size on time in the form of a diffusion differential equation, the solution of which is provided by specific functions: logistic function and cotangent (Kapitsa, 2009). Despite careful calibration, Kapitsa's model does not include any growth factors, and therefore provides a very primitive explanation for the mechanism of expansion of human population. In this sense, the Kapitsa model has extremely limited usage – for tracking population growth on a global scale and over a very long time interval with its subsequent stabilization.

Malthus' ideas were further developed in the models describing the functioning of an ecological and economic system with the participation of the population and its resource-ecological basis (Lee, 1980; Wood, 1998). Recently, interesting models of this type have been built by P.V. Turchin, who considers the dynamics of the elite (consumers) and commoners (producers) against the background of state resources (budget) (Turchin, 2020). Turchin's models are distinguished by the fact that they undergo careful calibration on historical data and are already being used to forecast large-scale political upheavals (Turchin, 2023).

In addition to the above population models, which are focused on revealing historical patterns over long time intervals, there exist a number of more specific model developments with an emphasis on identifying human population growth factors over shorter time intervals. Here the list of

indicators acting as determinants is quite extensive and diverse and includes both external (global) and intracountry factors (Biryukova, Kozlov, 2023). In particular, global factors that have a reactive effect on population decline include various kinds of epidemics and pandemics, mass migration, military conflicts and natural disasters. For example, according to the World Health Organization, the number of deaths from coronavirus infection amounted to 6.9 million people[1], and the latest earthquake in Türkiye in 2023 alone reduced the population by more than 50 thousand people[2]. Studies of epidemiological shocks have shown that they can have a delayed effect and affect not only demography (Boberg-Fazlic et al., 2021; Chandra, Yu, 2015; Rangel et al., 2020), but also other spheres of human life – from the economy (Karlsson et al., 2014) and education (Percoco, 2016) to the level of public trust (Aassve et al., 2020) and the impact of stressful situations experienced in childhood on demographic indicators in the future (Noghani-Behambari et al., 2020; Johnson et al., 2020). Currently, a large number of works consider the impact of the COVID-19 pandemic on demographic aspects, but it is too early to draw unambiguous conclusions, since measures to counteract the pandemic itself in many countries were combined with unprecedented socio-economic support, which makes it difficult to determine its consequences (Vakulenko et al., 2022; Kazenin, Mitrofanova, 2023; Emery, Koops, 2022; Sobotka et al., 2022).

The range of internal demographic factors is represented by a fairly extensive list, including the influence of economic and social aspects (Semeko, 2021; Khasanova, Zubarevich, 2021; Butz, Ward, 1979; Sobotka et al., 2011; Dzhioev, Caberty, 2021; Aassve et al., 2020; Charles-Edwards et al., 2021; Ullah et al., 2020), and a wide palette of cultural cross-section, which can include the institution of family (Arkhangelskiy, Zayko, 2022; Bessonova, 2020; Ibragimova, Ildarkhanova, 2021; Galoyan et al., 2021), religion (Buber-Ennser, Berghammer, 2021; DeRose, 2021; Herzer, 2019), effects of age, period of life and social cohort (Vakulenko, 2023; Frantsuz, Ponarin, 2020) and other indicators (Kalabikhina, Kuznetsova, 2023).

The latest work of this type of research is the article (Balatsky, Ekimova, 2023), which reveals the cumulative influence of institutional, economic and cultural factors on population growth. It is this very model that will be the basis for further empirical research. This choice is due, at least, to the following circumstances: first, the dependence of population growth on sufficiently mobile factors that comprehensively reflect deep shifts in the social nature of the nations and counties under consideration; second, the opportunity to rely on such a relatively new concept as the demographic scale effect, which means the ability of the population to increase in response to an increase in welfare. Thus, economic and demographic growth are either consistent if there is a demographic scale effect, or inconsistent if there is no such effect. Accordingly, in the first case, we can talk about the presence of the potential for further growth of the nation and the state, and in the second – about its absence.

Research methodology

To determine the demographic potential of different countries and parts of the world we will use simple econometric models that help to establish population reproduction regimes that have developed over the past 15–30 years. To do this, we will use the approach tested in (Balatsky, Ekimova, 2023). The essence of this approach lies in constructing two econometric dependencies. Let us consider their structure in more detail.

[1] See: https://www.rbc.ru/society/13/05/2023/645cb6969a7947b6fba130a6

[2] See: https://www.mk.ru/incident/2023/04/05/turciya-obnovila-dannye-po-chislu-pogibshikh-izza-zemletryaseniya.html

The first econometric model sets the mode of population growth depending on birth rate and can be represented by the following linear dependence:

$$P_t = \alpha + \beta \times B_t + \gamma \times F_t, \quad (1)$$

where t – observation period (year); P – "net" population growth rate, i.e. actual population growth minus migration growth, which is the difference between the number of those who arrived in the country and those who left it in the current year; B – birth rate, which uses the traditional total fertility rate, showing how many children on average one woman would give birth to throughout the entire reproductive period (15–50 years old) while maintaining the age of fertility at the level of the year for which the indicator is calculated; F – dummy binary variable that takes the values 0 and 1 and is intended for technical calibration of the model; α, β and γ – model parameters.

The second econometric model reflects the birth rate regime depending on the main economic, cultural and institutional factors and can be represented by a linear autocorrelation dependence of the following type:

$$B_t = n + mB_{t-1} + a \times L_{t-v} + \\ + b \times D_{t-w} + c \times Y_{t-h}, \quad (2)$$

where L – life expectancy at birth (number of years); D – divorce rate (number of divorces/ number of marriages); Y – GDP per capita in comparable prices; v, w and h – lags in variables L, D and Y, respectively; n, m, a, b and c – model parameters.

Thus, we investigate a two-stage regime of population growth and assume that specifications (1) and (2) are sufficiently universal and can be applied to all the countries under consideration. An important advantage of model (2) consists in a balanced set of factors: determinant L takes into account the effectiveness of social institutions, D – the culture of family relations, and Y – the achieved level of economic welfare. Thus, institutions, culture and economy are present as explanatory variables in model (2) (Balatsky, Ekimova, 2023).

Here and further we will proceed from the fact that the parameters of the models are sufficient for a complete understanding of the demographic regimes established in the countries under consideration. At the same time, it is also quite obvious that models (1) and (2) cannot be used directly for a correct comparison of different countries; to do this, it is necessary to construct additional demographic indicators on their basis. In the future, three such indicators will be used in applied calculations; let us look at them in more detail.

The first indicator assumes assessing the *stability of the demographic growth regime*; we can use the traditional half-life indicator for its quantification. In this case, we mean taking into account the nature of the autocorrelation mode of birth rate, which is characterized by parameter m in model (2). Then half-life period θ is estimated by the formula:

$$\theta_i = -ln2/lnm_i, \quad (3)$$

where i – index of the analyzed country.

In this case, the value θ shows how many years later the initial birth rate will decrease by half in the absence of the influence of all other reproductive conditions[3]. The greater the value θ, the longer the self-sustaining fertility effect lasts. We note that indicator (3) imposes a natural restriction on econometric dependence (2): $\theta > 0$. This automatically puts forward a requirement for the corresponding model parameter: $m < 1$; otherwise, there is not a damping, but a self-reinforcing mode, which does not make economic sense.

The second and, perhaps, the most important indicator of demographic growth is the indicator of

[3] Instead of (3), we can use a simplified formula: $\theta = -0.693/ln(m_i)$.

demographic scale effect (E), which refers to the ability of the population to increase with the growth of welfare. To construct the specified indicator, the following formula can be used:

$$E_i = c_i\beta_i(T - h_i)\,, \qquad (4)$$

where T – time horizon of the long-term estimation.

Let us explain formula (4). The meaning of the demographic scale effect implies assessing the degree of sensitivity of the population growth rate to changes in per capita GDP, i.e. $E = dP/dY$. Given that the population growth model consists of two econometric models (1) and (2), we obtain the ratio $E = (dP/dB)(dB/dY) = c\beta$. However, in model (2), indicator Y has time lag h, which may vary greatly for different countries. Consequently, the growth of per capita GDP does not affect population growth immediately, but with a significant and differentiated delay by country. This means that to measure the scale effect, we should switch from a point (short-term) value to an interval (long-term) one. For certainty, we will consider the 10-year effect: $T = 10$. Then the accumulated effect of the growth of per capita GDP over T years will be expressed by formula (4)[4]. In the case of $E > 0$, we will talk about the presence of a demographic scale effect; otherwise, this effect is absent. The greater the value of E, the greater the potential for population growth during economic growth and, consequently, the greater the overall potential for economic development of the country.

The third indicator of demographic potential is *the indicator of the population's welfare growth reserve R*:

$$R_i = Y_{USA}/Y_i\,, \qquad (5)$$

where Y_{USA} – reference (maximum) value of per capita GDP, for which the US level for the last year of observation (2021) is taken.

[4] This automatically follows from the generalized cumulative scale effect: $E = \sum_t^T E_t$.

The meaning of the demographic growth reserve R in formula (5) is extremely simple: how many times a country can increase its per capita GDP to reach the level of the USA, after which it is legitimate to expect a weakening of the influence of the welfare factor on the birth rate and, consequently, population growth.

Somewhat isolated, but no less important is another characteristic of the demographic regime – the critical value of birth rate B^*, which ensures *simple reproduction* of the population. This calculated value is obtained directly from model (1) at $P = 1$ for modes $F = 0$ and $F = 1$, respectively:

$$B^* = (1 - \alpha)/\beta\,, \qquad (6)$$

$$B^* = (1 - \alpha - \gamma)/\beta\,. \qquad (7)$$

Comparison of indicators (3)–(7) for different countries allows us to get a completely objective picture of civilizational growth potential for each of them. At the same time, it is obvious that these characteristics can "scatter" in different directions for different countries and thereby hinder simple and unambiguous conclusions. In such a situation, the procedure of aggregating private indicators into one composite index is often used, but in this case it is practically impossible due to their substantial incompatibility. As a more rational scheme of analysis, it is proposed to consider the "main" indicator – the demographic scale effect E – against the background of three other "auxiliary" indicators.

We should emphasize that the logic of all model constructions involves determining the *potential* economic and demographic growth of countries depending on their current situation. Of course, from this point of view, African countries, which are currently on the periphery of the world economic system, possess great potential. This approach is aimed at understanding the very ability of countries to grow in the course of economic growth, and this

ability is not typical for all countries today. The intrigue of analytical calculations lies in determining the potential of future activity of regional centers; the realization of the discovered potential lies at the heart of future geopolitical castling.

Initial data and statistical sources

Despite the presence of a considerable amount of data and arguments that allow us *a priori* to determine possible "growth points" of human civilization, it is still necessary to scan all possible demographic movements of the planet. All five continents, as well as the main cultures – Europe, Asia, Africa, Latin America, the post-Soviet space, the Anglo-Saxon states – should be in the spotlight. Of course, it is difficult to conduct a comprehensive monitoring of all countries; therefore, we will limit ourselves to the most representative members of the enlarged regions of the world.

A significant limitation in the selection of countries for our sample consists in the lack of statistics. For example, for a large number of countries, one or two indicators needed to build models (1) and (2) are missing. In this regard, the final set of regional groups of countries turned out to be as follows: the post-Soviet space is represented by four states – Russia, Ukraine, Kazakhstan and Kyrgyzstan; the sample of Asia is limited to three countries – China, Japan and Iran; when considering continental Europe, we limited ourselves to the two largest economies – France and Germany; Latin America is represented by one country – Mexico, and Africa – by Egypt; the Anglosphere is represented by four countries – the UK, the USA, Canada and Australia. We believe that the listed 15 countries are sufficient for system-wide diagnostics of the main zones of geopolitical activity.

When collecting data for models (1) and (2), we used mainly the statistical databases of the World Bank and the United Nations; in some cases they were supplemented with information from the official websites of national statistics of the countries under consideration.

Results of empirical calculations

The results of applied calculations for 15 countries for model (1) are presented in *Table 1,* for model (2) – in *Table 2*. When constructing country models (1), we used the following logic of applying dummy variables: for Iran, $F = 1$ for the failure of 1994, $F = 0$ for the rest of the years (since $F = 1$ neutralizes a single outlier, then the calculation of B^* for this regime was not carried out); for Japan, $F = 1$ for the growth regime ($P > 1$), $F = 0$ for the depopulation regime ($P < 1$); for Germany, $F = 1$ for the "tail" of the 20th century (1990–1996), $F = 0$ for the subsequent period.

In Tables 1 and 2, the value of the regression coefficients is indicated in curly brackets, and their t-statistics are in parentheses; in Table 2, the value of the time lag of the corresponding variable is indicated under t-statistics. The following characteristics of the model are indicated: n – number of observations (years); A – approximation error (in percent); R^2 –determination coefficient; DW – Durbin – Watson coefficient; h – Durbin's h-criterion used to test the hypothesis of auto-correlation of residues in models that include lag values of the resultant attribute as independent variables ($|h| < 1.96$). In Tables 1 and 2, the calculation results for Canada and Australia are highlighted in dark color, thereby demonstrating the unsatisfactory nature of the models constructed; the remaining models have fairly good statistical characteristics. For Canada, $\beta < 0$ occurs in model (1), which contradicts the a priori condition of the positive effect of birth rate on population growth; no experiments helped to eliminate the indicated contradiction. For Australia and Canada, $m > 1$ is observed in model (2), which also contradicts the a priori condition of the fading of the influence of the past period on the current values of the output variable; and in these cases, working with models

Table 1. Characteristics of econometric model (1) in the context of countries

Country	Years	Model parameters			Model characteristics	B^*
		A	β	γ		
Post-Soviet space						
Russia	1990–2021	0.977 (245.33)	0.014 (5.39)	–	n = 32; R^2 = 0.49; DW = 2.30; A = 0.16%	1.60
Kazakhstan	1991–2021	0.959 (56.27)	0.019 (2.76)	–	n = 31; R^2 = 0.21; DW = 2.13; A = 1.18%	2.20
Kyrgyzstan	1996–2021	0.993 (113.73)	0.007 (2.52)	–	n = 26; R^2 = 0.21; DW = 2.00; A = 0.43%	0.86
Ukraine	1991–2021	0.970 (231.65)	0.018 (5.86)	–	n = 31; R^2 = 0.54; DW = 1.80; A = 0.18%	1.65
Asia						
China	2001–2021	0.994 (607.79)	0.006 (5.92)	–	n = 21; R^2 = 0.65; DW = 1.53; A = 0.30%	0.98
Japan	1990–2021	0.986 (295.68)	0.009 (3.69)	0.003 (9.99)	n = 32; R^2 = 0.80; DW = 2.14; A = 0.07%	1.55 1.16
Iran	1991–2021	0.991 (222.40)	0.012 (5.97)	–0.049 (–6.21)	n = 31; R^2 = 0.68; DW = 1.74; A = 0.51%	0.73
Continental Europe						
Germany	1990–2021	0.969 (79.04)	0.022 (2.56)	0.008 (3.98)	n = 32; R^2 = 0.36; DW = 1.59; A = 0.23%	1.40 1.03
France	2007–2021	0.986 (132.32)	0.009 (2.33)	–	n = 15; R^2 = 0.30; DW = 1.55; A = 0.13%	1.53
Latin America						
Mexico	1991–2021	0.988 (383.86)	0.011 (10.19)	–	n = 31; R^2 = 0.78; DW = 1.78; A = 0.16%	1.14
Africa						
Egypt	1999–2021	0.990 (191.16)	0.009 (5.84)	–	n = 23; R^2 = 0.62; DW = 1.62; A = 0.09%	1.03
Anglosphere						
United Kingdom	1991–2021	0.990 (230.39)	0.010 (4.12)	–	n = 31; R^2 = 0.37; DW = 1.67; A = 0.86%	0.97
USA	1991–2021	0.982 (127.42)	0.014 (3.54)	–	n = 31; R^2 = 0.30; DW = 1.89; A = 0.20%	1.28
Australia	1990–2021	0.303 (4.48)	0.394 (10.83)	–	n = 32; R^2 = 0.80; DW = 0.73; A = 3.17%	1.76
Canada	2002–2020	1.048 (79.94)	–0.023 (–2.77)	–	n = 19; R^2 = 0.31; DW = 1.90; A = 0.23%	2.07

Compiled on the basis of own calculations.

Table 2. Characteristics of econometric model (2) in the context of countries

Country	Years	Model parameters					Model characteristics
		n	*m*	*a*	*b*	*c*	
Post-Soviet space							
Russia	1998–2021	2.470 (6.15)	0.712 (7.93)	−0.030 (−5.17) 1	−0.539 (−4.45) 3	2.36E − 05 (4.86) 3	n = 24; R^2 = 0.97; h = 0.089; A = 1.68%
Kazakhstan	1994–2021	4.539 (4.41)	0.403 (3.24)	−0.067 (−4.32) 0	0.872 (2.55) 4	7.16E − 05 (5.63) 2	n = 28; R^2 = 0.98; h = -0.112; A = 2.09%
Kyrgyzstan	1996–2021	6.558 (3.37)	0.303 (2.12)	−0.073 (−2.37) 0	−3.253 (−2.66) 6	2.66E − 04 (4.22) 0	n = 26; R^2 = 0.91; h = -0.190; A = 2.71%
Ukraine	1991–2020	1.124 (3.15)	0.710 (15.55)	−0.012 (−2.09) 1	−0.278 (−2.63) 1	1.99E − 05 (4.84) 0	n = 30; R^2 = 0.96; h = 1.911; A = 1.99%
Asia							
China	1995–2021	−4.284 (−4.59)	0.513 (3.64)	0.076 (4.88) 3	−2.244 (−4.32) 5	−2.00E − 05 (−2.25) 3	n = 27; R^2 = 0.87; h = -0.584; A = 2.42%
Japan	1991–2020	−2.362 (−3.08)	0.493 (3.64)	0.052 (3.65) 0	−1.078 (−3.34) 0	−2.20E − 05 (−2.96) 1	n = 30; R^2 = 0.88; h = 1.516; A = 1.32%
Iran	1998–2020	−0.350 (−2.07)	0.946 (15.65)	–	−0.954 (−4.74) 2	4.40E − 05 (5.55) 4	n = 23; R^2 = 0.93; h = 0.467; A = 1.64%
Continental Europe							
Germany	1999–2020	−5.420 (−4.81)	0.547 (4.24)	0.085 (4.89) 2	−0.558 (−3.48) 8	−1.00E − 05 (−2.50) 7	n = 22; R^2 = 0.95; h = 0.770; A = 1.12%
France	1999–2020	2.810 (3.25)	0.763 (6.95)	−0.036 (−2.76) 1	−0.272 (−1.96) 9	1.75E − 05 (2.55) 6	n = 22; R^2 = 0.91; h = -1.782; A = 0.83%
Latin America							
Mexico	1996–2020	1.942 (5.06)	0.740 (16.57)	−0.019 (−5.16) 1	−1.316 (−6.54) 3	1.29E − 05 (2.60) 6	n = 25; R^2 = 0.99; h = 1.161; A = 0.35%
Africa							
Egypt	1993–2020	5.670 (2.44)	0.843 (9.42)	−0.086 (−2.54) 1	−1.204 (−2.07) 1	1.10E − 04 (3.57) 2	n = 28; R^2 = 0.97; h = 0.620; A = 1.06%
Anglosphere							
United Kingdom	1999–2019	1.745 (2.80)	0.901 (9.44)	−0.030 (−3.19) 2	0.797 (2.73) 9	1.05E − 05 (2.31) 3	n = 21; R^2 = 0.93; h = -1.033; A = 1.34%
USA	1998–2021	3.095 (4.82)	0.980 (16.44)	−0.049 (−4.76) 0	0.813 (2.98) 4	6.00E − 06 (2.20) 0	n = 24; R^2 = 0.98; h = 0.507; A = 0.90%
Australia	1998–2020	7.382 (2.18)	1.019 (13.22)	−0.117 (−2.25) 1	0.771 (4.18) 5	4.02E − 05 (2.22) 0	n = 23; R^2 = 0.94; h = 1.215; A = 1.20%
Canada	1999–2020	2.552 (2.96)	1.177 (13.89)	−0.043 (−3.05) 2	0.087 (2.17) 1	1.23E − 05 (2.24) 1	n = 22; R^2 = 0.92; h = 0.846; A = 0.96%

Compiled on the basis of own calculations.

did not give a positive result. Thus, the models for Australia and Canada pass formal statistical tests, but do not meet the substantive requirements and must be recognized as degenerate; in the future they are excluded from the analysis.

Let us consider some characteristic results of the models constructed.

First, models (1) and (2) have shown their versatility. Thus, out of 15 countries, only three required the introduction of a dummy variable to calibrate the results; for the rest of the countries, model (1) is implemented in its "pure" form. Only in relation to Iran did model (2) give a deviation in the sense that parameter a turned out to be insignificant under all modifications of the econometric dependence. This means that at the current stage of development of the Islamic Republic of Iran, life expectancy of its population does not directly affect the birth rate.

Second, alongside the specification versatility in model (2), there is a great variety in the nature of the influence of three factors on birth rate, which is manifested in different signs of regression coefficients. For example, life expectancy factor has a beneficial effect on birth rate only in China, Japan and Germany; whereas in other countries it leads to a reduction in women's reproductive activity. We should note the symmetry in relation to the welfare level, which positively affects birth rate in all countries except China, Japan and Germany. This fact suggests that in these three countries, the financial factor has already lost its stimulating value and its role has shifted to the factor reflecting the general health status of the nation, which is shown by the indicator of life expectancy. Considering that life expectancy depends on the general institutional welfare of society (state of health, social security, public safety and observance of the law), we can say that for China, Japan and Germany economic (material) incentives for birth rate are already being actively replaced by institutional (organizational) ones. This circumstance clearly shows that these three countries are at a later stage of social evolution compared to the rest of the countries within the sample.

Third, there are traditional and nontraditional (abnormal) family models in the world. Calculations convincingly show that the culture of family relations can undergo a complete inversion over time. This follows from the fact that the increase in the divorce rate in all countries negatively affects the birth rate, whereas in Kazakhstan and the Anglo-Saxon countries – the UK and the USA (and with the above reservations in Canada and Australia) – this phenomenon has a stimulating effect. At first glance, this situation seems paradoxical and abnormal, but a completely natural explanation can be found for it. In Western countries, the institution of family is becoming increasingly weak, but even in its current weakened form restrains, rather than promotes, the reproductive imperatives of the female population. Currently, an interesting phenomenon has arisen – remarriage is accompanied by the birth of children, because joint children, rather than the children from previous marriages, are required to consolidate the new marriage. In this regard, there is a latent rule: the more marriages a woman enters into, the more children she gives birth to. Conversely, maintaining one marriage union does not contribute to the birth of a second or third child in an already established family. As a stylized example, the following real case from life in the United States[5] can be cited: a woman who is legally married gave birth to a child from another man and was ready to divorce for this man, and to give birth to one or two more children in a new marriage; however, the orthodox Jewish community to which this woman belonged prevented the implementation

[5] This case took place in California and was accompanied by a lengthy trial between its participants, because the preservation of the woman's previous marriage occurred against the background of a ban for the biological father of the child to participate in their life and fate. Thus, the struggle for the right to influence the fate of the child leads to conflicts and the desire to destroy the old marriage in favor of a new one.

of such a scenario, because the Jewish tradition requires the preservation of an already established family: pressure from the parents and relatives of both the woman herself and her husband outweighed her original desire. In this regard, countries within the Anglosphere provide a vivid example of a new family culture typical of the later stages of post-industrial society; the case of Kazakhstan requires separate consideration.

Fourth, among the sample countries, there is an extremely high differentiation in the sensitivity of birth rate to different groups of factors. For example, the sum of lags for all variables for Japan is 1 year, Ukraine – 2 years, Russia – 7 years, UK – 14 years, France – 16 years, and Germany – 17 years; the maximum difference between Germany and Japan is 17 times. Thus, Germany is characterized by an extremely retarded reaction to various incentives in relation to birth rate. No less impressive is the gap in the response to the material incentive. For example, the growth of per capita GDP in the United States immediately has a positive effect on the birth rate (in the current year, without lag), whereas in Germany – only after 7 years. It seems that Europe provides examples of the most conservative countries with regard to the impact on birth rate. In addition, there is another interesting pattern: the richest countries not only demonstrate a slower response to existing incentives, but they are characterized by lag inequality $w > h$, i.e. the population overlooks the influence of the cultural factor for a longer time, compared to the influence of the material factor; for "younger" countries, the situation is vice versa. This observation can be interpreted as follows: rich countries have already formed their culture and changes in it do not manifest themselves soon, whereas less rich countries are in the stage of cultural construction and the corresponding changes are noticed by the population much faster. With regard to the material incentive, everything is exactly the opposite: rich countries are more sensitive to it because of the high standard of living, while poor people with their low level of financial security may not react to its growth for longer, because small improvements do not change their lives dramatically.

Fifth, model calculations reject the common cliché that simple population reproduction requires birth rate at the level of two children in a family. As it turns out, this indicator (B^*) varies enormously across countries – from 0.7 in Iran to 2.2 in Kazakhstan, i.e. we see a threefold gap. These figures may seem unrealistic at first glance, but they are easily explained. To do this, we recall that model (1) is one-factor and, therefore, extremely simplified. Only in 7 out of 15 countries the coefficient of determination exceeds 0.5, which means that many circumstances affecting population growth are not taken into account. Suffice it to say that the same birth rate can be accompanied by a completely disparate population structure; it is the structural differences that determine the significant spread of the critical value B^*. Thus, the proportion of women relative to the proportion of men may vary greatly; the proportion of women of childbearing age in different countries may also vary significantly; no less strong are the discrepancies in the distribution of new and expectant mothers on the age scale. With equal values of B^*, these structural differences will give a completely different rate of population growth. The main thing is that different levels of B^* determine completely different demographic reserves of countries. For example, in Kyrgyzstan and Iran, even a sharp drop in the birth rate in the medium term may not cause a demographic collapse, whereas in Russia, Kazakhstan and Ukraine, any reduction in the birth rate is associated with the threat of depopulation of the nation.

All of the above indicates that the countries under consideration differ in "demographic age": some of them are capable of and ready for demographic expansion, while others have already passed this stage of their development.

Regional foci of potential geopolitical activity

Now let us find out which countries and regions can act as foci of economic and, as a consequence, geopolitical activity in the coming decades. We will use demographic indicators, which are summarized in *Table 3*; for the *E* effect, all values are reduced for convenience to one denominator (multiplier $E - 06 = 10^{-6}$). At the same time, the future geopolitical activity of a country depends on its size, which considerably limits the set of candidate countries.

A close study of Table 3 allows us not only to confirm certain traditional assumptions and provisions, but also to reject some of them. Let us consider this question in more detail.

First, China, the world's top economy, has already exhausted its potential and in the future its growth will not be able to last for too long. The growth of welfare in China leads to demographic compression, and taking into account the already accumulated population, other factors are unlikely to reverse this process. Thus, in the near future, we can say there might be a slowdown in the economic development of the Celestial Empire and stabilization of demographic processes in it. This aspect leads to the understanding that China is currently at the peak of its development, and further strengthening of its position will be insignificant and short-lived – no more than 10–15 years.

Second, the two most developed economies – the Japanese and the German – are also facing a situation that does not contribute to further demographic and economic growth. For Japan, given the density of its population, such a situation looks quite natural, while for Germany this conclusion is somewhat unexpected. Moreover, even in France, which is close to Germany in many aspects, the situation is fundamentally different – its demographic scale effect *E* is a positive value. In this regard, there are quite serious reasons to believe that the dynamism in the development of Japan and Germany will decrease in the future, and these countries may lose their leading positions in the world economic system. We do not intend to explain the fundamental demographic differences between Germany and France, but in this context we cannot but recall that after the Second World

Table 3. Characteristics of national demographic regimes

Country	Characteristics of a demographic regime		
	θ, years	*E*, conv. units	*R*, multiplicity factor
Japan	0.9	-1.8 E-06	1.6
China	1.0	-0.8 E-06	3.6
Germany	1.1	-0.7 E-06	1.2
Mexico	2.3	0.5 E-06	3.3
France	2.6	0.6 E-06	1.4
United Kingdom	6.6	0.7 E-06	1.4
USA	34.8	0.9 E-06	1.0
Russia	2.0	2.4 E-06	2.3
Iran	12.6	3.1 E-06	4.2
Ukraine	2.0	3.6 E-06	4.9
Egypt	4.0	8.3 E-06	5.5
Kazakhstan	0.8	10.7 E-06	2.4
Kyrgyzstan	0.6	20.5 E-06	13.2
Source: own calculations.			

War these countries found themselves in different camps: France was among the winners and retained its political sovereignty, while Germany lost it and faced all the implications thereof. A similar picture can be seen in the differences between Germany and the UK whose demographic parameters are even slightly better than those of France. It is possible that at present we are witnessing the long-term consequences of Germany's subordinate position in the world political hierarchy in the post-war period.

Third, we can already say with a high degree of confidence that the United States will remain a focus of significant geo-economic and geopolitical activity for a long time. Among Western countries, America holds the record value of the long-term scale effect against the background of the highest value of parameter θ among all countries in the sample. This means that the demographic growth regime established in the country is extremely stable – if it does not encounter negative extraordinary events, this regime will last for a long time. Thus, the United States will continue to play an important role in the global geopolitical system for the next 25–30 years.

Fourth, such diverse countries as Kyrgyzstan and Mexico fall into the group of states with questionable demographic potential. For example, Kyrgyzstan, in comparison with the United States, has a long-term sensitivity to welfare growth, almost 23 times higher, and a 13-fold comparative reserve for its growth, but the regime established in Kyrgyzstan is characterized by extreme instability against the background of its small territory. Consequently, Kyrgyzstan can essentially become a local focus of economic activity, but its impact on the world economic system will be hardly noticeable. As for Mexico, its demographic characteristics look more stable and reliable, but their scale is not impressive; therefore, this country is unlikely to become at least a regional driver of economic development in the future. Most probably, these countries will move in the economic wake of other regional leaders.

Fifth, among the countries in our sample, Russia, Kazakhstan, Ukraine, Iran and Egypt are clear contenders for the role of future regional foci of geopolitical activity. The first three make up the backbone of the post-Soviet space and could switch to revanchist strategies in the future; Iran and Egypt are literally at the start of their economic and geopolitical activity. Given the size of the territory and its development reserves, it is the countries of the post-Soviet space that have the most impressive potential for demographic growth with the subsequent increase in their geopolitical influence. However, it is also necessary to take into account the fact that the conclusions obtained are based on statistical data until 2021, whereas the special military operation that has unfolded on the territory of Ukraine since 2022 has "broken" its reproductive regime and, apparently, deprived it of any demographic and economic drivers for a long time. As for Iran and Egypt, they will undoubtedly become powerful regional leaders. This conclusion is supported by the high values of all three demographic indicators for these two countries.

The sample did not include countries such as Brazil, Argentina, Algeria and India, which can be considered as future regional drivers of geopolitical activity. However, there is reason to assume that their underestimation does not change much in our picture. Argentina and Brazil are most likely similar in their characteristics to Mexico, which means their activity in the future will be moderate. Algeria is most likely similar to Egypt and will complement it as a regional driver of Africa in the coming decades. As for India, its demographic growth has already reached its physical limit; if it continues, its productivity will be in great doubt. However, these are only preliminary theses that need careful empirical verification.

Summing up, we would like to point out once again that we are not talking about a forecast of how demographic and economic processes *will* proceed, but about how they *may* proceed based on the characteristics of each country. Naturally, there is no guarantee that the detected potencies will be realized. However, the presence of these potencies in the future will exert constant pressure in the direction of their implementation, which justifies the very task of determining them.

Conclusion

The demographic models constructed in the course of the work for each country under consideration allowed us to see some nuances in the development of the current geopolitical space. Today, US economic activity is fading amid its growth in China. At the same time, over the past 30 years, the post-Soviet space has not manifested itself in any way. At first glance it may seem that this configuration will become the main evolutionary trend for future decades, but calculations show that more serious geopolitical castling may take place. Thus, the calculations prove that there are territories that have not yet reached the limit to their development – they are not too heavily populated, they have rich natural resources and quite sufficient civilizational potential. It is these regional foci that can become the drivers that push the world forward. The applied calculations make it possible to identify these zones of future geopolitical activity: they are Russia, Kazakhstan and Iran. Thus, the future economic and political activity of the planet will be concentrated on the territory of Eurasia, mainly its Asian part.

In addition to good demographic characteristics, these countries have a vast territory, rich natural resources and a relatively low population density. Thus, they can be considered as new potential centers of activity. In addition, these countries are adjacent to each other and form a kind of country cluster at the intersection of the main international trade zones, which further increases the likelihood of their transformation into a global cauldron of economic and political activity. We can talk about the high probability of economic cooperation of these countries with neighboring nation-states – Belarus, Uzbekistan, Turkmenistan. This will increase the scale of the emerging regional cluster of geopolitical activity and strengthen the ties within it.

Of course, the conclusions drawn are preliminary, they need to be rechecked and supplemented. However, as a primary guideline for the future geopolitical configuration, the picture we provide can be a useful tool for developing national economic and political strategies. The significance of the proposed approach to determining possible activity in different parts of the world consists in finding another effective scheme for analytically linking the two fundamentally different aspects of society – demographic and economic growth.

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