Estimation of indirect demographic losses in Ukraine due to armed conflict

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Abstract

Any military actions lead to population losses. Direct losses – killed and dead as a result of armed confrontation, forced emigration, as well as the loss of residents through the alienation of the territory in which they remained. The estimate of the extent of direct demographic losses could partly be done by current estimation and more completely – by census. But any statistical survey is not able to determine the size of indirect losses – the number of unborn children due to the hostilities. In this case, it's possible to apply statistical modeling.

In this article we presented the results of statistical estimation of the impact of armed conflict on reduction of the number of births using the Interrupted ARIMA model $(0,1,1)(0,0,1)_4$, which also takes into account the seasonal character of childbearing. The model allows us to conclude that the number of births in Ukraine only in the second quarter of 2014 decreased by 9749 persons, through the annexation of the Crimea and the armed conflict in the Donbas. Continued hostilities, worsening of medical-demographic and socio-economic situation as in combat zone, as well as generally around Ukraine, gives reason to anticipate a further increase in indirect demographic losses.

***Keywords**:* indirect demographic losses, armed conflict, interrupted ARIMA

***JEL Classification**:* C22, C32, J11

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1 Introduction

Today's demographic losses in Ukraine are a consequence of not only recent large-scale tragic events: internal social upheavals and the armed conflict Russia and Ukraine. To this day, the population of Ukraine bears a historical trace of previous numerous losses. If Ukraine had not gone through a series of demographic catastrophes in wake of socio-political disasters and economic crisis, the hypothetical population at the beginning of 1991 would have been 87 million people instead of the actual 52 million (Romaniuk and Gladun, 2015). Thus, according to retrospective calculations of scientists of the Ptoukha Institute for Demography and Social Studies National Academy of Sciences of Ukraine, from 1904 until the beginning of the Russian aggression (2014), the total population losses in Ukraine, according to the current administrative-

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territorial boundaries, amounted to 35.6 million people (Romaniuk and Gladun, 2015). Ukrainian population has suffered such a devastating blow as a result of three wars, the Bolshevik revolution, three stages of mass famine of 1921-1923, 1932-1933, 1946-1947, the cholera epidemic (1910), Stalin's repressions and deportations, compulsory migration, as well as due to the "mortality crisis" (1969-1989) in peaceful times. In fact, the depopulation in Ukraine has been evident over the last 25 years, with its acceleration having started already 11 years before the Russian military aggression. After a prolonged fertility crisis and the survival mode (1992-2002), as well as a powerful wave of emigration (1994-2004), a period of "demographic thaw" came around in wake of a notable increase in fertility, reduced infant mortality, prolonged life expectancy, and a positive surplus in external migration. However, with an aggravation of the socio-political situation and the deployment of military actions (2014-2017), the indicators of natural and migration increase and the process of depopulation accelerated (during 2013-2017 the population decreased annually by an average of 0.58% against -0.51% in 2005-2012). In total, over the years of independence, the population of Ukraine has decreased by 7.3 million persons, also taking into account the loss of residents of Crimea - by 9.2 million persons. As a result of the annexation of Crimea and escalation of the armed conflict in the Donbas region, Ukraine has suffered significant human losses. According to UN data, from April 2014 to August 2017, the total number of deaths (military men on both sides and civilians) reached 10 225 and 24 541 wounded (*Report on the Human Rights*..., 2017).

Formulation of the problem**.** The estimation of the extent of direct demographic losses can be partially done based on current estimation and completely enough during census. Unfortunately, Ukraine has missed the preliminary world round of censuses in 2010-2011; and since the last all-Ukrainian census of 2001, it has been using the current estimates of natural and migration increase. It is clear that during of war it is not possible to ensure reliability of the current estimation, even in the controlled territory because of the unaccounted actual external migration (emigration) and high mobility of internally displaced persons, as well as incompleteness of the registration of deaths and births in the zone of military actions. Partially this gap should be filled by the data of statistical registers: internally displaced persons and taxpayers. But no statistical survey can determine the amount of indirect losses – the number of unborn children as a result of hostilities. Military mobilization, large-scale emigration, worsening living conditions have exacerbated the current regime of population replacement and its gender

balance, especially in the reproductive age, which has adversely affected the intensity of marriage and childrearing.

Therefore, the problem of estimating indirect demographic losses is relevant; In particular, the question arises about the choice and application of statistical estimation methods: interpolation of the parameters of demographic models (Ediev, 2010; Mesle and Valin et al., 2008), reconstruction of interrupted time series using archival data of censuses and accounting (Duthe et al., 2010; Pechholdova et al., 2017; Rudnytskyi et al., 2015), simulation modeling based on certain assumptions, etc. (Palian, 2016). The results of a comprehensive scientific research of direct and indirect hypothetical losses of the population of Ukraine due to three demographic disasters were first published in monograph (Mesle and Vallin et al., 2008). Well-known Russian researchers have been fruitfully working on statistical assessment of the effects of demographic disasters on the territory of the former USSR (Andreev et al., 2006). Results of a multifaceted scientific work by scientists of the Ptoukha Institute for Demography and Social Studies National Academy of Sciences of Ukraine together with Romaniuk and Gladun (2015), Rudnytskyi et al. (2015) deserve special attention. Due to a thorough archival search, diverse scientific developments performed by O. Rudnyts'kyi, time series of population size and number of births and deaths in Ukraine (in its current borders) between 1850 and 2013 were reconstructed. Thus, today we have an idea of the size of losses of the Ukrainian population as a result of social cataclysms of the last century (Rudnytskyi, et al., 2015). It is extremely important for Ukraine to know about demographic consequences of the current armed conflict not only from the point of view of population forecast, but also for the formation of an adequate state demographic policy. Indirect demographic losses as a result of military conflicts affect both natural population increase and its sex-age structure, in particular, the deepening of aging. The topic of impact of military events on demographic losses, infant mortality and deficiency of births was considered in works (Duthe et al., 2010; Krimer, 2015; Palian, 2016). In particulary, an analysis of changes in childbearing behavior of women during and after armed conflicts in the countries of the Balkan Peninsula with reflection to Ukraine (Krimer, 2015) was made, and an attempt to estimate the size of direct and indirect losses of Ukrainian population as a result of the annexation of Crimea was done by means of simulation, cohort component method and side calculations (Palian, 2016).

From the beginning of the socio-political crisis and Russian military aggression, the birth rate between 2013 and 2016 dropped by an average of 2.5% annually and the number of births – by 35.5 thousand children, including the results of complete alienation of the Crimean territory and parts of Donetsk and Luhansk regions.

The purpose of the article is to assess indirect demographic losses of Ukraine due to the annexation of Crimea and escalation of the armed conflict in the Donbas region.

Methodology. To substantiate the model describing the trend of live births in Ukraine, we will consider quarterly data for 2003-2016 (Fig.1).

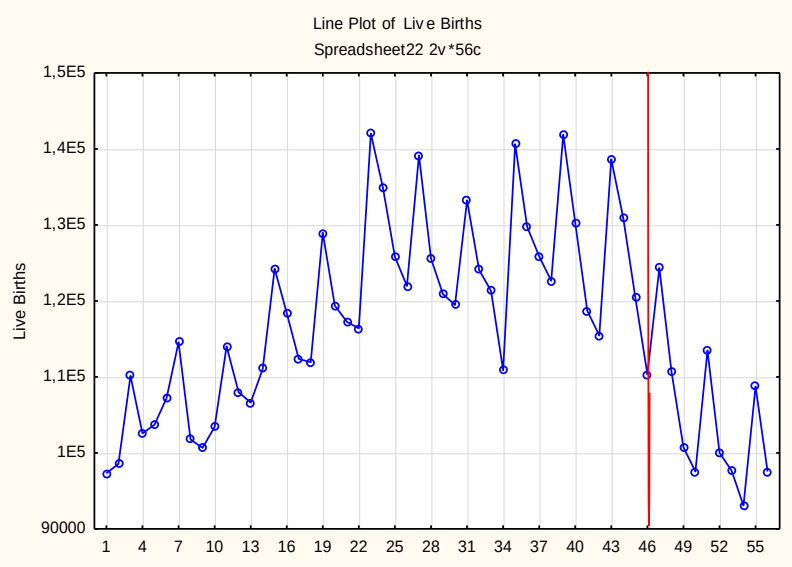

Fig. 1. Dynamics of the quarterly of live births in Ukraine by 2003-2016.

Source: calculated by the data of the State Statistics Service of Ukraine.

It is obvious that the dynamics reveals two peculiarities of the process of childbearing: 1) significant seasonal fluctuations; 2) breaking the positive trend through external influence – the intervention that took place since the beginning of the annexation of Crimea and the armed conflict in the Donbas (in the second quarter of 2014). For analyzing and forecasting processes related to seasonal fluctuations and the broken trend, the Autoregressive Integrated Moving-Average (ARIMA) model is most effective. ARIMA is formed through a combination of autoregressive models of order p and a moving average of order q. The non-stationary series reduces to a stationary type with the help of the operator of finite differences d. The ARIMA model (p, d, q) is quite flexible and describes a wide range of processes. In the presence of

seasonal fluctuations, the model takes into account their periodicity with the lag *s*, which is equal to the seasonal cycle and the analogous content of seasonal parameters (*P, D, Q*) *s*. Therefore, the full seasonal ARIMA model has the form of *ARIMA (p, d, q) (P, D, Q) s.* Depending on the type of intervention, to assess its consequences corresponding additional parameters are introduced to the ARIMA model. In the integrated STATISTICA system, three types of intervention are distinguished: (1) Abrupt, Permanent; (2) Gradual, Permanent; (3) Abrupt, temporary. The type of intervention and values of the parameters of the autoregression *p*, the moving average *q* and the operator *d* are determined at the identification stage of the model.

Principles and concepts of the Interrupted time-series analysis method are elaborately described by McDowall et al. (1980). Numerous scientific studies confirm the analytical capabilities of Interrupted ARIMA for measuring effects the effects of different types of interventions (see more: Linden, 2015; Norpoth, 1981). In the context of analysis of consequences of military conflicts, the study of Norpoth (1987) deserves attention; in it, the Interrupted ARIMA is used to assess the impact of the 1982 Falkland War and the change in macroeconomic policies on the popularity of Thatcher's government and the Conservative Party. The Interrupted time-series analysis techniques tend to improve over time. Thus, Linden (2017) suggests additional Interrupted ARIMA procedures allowing assessment of the effects of interventions on several groups and compares the effects of different interventions.

2 Estimation and forecasting of live births based on the Interrupted ARIMA

Adequacy of the ARIMA model to the real processes and its predictive properties depend on the parameters *p, d, q.* Analysis of correlograms gives grounds to identify the model of the number of births in Ukraine as ARIMA$(0,1,1)(0,0,1)_4$. The filtration of the trend is performed by an operator of differences of the first-order ($d = 1$), the type of the model is an exponential average ($q = 1$). The model takes into account the seasonal nature of fertility. Analysis of the graphically presented dynamics of live births in Ukraine (Fig.1) shows a sharp shift in the positive trend in point 46: the time series is rapidly breaking to a certain level, without changing the seasonal mode of fluctuations. This is a result of the escalation of the armed conflict in the 2nd quarter of 2014. In this regard, the Interrupted ARIMA model was used to predict the live births: the intervention number is 46, the type of intervention is Abrupt, Permanent. The parameters of the Interrupted ARIMA model $(0,1,1)(0,0,1)_4$ provided in Table 1 give grounds to conclude that the

model is adequate to the actual process. Thus, the parameters of smoothing of the series (q(1) = 0.66 and $Q_4(1)$ = -0.57) turned out significant with a probability of 0.999; the parameter of influence of intervention ω with the probability of 0.913 indicates that due to the annexation of Crimea and the armed conflict in the Donbas, the live births in Ukraine per quarter decreased by 9749 persons. Adequacy of the model is also confirmed by results of the analysis of residues.

Table 1. Parameters of the Interrupted ARIMA model $(0,1,1)(0,0,1)_4$ for the time series of live births in Ukraine in 2003-2016.

Input: Live Births								
Transformation: D(1) (Interrupted ARIMA)								
Model (0, 1, 1)(0,0,1) Seasonal lag: 4 MS Residual= 5466E4								
Paramet.	**Param.**	**Asympt. Std. Err.**	**Asympt. t(52)**	**p**	**Lower 95% Conf**	**Upper 95% Conf.**	**Interv. Case No.**	**Interv. Type**
q(1)	0.66	0.132	4.998	0.000	0.40	0.92		
$Q_s(1)$	-0.57	0.099	-5.804	0.000	-0.80	-0.38		
Omega	-9749	5587	-1745	0.087	-20961	-1462	46	Abr/Perm

Table 2. Estimated values of the live births in Ukraine in 2016 and 2017.

Forecasts: Model (0,1,1)(0,0,1) 1 interventions Input Live Births						
Start of origin: 1 End of origin: 52						
Case #	**Forecast**	**Lower 95%**	**Upper 95%**	**Std. Err.**	**Observed**	**Residual**
53	97939	85168	110711	7626	97678	-261
54	95270	81780	108760	8055	93076	-2194
55	103606	89434	117778	8462	108743	5137
56	99539	84716	114361	8851	97542	-1997
57	101736	88940	114411	7604		
58	98633	84780	112486	8272		
59	102762	87874	117650	8890		
60	98556	82721	114430	9467		

Defined on the basis of Interrupted ARIMA $(0,1,1)(0,0,1)_4$, the forecasted values of the number of births in Ukraine for 2016 and 2017 are given in Table 2. The predicted properties of the model are confirmed by a retrospective assessment of the expected number of births in 2016. Relative errors of quarterly forecasts by modulo: for the first quarter – 0.27%; for the second – 2.35%; for the third – 4.72%; for the fourth – 2.04%.

Thus, in a short-term perspective, a slight decrease of the live births is expected. A logical question arises as to how corresponding is the dynamics of the two interrelated processes – childbearing and marriage?

3 Specificity of marriage trends

Despite the current global trends in the formation of marriage and family relations, the complex and unstable socio-economic situation, in Ukraine the preferences of partners for marriage and family are preserved. The main form of marital relations remains the officially registered marriage. As shown on Fig. 2, the dynamics of the number of registered marriages with internally annual minimum and maximum values for 2003-2016 does not show a clear tendency to decrease. At the same time, there is an effect of people's commitment to ancient folk traditions: in leap years (2008, 2012, 2016) that are considered unfavorable for marriage, their number decreases, while in years before the leap year - on the contrary, increases. It is noteworthy that recently (from 2012) there is a contraction of internal annual differences between the maximum and minimum number of registered marriages. That is, the monthly seasonality of marriages is less expressive, and the dependence of motivation of marital behavior on old traditions diminishes.

The armed conflict in the Donbas region and economic difficulties became a major challenge for Ukrainian families: the numbers of widows and orphans increases, family ties weaken due to forced migration (internally displacing from the combat zone, emigration). At the same time, in conditions of instability and unpredictability of the future, it is family solidarity and mutual assistance that allows maintaining life activity, and sometimes even survival. Many pairs want to register their marital relationships, give birth to children. If there were 31200 marriages per year by three pre-war years, but over a period of the escalation of the armed conflict (2014-2016), the average annual number of registered marriages was 27500. Therefore,

even if part of the population remained in the annexed and occupied territory of Ukraine, the number of marriages decreased insignificantly.

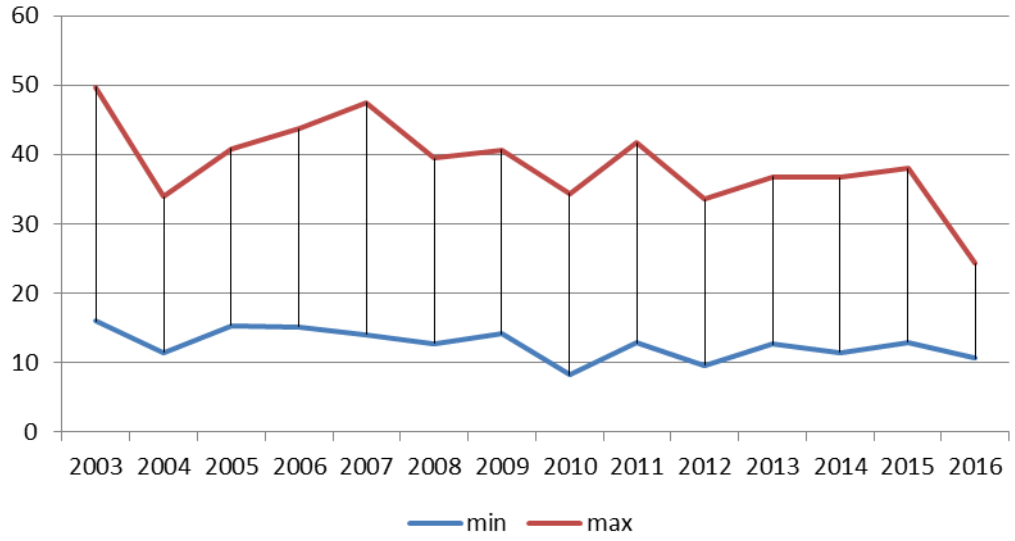

Fig. 2. Number of registered marriages in Ukraine by 2003-2016, 000'.
Source: calculated by the of the SSSU.

The specificity of the modern marriage process in Ukraine is also evidenced by the correlogram: 1) absence of the trend confirms the non-essential nature of the first-order auto-correlation coefficient r_1; 2) statistically significant coefficients of autocorrelation r_k, which at k = 2, 4, 6, 8, 12, alternately change the sign, indicate an intra-annual cyclicity when peaks and recessions of marriage registration are alternating (Fig. 3). Thus, marriages registration during the period of escalation of the armed conflict didn't suffer such significant changes that happened to the number of births. On the other hand, the relative stability of the time series of registered marriages is an important prerequisite for an expected equalization of the dynamics of childbearing. It is obvious, however, that responsible parenting requires a stable internal political and socio-economic situation. As long as the undeclared war on the part of Russia continues in Ukraine, moderate state demographic, environmental, health and sanitary, as well as economic policies should play an important role in the country. This also implies social support of young families, including those with children, as well as employment for young people and middle-

aged people at the regional level, regardless of the status of the territory: whether it is peaceful, de-occupied or a buffer zone.

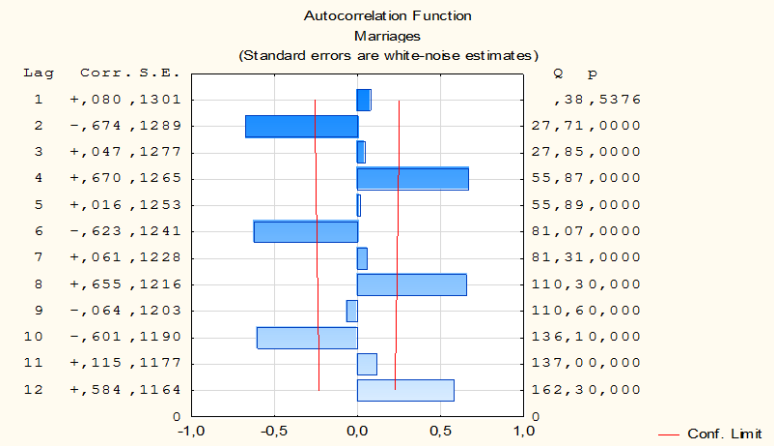

Fig. 3. Correlogram of the number of registered marriages.

Source: calculated by the data of the SSSU.

Conclusions

An armed conflict inevitably leads to human losses, and in the context of modern wars on the post-Soviet territories (Moldova, Armenia, Georgia and Ukraine), it also means losses of the population due to violation of integrity of the countries. Statistical estimation the size of direct and indirect demographic losses is complicated by incomplete registration, territorial incomparability of data and fragmentation of time series. Application of adequate modeling methods can find the effect of occupation the part Ukrainian's territory on indirect population losses. Further research in this area may focus on the estimation of expected indirect population losses as a result of partial deformation the sex-age structure of the reproductive contingent due to the armed conflict in country.

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