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THE IMPACT OF "FAMILY 500+" BENEFIT PROGRAMME ON THE BIRTH RATE IN POLAND

Abstract: The aim of this work is to examine the impact of the introduced "Family 500+" benefit programme and its continuation ("Family 800+") on the birth rate in Poland with the use of dynamic econometric modelling.

Keywords: "Family 500+" benefit, social programme, birth rate, fertility index, demography

INTRODUCTION

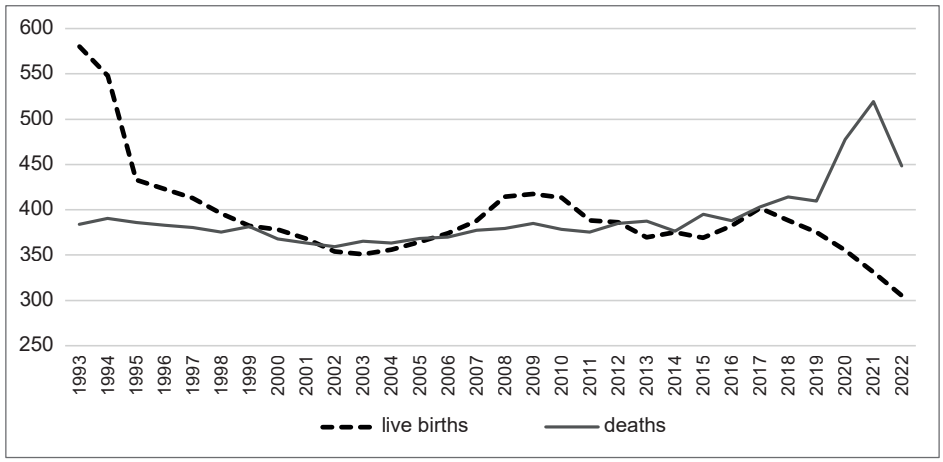
Human resources are the biggest asset of any country that is competing to become one of the most developed. Technological dominance or deposits of raw materials are not sufficient because without human factor it is impossible to keep the growth rate.

One of the direct causes of the decrease in Poland's population (that has been observed in the long term) is decline in the birth rate (registered since 1984) — with insignificant changes in the number of deaths (the increase of the number of deaths was significantly higher during COVID pandemic). Since 1995 the birth rate the birth rate has been below 500 000 (Figure 1), and since 1998 below 400 000. In 2008–2010 the number of live births has slightly exceeded 400 000. Nevertheless it was a short-term increase. An increase of birth rate was also observed in 2017 when 402 000 children were born and most probably it was a short-term effect of the "Family 500+" programme introduced by the government. Later, the number of births returned to its decreasing tendency and has been decreasing until now.

In the cities the number of live births was lower than in the rural areas during the entire study period (Figure 2). For instance, there were 7.9 live births for every

1000 inhabitants of urban agglomerations in 2022, when at the same time in the rural areas there were 8.3 births.

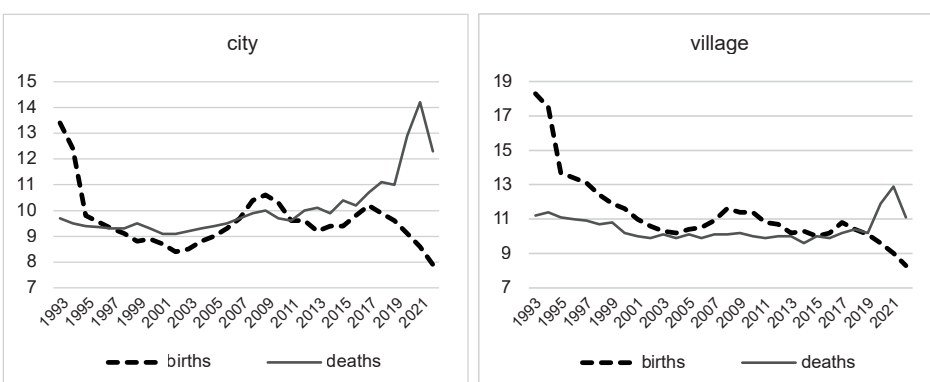
Figure 1. The natural movement of population in 1993–2022 (in thousands)



Source: Own elaboration

Although the decrease of birth rate is noticeable throughout the period, greater fluctuations are observed in the urban area. An increase of birth rate is visible in the period of 2006–2010. Nevertheless, it is worth noticing, that an increase in births was recorded both in urban and rural families — with a slight advantage of urban population, the rural birth rate was still higher though. The next increase of the number of births has been visible again from 2016 (the number of births exceeded 10 per 1000 inhabitants). Unfortunately, since 2018 a decreasing trend in the number of births has been visible and this concerns both urban and rural areas.

Figure 2. The natural movement of population according to the place of residence in 1993–2022 (for 1000 inhabitants)

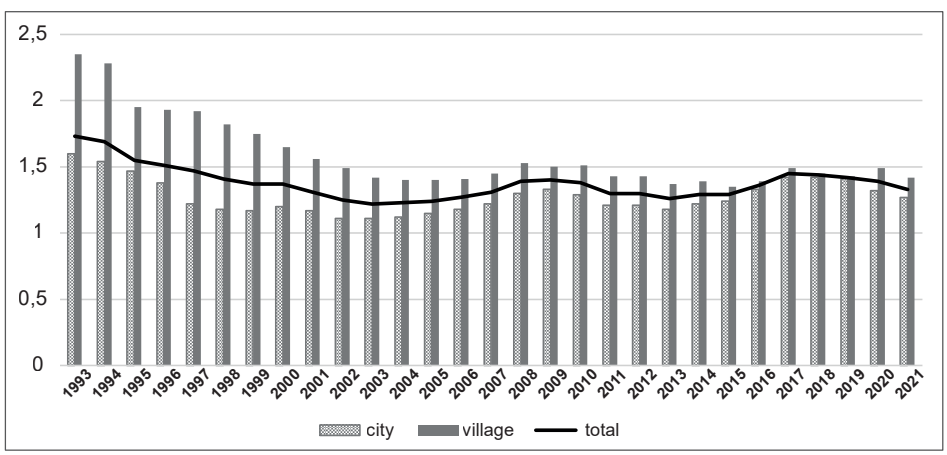


Source: Own elaboration.

The highest levels of live births occur in voivodships with the areas of the largest and most developing urban agglomerations (Pomorskie, Mazowieckie, Małopolskie, and Wielkopolskie voivodships — in 2012 the values of the coefficient were between 9.6 and 9.9‰)[1].

Despite the rising tendency of birth rates in several periods of time, the level of reproduction still does not guarantee a replacement of generations. Since 1989, Poland has been in a deep birth depression which is reflected in the fertility coefficient, that is: an indicator that defines the average number of children that a woman would give birth to during her reproductive period (15–49 years of age), assuming that she would give birth to as many children as the average woman in the researched year[2]. In 2021 the fertility rate was 1.33 which indicates an increase (of about 0.11) in comparison to 2003, which was the lowest in more than 50 years (Figure 3). It is worth mentioning that the most advantageous demographic situation was defined by a ratio of 2.1–2.15, that is: when there are two children per one woman aged 19–49 in a given year[3].

Figure 3. Fertility rates in 1993–2021



Source: Own elaboration.

It is worth mentioning that since 2016 a short-term increase of fertility coefficient has been observed, which in 2017 was 1.45 for whole Poland (1.49 for the rural areas, 1.42 for the urban areas), the highest result since 1997.

Demographic transitions from 1990s indicate highest female fertility shift from the group of 20–24 years of age to the group of 25–29 years of group — and now to the group of 30–34 years. A significant increase of fertility rate is also

[1] Główny Urząd Statystyczny, *Sytuacja demograficzna Polski do 2021*, https://stat.gov.pl/obszary-tematyczne/ludnosc/ludnosc/sytuacja-demograficzna-polski-do-roku-2021,40,2.html- (accessed: 4.08.2023).

[2] J.Z. Holzer, *Demografia*, Warszawa 1999.

[3] *Ibidem*.

visible in the oldest age groups. Between 1990–2021, the percentage of mothers aged 30 and morer has doubled and they constitute 55% of women that gave birth to a child in 2021. This a result of the choice of young people to first achieve some level of education and economic stability and only then to start a family. Changes in the fertility pattern shape the average age of mothers at their first birth. As a consequence of an increase in fertility in older age groups, the median age of women giving birth has increased — reaching 31 in 2021, in comparison to 26 in 1990–2000. The average age of giving birth to the first child increased in this period by six years and in 2021 reached almost 29 years of age[4].

The structure of the educational level of mothers has also changed. Since the beginning of the 1990s the percentage of mothers with university education has quadrupled (from 6% to over 26%), while the percentage of women with primary education or without education has significantly decreased (from 18% to less than 11%)[5].

The number of new marriages and their durability (as an element of demographic development) has a direct influence on demography, since the fertility of women in Poland is determined, among other things, by the number of marriages[6]. Unfortunately, there is an unfavourable trend in the process of family building (Figure 4): the number of new marriages has remained below 200 000 since 2013. In 2021 168 000 new marriages were registered. In 2020, due to the COIVD-19 pandemic and the limited work of courts only 51 000 divorces were decreed and in 2021 — almost 61 000. As a consequence the number of existing marriages has been decreasing since 2011, that is: each year the number of new marriages is lower than the number of marriages dissolved by the death of spouse or by divorce. The marriage coefficient in Poland has not exceeded 5‰ in recent, with 4.4‰ in 2021. The frequency of marriage rates in urban and rural areas is similar, increasing by 0.6 ‰ compared to 2020[7].

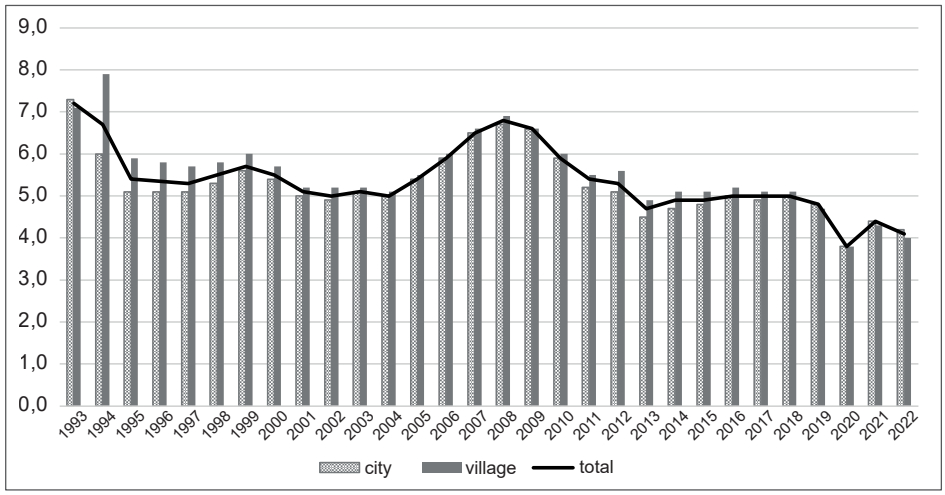
[4] *Ibidem*.

[5] *Ibidem*.

[6] Główny Urząd Statystyczny, *Sytuacja demograficzna Polski do 2018. Tworzenie i rozpad rodzin, Część II*, https://stat.gov.pl/obszary–tematyczne/ludnosc/ludnosc/sytuacja–demograficzna–polski–do–2018–roku–tworzenie–i–rozpad–rodzin,33,2.html (accessed: 21.07.2023).

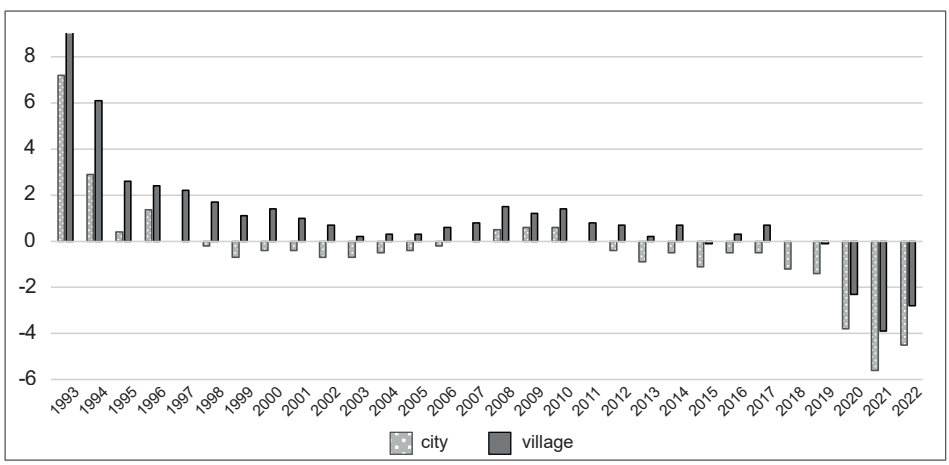
[7] Główny Urząd Statystyczny, *Sytuacja demograficzna Polski do 2021*, https://stat.gov.pl/obszary-tematyczne/ludnosc/ludnosc/sytuacja-demograficzna-polski-do-roku-2021,40,2.html- (accessed: 4.08.2023).

Figure 4. Marriages (per 1000 inhabitants)



Source: Own elaboration.

Figure 5. The number of birth, deaths and population growth in Poland (in thousands)



Source: Own elaboration.

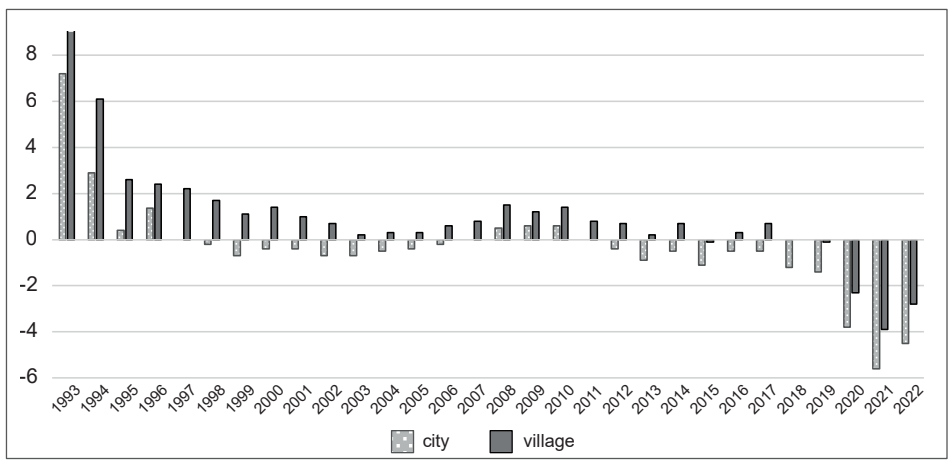
Birth rate is the difference between the number of live births and the number of deaths[8], but it is also a result of all above mentioned demographic phenomena and their trends observed in recent years. This has resulted in a natural decrease since 2013 (that also occurred in 2002–2005) which is mainly due to a low number of births and high number of deaths over the past years. Since 2013 over 422 000 more people have died than children have been born (Figure 5). Despite the "Family 500+" programme that was implemented in 2016, the aim of which among other

[8] J.Z. Holzer, *Demografia*, Warszawa 1999.

things was to stimulate the demographic growth in Poland, the birth rate still remains negative (although in 2017 it had a record high value of –0.9).

The changes in the age structure of population (reduction in the number of children and young people) and the decrease of marriages imply that this process will continue. The natural increase of population has for many years been assured by the population living in rural areas (Figure 6), whereas there has been a constant decrease in urban areas. In 2021 there was a natural decrease in both urban and rural areas: –3.9‰ in rural areas and –5.5‰ in urban areas.

Figure 6. The birth rate in Poland by the residence (per 1000 population)



Source: Own elaboration.

1. FAMILY BENEFITS

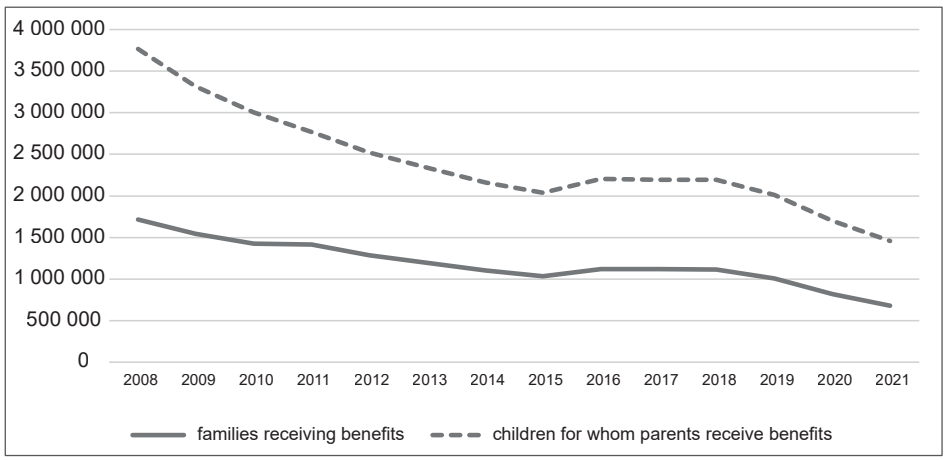
In the Polish social system, there are so-called family benefits, which include: family benefit and its supplements, childbirth benefit, care benefits, caretaker benefits, as well as parental benefits. These benefits are granted to the citizens of the Republic of Poland and foreign residents on the territory of the Republic of Poland under the condition of meeting relevant requirements[9].

The number of families who received the family benefits in 2008 was 1 718 943. After 13 years there has been a decrease of beneficiaries by more than 1 million of families[10]. This decrease was more than 60%. A similar trend was among the number of children for whom the family received the benefits. In 2008 3 768 663 children benefited from the social services. In 2021, this was already half of the beneficiaries (Figure 7).

[9] Serwis Rzeczypospolitej Polskiej, *Informacje dla Obywatela*, https://www.gov.pl/web/rodzina/swiadczenia-rodzinne (accessed: 24.07.2023).

[10] Bank Danych Lokalnych, *Ochrona Zdrowia, Opieka Społeczna, i Świadczenia na Rzecz Rodziny*. *Grupa: Świadczenia na Rzecz Rodziny*, https://bdl.stat.gov.pl/bdl/metadane/podgrupy/477 (accessed: 24.07.2023).

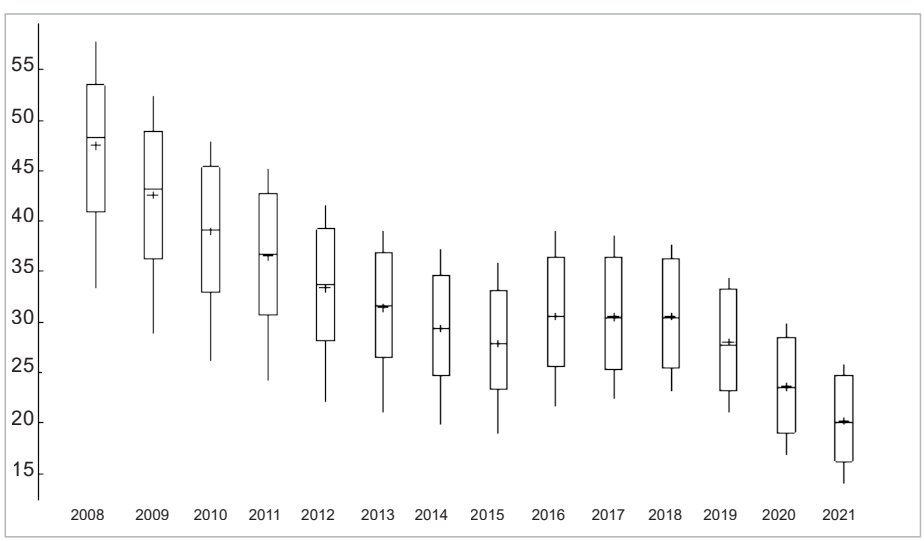
Figure 7. The number of families and children receiving social benefits



Source: Own elaboration.

A decreasing trend occurred in all voivodships in Poland in the share of children aged up to 17 for whom the parent have received the family benefit (Figure 8). In 2008, 47 out of 100 children up to 17 years received a child benefit. In 2021 the average in this group was only 20.24%. The distribution of the share of children whose family received benefits in the study period, was characterized by slight left asymmetry which meant that there were voivodships where researched factor was significantly lower than the average amount in the group.

Figure 8. Share of children up to 17 years of age for whom parents receive a child benefit in the total number of children at this age — box charts according to voivodships



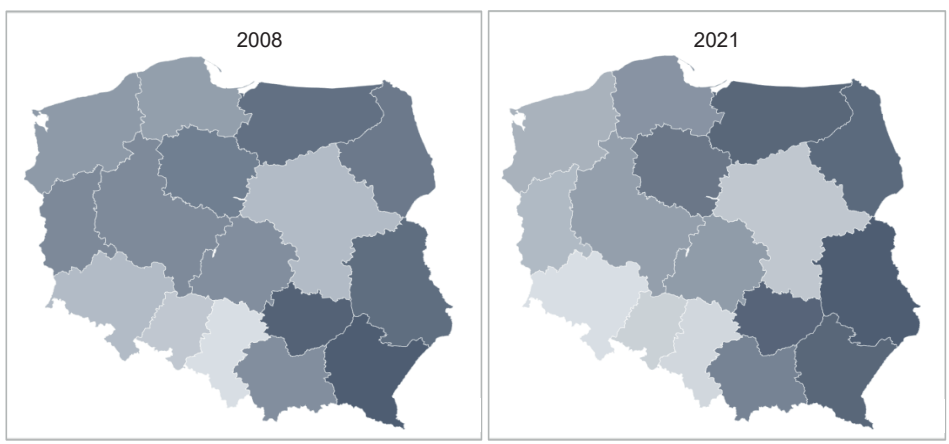
Source: Own elaboration.

The Mazowieckie, Dolnośląskie, Opolskie, and Śląskie voivodships recorded the lowest values of the share of children for whom the parents received the benefits during the researched period (Figure 9). In 2008 in these voivodeships the average share of children for whom parents received social benefits was 37.5% (the average result among all voivodeships was 47.50%). In the same voivodships 13 years later the benefits were granted to around 15% of children up to 17 years (an average share in this period among this group was 20.24%).

During the period, the highest number of beneficiaries was recorded in the eastern voivodships of Poland, that is: Podkarpackie, Świetokrzyskie, Lubelskie, and Warmińsko-Mazurskie; however, a decrease in the share of children entitled to the benefit was registered in the years of the study: on average from 55.8% to 25.1%.

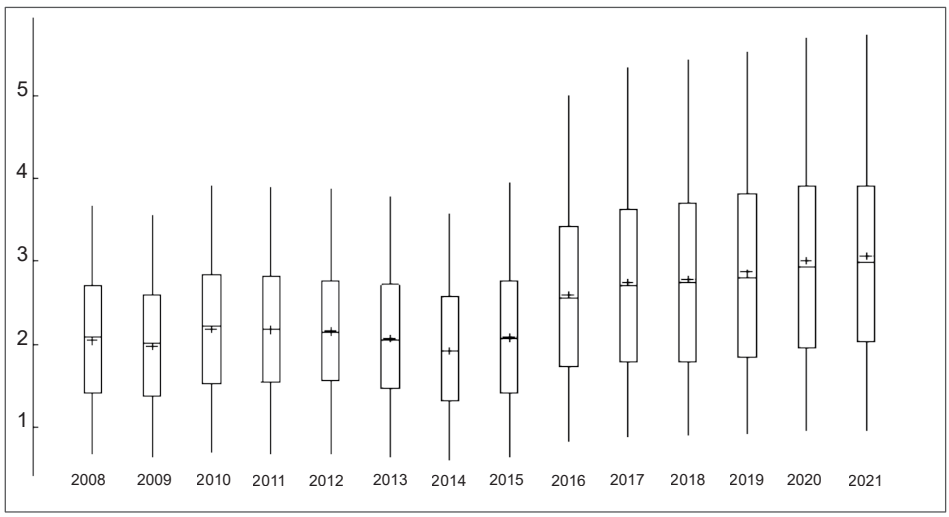
There is also a noticeable reduction of the number of families who remain beneficiaries. With a decreasing number of households qualifying for this type of benefit, incomes in families are increasing. The financial situation of households in the researched period has improved.

Figure 9. The share of children up to 17, for whom parents receive a family benefit in the total number of children of that age in 2008 and 2021



Source: Own elaboration.

Figure 10. The amount of benefits paid out to the number of children for whom family benefits were paid out in the voivodships in Poland — box chart



Source: Own elaboration.

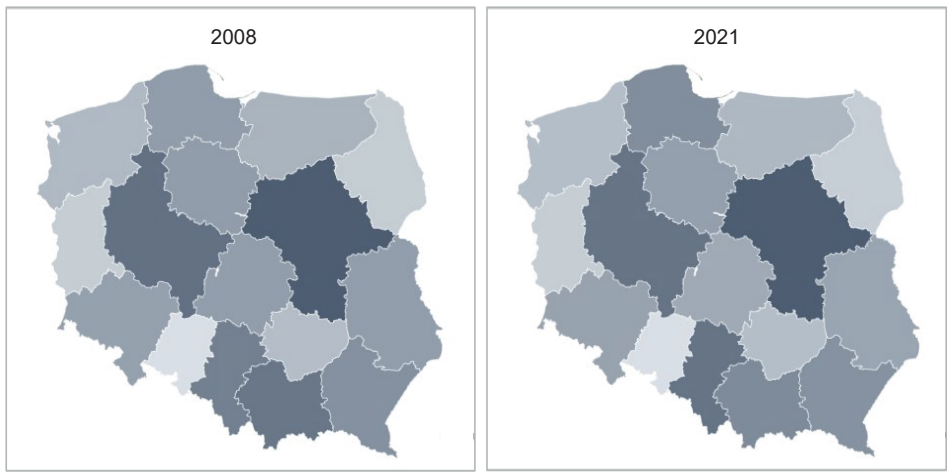
In 2008 PLN 7.355 billion was allocated for family benefits in Poland. This amount increased in 2021 up to PLN 11 billion. Looking at the data for the whole country an increasing trend is visible[11]. The amounts of family benefits in voivodships in relation to number of children for whom parents receive benefits are shown in Figure 4[12]. Despite the fact that larger amounts of money have been granted for a family each year, there was no significant increasing trend in the amount per child in granted family benefits until 2015. An increasing tendency has been visible since 2016 when new social programmes were implemented, such as "Family 500+" benefit.

The lowest number of benefits per household were registered in the researched period in the Opolskie voivodship. These amounts were PLN 680 per child in 2008 and 966 per child in 2021. Mazowiecki voivodship was the one with highest benefits per child (Figure 11).

[11] Bank Danych Lokalnych, *Ochrona Zdrowia, Opieka Społeczna i Świadczenia na Rzecz Rodziny. Grupa: Świadczenia na Rzecz Rodziny*, https://bdl.stat.gov.pl/bdl/metadane/podgrupy/477 (accessed 24.07.2023).

[12] Family benefits are not only family benefits, but in order to compare provinces, the ratio of the amount of benefits paid to the number of children for whom family benefits were paid was used.

Figure 11. The distribution of the amounts paid out to the number of children for whom a family benefits were paid in the voivodeships



Source: Own elaboration.

2. "FAMILY 500+" BENEFIT PROGRAMME

The "Family 500+" benefit programme is an example of a social programme introduced in recent years in Poland. Parental benefit is given to parents and caretakers of children up to 18 years of age. Single parents, patchwork families, foster families, and family children's homes could also apply for such support[13].

The main aim of this programme was to reduce child's poverty and to improve the financial situation and to stimulate the demographic growth in Poland[14]. The programme (introduced in 2016) was initially for the second and subsequent child. Parents were to receive the benefit of PLN 500 every month for the second and subsequent child regardless of their income.

In the first phase, 2.7 million families with 3.7 million children were to be included in the programme. Originally, this benefit was for the first child and was only paid when the income per family member did not exceed PLN 800. Nevertheless, this condition was removed in 2019 and now the PLN 500 benefit is granted

[13] Dolnośląski Urząd Wojewódzki, *Program rządowy „Rodzina 500 plus"*, https://duw.pl/pl/urzad/programy/program-rzadowy-rodzina/11783,Program-rzadowy-Rodzina-500-plus.html (accessed: 29.07.2023).

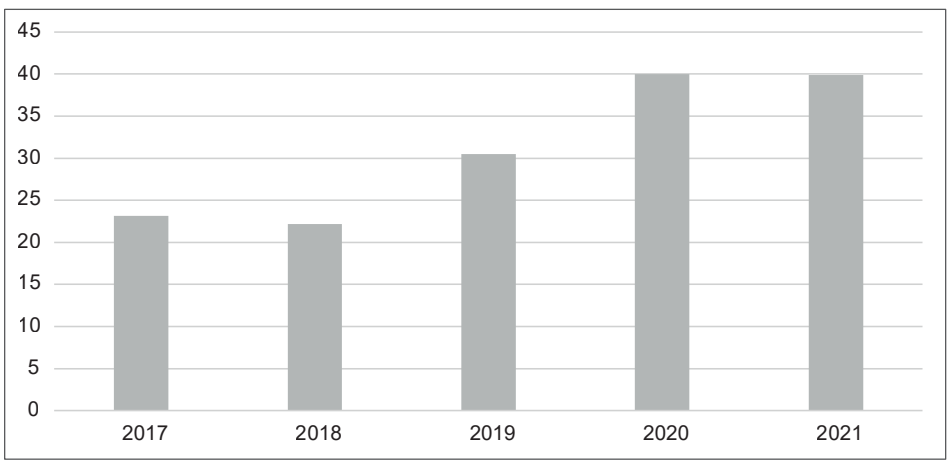
[14] M. Marek, *Program „Rodzina 500 plus" od 1 kwietnia 2016 r.*, https://samorzad.infor.pl/sektor/zadania/opieka_spoleczna/739780,Program-Rodzina-500-plus-od-1-kwietnia-2016-r.html (accessed: 29.05.2022).

for each child regardless of the income in the family[15]. It is worth mentioning that PLN 500 benefit is a net amount, exempt from income tax and is not a subject to enforcement, similarly to some other benefits for families. The child benefit is not considered part of the income when establishing the right to some other benefits for families, that is for social support, alimony fund or family benefits[16].

In 2022 changes were introduced in the programme, including a new accounting period and application deadline. From 1 January 2022, the 500 plus benefit is paid by the Social Insurance Institution and the money is paid only by bank transfer. Since 2024 500 plus has been changed to 800 plus.

In 2017, PLN 23.3 billion was allocated for the benefits under "Family 500+" programme (Figure 12). In 2021, the value changed by 16.7 billion and reached a level of almost 40 PLN billion[17]. In the starting period of the programme, almost 3.8 children benefited from the child benefit and in 2021 almost 6.5 million children were to be granted the benefit.

Figure 12. Expenditure on child benefits under the "Family 500+" programme (in billion PLN))



Source: Own elaboration.

[15] Ministerstwo Rodziny, Pracy i Polityki Społecznej, *Rodzina 800 plus*, https://www.gov.pl/web/rodzina/rodzina-500-plus (accessed: 29.07.2023).

[16] Dolnośląski Urząd Wojewódzki we Wrocławiu, *Program rządowy „Rodzina 500 plus"*, https://duw.pl/pl/urzad/programy/program-rzadowy-rodzina/11783,Program-rzadowy-Rodzina-500-plus.html (accessed: 29.07.2023).

[17] Bank Danych Lokalnych, *Ochrona Zdrowia, Opieka Społeczna, i Świadczenia na Rzecz Rodziny. Grupa: Świadczenia Wychowawcze*, https://bdl.stat.gov.pl/bdl/metadane/podgrupy/598 (accessed: 24.07.2023).

3. DYNAMIC MODELS INCLUDING RANDOM FLUCTUATIONS — TEST METHODOLOGY

Dynamic models are econometric models which are designed to describe a phenomenon, based on a time series model in dynamic terms. According to the definition of the Central Statistical Office (GUS), a time series is a system or a sequence of certain observations presenting a view of the development of a phenomenon (mostly economic or social), researched in consecutive periods, most often in decades, years, quarters, months, days or hours. The term of a time series contains several components that may be a consequence of interaction of particular factors on the phenomenon that is being studied[18]. The following components of the time series should be identified[19]:

— A trend or so-called development trend (T_t) is most often a long-term inclination to changes (decrease or increase) in the values of the examined variables of a single direction nature. Economists consider it as a consequence of the influence of an unchanging set of factors;

— Seasonal fluctuations (S_t) are fluctuations of a set of values that are included in a time series that are connected with its trend development, where the fluctuations period does not exceed one year. These fluctuations show the results that appear at repeated intervals, most often at similar periods every year;

— Cyclic fluctuations (C_t) are presented by periodic, long-term fluctuations in the value of a time series, considering the development trend. They are mostly linked to economic business cycles;

— Random fluctuations (I_t) (so called non-systematic fluctuations) — fluctuations in a time series that cannot be assigned or defined according to the above mentioned sources of variability but are due to the occurrence of a qualitative phenomenon (e.g. change of legislation, conflict or pandemic).

Within the process of initial adjustment, the following procedures are usually carried out[20]:

— Identification of the type of relationship among the component elements — additive or multiplicative, e.g. by means of logarithmic transformation;

— Looking for deviations in a set; isolating abnormal disturbances occurring in a given time series;

— Model recognition.

When there are abnormal disturbances in the time series, which may be the result of arrhythmic, jumping incidents, there is a distortion in the analysis of the

[18] Główny Urząd Statystyczny, *Wyrównywanie sezonowe szeregów czasowych*, https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://stat.gov.pl/metainformacje/szeregi-czasowe-4712/%3Fpdf%3D1&ved=2ahUKEwjEhMmIp_eJAxV0QFUIHYLpBsUQFnoECBYQAQ&usg=AOvVaw0qntQaOWSvYAPowENvOcEd (accessed: 11.05.2023).

[19] *Ibidem*.

[20] *Ibidem*.

series, so further modelling is significantly more difficult and sometimes even impossible. Therefore, disturbances must be properly identified and some adequate measures taken[21].

When undertaking a time series analysis, the objectives and components should be presented and identified. This should be done in an accurate but not necessarily formal was, since once established formula can also be applied to a set of other data (i.e. applied around a theory of the phenomenon, e.g. seasonal or cyclical prices of services or goods). The choice of method to be used for the analysis of a time series is influenced by the unit of time according to the phenomenon that was investigated[22].

Using dynamic models is vital in decribing economic phenomena since most theories on principles of their operation refer to relations based on the principle on invariability of other factors. A special role when studing economic phenomena, which are influenced not only by short-term factors but also by long-term factors are played by[23]:

- A Distributed Lag model (**DL**):

$$Y_t = f(X_t, X_{t-1}, X_{t-2}, \dots, X_{t-q}, \varepsilon)$$

- An Autoregressive Distributed Lag model (**ADL**):

$$Y_t = f\left(X_t, X_{t-1}, X_{t-2}, \dots, X_{t-q}, Y_t, Y_{t-1}, Y_{t-2}, \dots, Y_{t-q}, \varepsilon\right).$$

In **DL** model the influence from the vector of independent variables is distributed in time. The use of the DL model id crucial when investigating the influence of explanatory variable on the explanatory variable over time. Nevertheless the usage of **ADL** model is crucial for the overall study of a particular economic phenomenon, as lagging of the explanatory variable makes it possible to identify the complexities of a given economic phenomenon which cannot be decsrived by the DL model[24].

It should be mentioned that the data may have different lag order values. Nevertheless, to indicate which lags are important in terms of the economic phenomenon under study, an investigation of the order of lagds is conducted on the basis of the Autocorrelation Function (ACF), presented by the formula. Nevetheless, in order to indicate which lags are vital in terms of economic phenomenon under investigation, an examination of the order of lags is conducted on the basis of ACF, Autocorrelation Function, presented by the formula[25]:

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[21] A. Zagdański, *Analiza i prognozowanie szeregów czasowych*, Warszawa 2015, p. 31.

[22] R. Firmin, *Advanced time series modelling for semiconductor process control: The fab as a time machine. MASM*, New York 2002, p. 9.

[23] M. Doman, R. Doman, *Modelowanie zmienności i ryzyka. Metody ekonometrii finansowej*, Kraków 2009, pp. 47–48; D. Witkowska, *Podstawy ekonometrii i teorii prognozowania: podręcznik z przykładami i zadaniami*, Warszawa 2012, p. 115.

[24] M. Doman, R. Doman, *Modelowanie…*, pp. 47–48.

[25] *Ibidem*.

$$p_k = \frac{Cov(y_t, y_{t-k})}{Var(y_t)}$$

Defined as a correation coefficient between two y_t distant of k periods, where k is a natural number and Partial Autocorrelation Function (PACF) which is presented by the formula[26]:

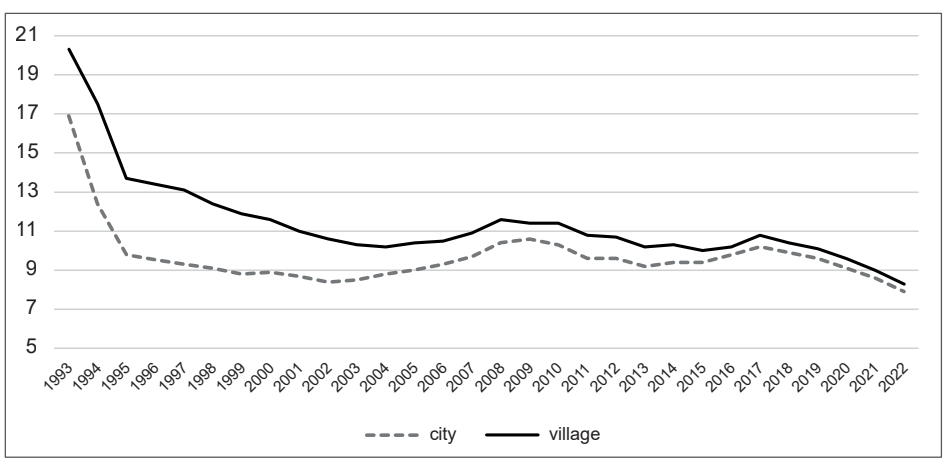
$$y_t = \mu + \alpha_1 y_{t-1} + \cdots + \alpha_k y_{t-k} + \varepsilon_t$$

4. MODELLING THE NUMBER OF BIRTHS IN POLAND — CONSIDERING "FAMILY 500+" BENEFIT

Due to the fact that in previous years there was a disruption in the number of deaths that was caused by the COVID-19 pandemic, only the data regarding the number of births was used for the analysis and not data on the birth rate. Since the programme (as one of its objectives) was supposed to stimulate the demographic growth in Poland, it seems logical to analyse the birth rate.

The analysis was based on annual data starting from 1993. The data came from Central Statistical Office (GUS) and is related to the total number of births in Poland (*birth* variable) and the number of births per 1000 inhabitants of urban (*birth_Mna1000* variable) and rural (*birth_Wna1000* variable) areas. The analysis of the time series of all investigated process (Figures 5 and 13) suggest appearance of a development trend of a non-linear (multinomial) nature.

Figure 13. The number of births per 1000 inhabitants according to the place of residence

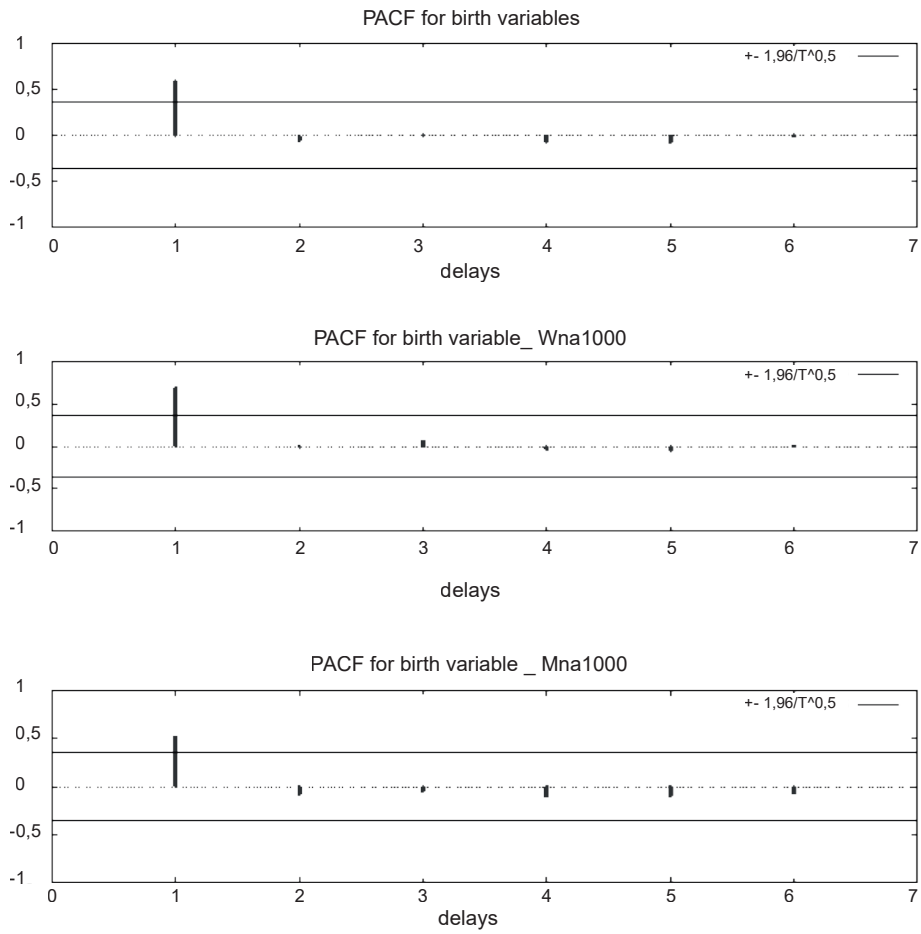


Source: Own elaboration.

[26] *Ibidem*.

Since the character of investigated demographic processes suggests that they may be autoregressive, in the next step of the analysis PACF graphs of the processes were examined (Figure 14). All graphs confirmed that the occurrence of vital first-order lags, therefore ADL (0,1) models will be used to model the processes.

Figure 14. PACF function graphs for the processes under study



Source: Own elaboration.

The aim of this study was to indicate the impact (or to show the lack of impact) of the introduction of the "Family 500+" benefit programme on the birth process. Additionally, in the study binary variables were included which represent a qualitative event concerning the occurrence of the programme and its course:

— *announcement_500plus* — a binary variable, taking the value 1 in 2016 (implementation of the programme in its original version: for the second and further children);

— *firts_child* – a binary variable, taking the value 1 in 2019 (correction of the programme, which also included the PLN 500 benefit for the first child);

— *duration500plus* — a binary maintained variable taking the value 1 from 2016 to the end of the study period in order to investigate the long-term influence of the introduction of the benefit in the original version from 2016;

— *duration500plus_1_dziecko* — a binary maintained variable taking the value 1 from 2016 to the end of the study period in order to investigate the long--term influence of the introduction of the benefit in the revised version from 2016. Taking into account the above-mentioned variables considerations on the nature of the form of a model using OLS[27] a birth rate model for Poland was estimated and after removing irrelevant variables the following Model 1 was obtained:

Model 1: KMNK estimation, observations used from 1994-2022 (N = 29)
Dependent variable (Y): births

	coefficient	standard error	t-Student	p value	
const	132,617	20,0657	6,609	7,77e-07	***
sq _ sq _ time	-0,000363261	7,26550e-05	-5,000	4,16e-05	***
time3	0,00840604	0,00201729	4,167	0,0003	***
duration500plus	26,3225	10,1228	2,600	0,0157	**
births _ 1	0,632005	0,0473201	13,36	1,32e-012	***

Arithmetic mean of dependent variable 384,2862 Standard deviation of the dependent variable 34,55284
Residual sum of squares 2656,234 Residual standard error 10,52029
Coefficient of determination R -square 0,920541 Adjusted R - square 0,907298
F(4, 24) 69,51107 Value p for a test F 7,63e-13
Logarithm of reliability -106,6511 Akaike information criterion 223,3021
Bayesian information criterion 230,1386 Hannan-Quinn criterion 225,4432
Autocorrelation of the residuals- rho10,304784 Durbin statistics h 1,697348

Further KMNK[28] assumptions were verified. Since there was a significant free expression in the model, the assumption about zero expected value of a random component was fulfilled[29]. The values of the correlation coefficient between the residuals and the explanatory variables in the model were smaller in the absolute value than the critical value (0.3673), so the assumption of no significant correlation between the random component and independent variables was also met[30]. Additionally, White's test for homoscedasticity also indicated that there were no reasons for rejecting the null hypothesis of homoscedasticity of the random

[27] Assumptions of the Ordinary Least Squares (OLS).

[28] J.B. Gajda, *Ekonometria praktyczna*, Łódź 1998, p. 69; M. Czekała, G. Kowalewski, *Weryfikacja modelu*, [in:] *Ekonometria. Metody, przykłady, zadania*, ed. J. Dziechciarz, Wrocław 2012, p. 138; G. Koop, *Wprowadzenie do ekonometrii*, Warszawa 2011, p. 126; J. Landmesser, *Kompedium wiedzy z ekonometrii*, Warszawa 2010, p. 9.

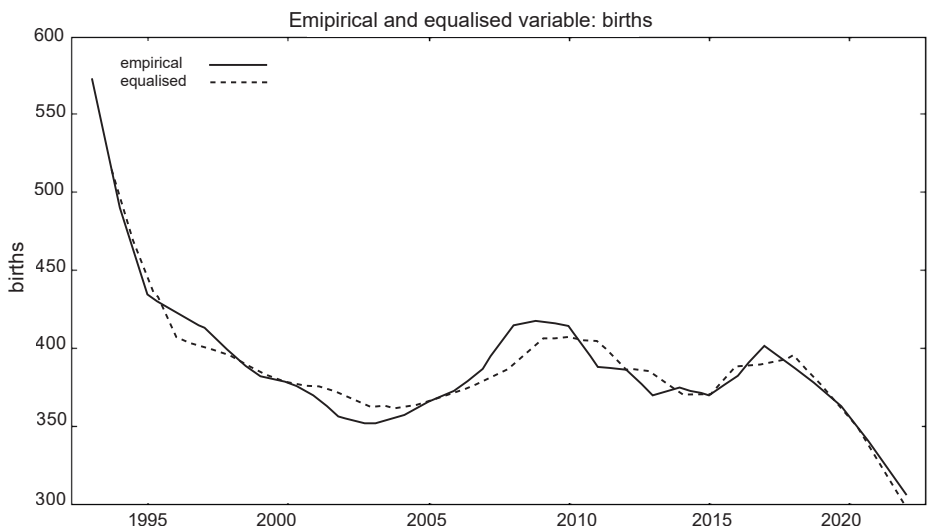
[29] J.B. Gajda, *Ekonometria praktyczna*…, p. 34.

[30] G. Koop, *Wprowadzenie*…, pp. 170–171.

component (p= 0,894711)[31]. There are lagged variables in the model tested, do the Durbin test of h[32]. The value of Durbin statistics h (1,697348) is smaller than the critical value of normal distribution at a level of 5% of significance level, so the assumption about no correlation of the random component is met. The last assumption is about the normal distribution of the random component. Using the Shapiro-Wilk test[33] value p= 0,50754 was obtained, which means that in this case the last assumption of KMNK was met. Thus the model passed the verification which means that it can be applied.

Therefore, all "shock" variables were removed due to the lack of significance in the model, which means that the birth rate was not influenced by the fact of introducing the social programme (this can be seen from the parameter with the variable: *duration500plus*). The value of this indicator is positive so it can be concluded that the programme had a positive influence (and significantly) for the number of births in Poland increasing the level of births over the duration of "Family 500+" benefit programme by more than 26 000. The number of births was not impacted by the "correction" of the programme which included the first child in the benefit.

Figure 15. Empirical and equalised values of birth rates in Poland



Source: Own elaboration.

As it can be observed, the model is supplemented with an autoregressive factor which had a positive effect on fitting to empirical data (92.05%) and the correctness of the specification. Empirical and equalised values are illustrated in Figure 15.

[31] B.R. Górecki, *Ekonometria. Podstawy teorii i praktyki*, Warszawa, 2010, p. 118.

[32] T. Kufel, *Ekonometria — rozwiązywanie problemów z wykorzystaniem programu GRETL*, Warszawa 2004, p. 111.

[33] S.S. Shapiro, M.B. Wilk, *An Analysis of Variance Test for Normality*, „Biometrika" 1965, no. 3–4, p. 592.

Similarly, an analysis of births in rural areas was conducted. Since the aim of this study was also to compare birth rates based on the place of residence, modelling was conducted in the two analysed groups on births per 1000 inhabitants. Analysing both processes and their trend and the fact that they were both autoregressive processes, a class of autoregressive functions was proposed for modelling with a multinomial trend and defined binary variables. After a stepwise elimination of insignificant parameters model 2 (urban) and 3 (rural) were obtained.

Model 2: Estimation KMNK, observations used 1994-2022 (N = 29)
Dependent variable (Y): births _ Mna1000

	coefficient	standard error	t-Student	p value	
const	3,91052	0,532015	7,350	1,37e-07	***
time3	0,000303745	5,29262e-05	5,739	6,49e-06	***
sq _ sq _ time	−1,18926e-05	1,93521e-06	−6,145	2,39e-06	***
duration500plus	0,654636	0,270384	2,421	0,0234	**
births _ Mna1~ _ 1	0,545120	0,0543603	10,03	4,65e-010	***

Arithmetic mean of dependent variable 9,398276 Standard deviation of the dependent variable 0,710694
Residual sum of squares 1,897190 Residual standard error 0,281158
Residual sum of squares 0,865851 Adjusted R - square 0,843493
F(4, 24) 38,72640 Value p for a test F 3,87e-10
Logarithm of reliability −1,608849 Akaike information criterion 13,21770
Bayesian information criterion 20,05418 Hannan-Quinn criterion 15,35880
Autocorrelation of the residuals- rho1 0,436769 Durbin statistics h 1,859832

Model 3: Estimation KMNK, observations used 1994-2022 (N = 29)
Dependent variable (Y): births _ Wna1000

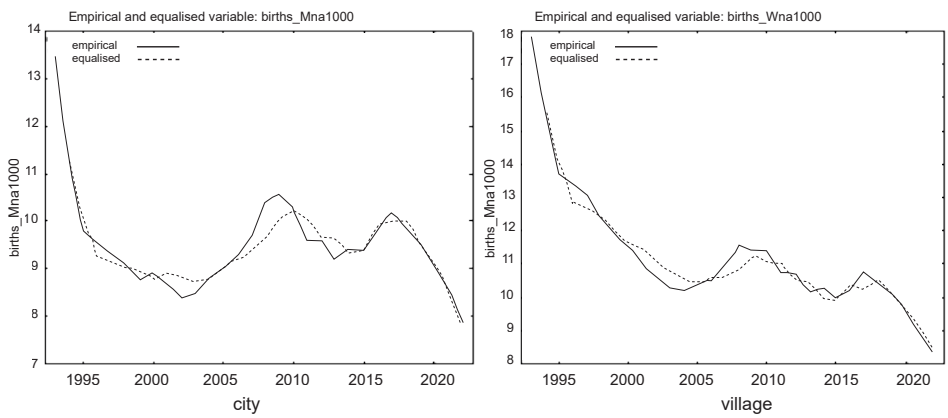
	coefficient	standard error	t-Student	p value	
const	3,69177	0,501898	7,356	1,05e-07	***
sq _ sq _ time	−2,35429e-06	6,32628e-07	−3,721	0,0010	***
trwanie500plus	0,659249	0,319970	2,060	0,0499	**
urodzenia _ Wna1~ _ 1	0,670325	0,0405848	16,52	5,84e-015	***

Arithmetic mean of dependent variable 11,04828 Standard deviation of the dependent variable 1,483630
Residual sum of squares 2,768107 Residual standard error 0,332753
Residual sum of squares 0,955087 Adjusted R - square 0,949697
F(3, 25) 177,2099 Value p for a test F 5,74e-17
Logarithm of reliability −7,086801 Akaike information criterion 22,17360
Bayesian information criterion 27,64279 Hannan-Quinn criterion 23,88648
Autocorrelation of the residuals- rho1 0,246777 Durbin statistics h 1,361856

Both models were subject to the verification of the KMNK and both passed this verification successfully. Specifically, since both models had significant free expressions, the assumption of zero expected value of the random component was met in both cases. The values of the coefficients of correlation between the residual and the explanatory variables in the model were lower as to the absolute

value (0.3673). Therefore, the assumption of no significant correlation between the random component and the independent variables was also met. White's test for homoscedasticity also indicated no grounds for rejecting the zero hypothesis of homoscedasticity of the random component (for a model 2 value p = 0.669588, for a model 3 value p = 0.504532). There are lagged variables in the model examined, so the Durbin h test was used to verify the assumption of the random component. The value of the Durbin h static in both cases (Model 2: *Dh* = 1.859832; Model 3: *Dh* = 1.361856) is lower than the critical value of the normal distribution at 5% significance level, so the assumption of no autocorrelation of the random component was met. The last assumption was that of normality of the distribution of the random component. Using Shapiro-Wilk test for the model 2 value p = 0.136104 was obtained, and for the model 3 value p = 0.135272 was obtained which means that in this case the last of the KMNK assumption was met. The models have passed the verification which means that they can be used for conclusions

Figure 16. Empirical and equalised values of births in Poland according to the place of residence (per 1,000 of inhabitants)



Source: Own elaboration.

Thus, all "shock" values were removed due to the lack of significance in the model, which means that the birth rate in Poland by place of residence was not impacted by the introduction of the social programme itself (regardless of its version), but as it can be seen by its long-term duration (as evidenced by the significance of the parameters for a variable *duration500plus).* The value of this indicator is positive and similar for both agglomerations, and thus it may be concluded that the programme had a positive (and significant) impact on the number of births in Poland, both in urban and rural areas, and to an equal extent (increasing the level of births by 0.66 per 1000 inhabitants of rural areas and 0.65 per 1000 urban agglomerations). The birth rate was not affected by the "correction" of the programme, covering the benefit for the first child.

As it can be seen, the models are completed by an autoregressive factor, which had a positive effect on the fitting to the empirical data (M2: 86.5%, M3: 95.5%) and the correctness of the specification. The empirical and equalised values are illustrated in Figure 16.

CONCLUSIONS

The fertility rate in Poland is systematically decreasing but it is difficult to show whether it would not have decreased even more rapidly without this benefit.

Accepting the statement that the programme has not had any positive impact on the fertility rate does not generate an automatic approval for its termination either.

Nevertheless, there is no doubt that the asset of the "Family 500+" (now: "Family 800+") programme is its absolute universality and unconditional character, although it is the most expensive family policy instrument introduced in Poland.

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