# ECONOMIC INDICATORS AND FERTILITY: A NEW APPROACH TO RELATIONSHIP ANALYSIS

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**Abstract**

The paper presents a new approach to analyse influence of the economic factor on fertility. The research is based on two types of analyses: 1) cluster analysis of Russian regions on the basis of economic indicators with the subsequent birth rate profiling of clusters; 2) correlation analysis and regression of birth rate and income time series. Thus, we combined the analysis of one time dimension data (in 2016) with the analysis of time series (the historical trends of 2010-2016). The results are as follows: firstly, we identified 3 clusters, which integrate the regions with the similar income issues. Secondly, we did not reveal statistically significant differences in the birth rate of the clusters. Thirdly, the results of time series correlation and regression analysis did not confirm the relationship between birth rate and income in Russia as a whole. Thereby, the relationship between income and fertility was confirmed by neither a one time dimension data nor historical trends. The results obtained demonstrate, that demographic policy in Russia, aimed primarily to increase the population income, may be inefficient. It is necessary to take a set of informational, legal and infrastructural measures in policy planning and implementation.

**Key words:** fertility, economic indicators, cluster analysis, correlation analysis, regression

**JEL Code:** J11, J13, C3

## Introduction

In any country, fertility is affected by economic, socio-cultural, religious and inner-political indicators. The influence of each group of indicators is studied at different levels. Thus, for instance, Morgan and Taylor identify three different scopes of low fertility theories: global, interactive and idiosyncratic (Morgan & Taylor, 2006), Mills et al. employ national, international and individual-level data source to study the reasons for low fertility in European countries (Mills et al., 2011), whereas Balbo et al. distinguish three levels of the influence, namely micro-, meso- and macro-level (Balbo et al., 2013). Among the group of economic indicators, the last-mentioned authors also consider the population income, the level of economic and employment uncertainty (micro-level) and economic and (un)employment trends (macro-level) as determinants of fertility. It is important to note that researchers' opinions differ widely on the relationship between these indicators and fertility.

In the demographic studies, two statistical tools – index method and correlation and regression analysis – are most commonly applied to assess the influence of different indicators on fertility. Within the index method, we can further distinguish its two varieties. In the first case, the analysis is based on building index models of relationship between fertility and multiple demographic structures. The second variety suggests correlating the actual birth rate with the level of 'natural fertility'. To offer an example, there are widely-known Coale's indices, used to assess the potentials of total, martial and illegitimate fertility on the basis of correlation between actual birth rates and those occurred in the Hutterites' sect (maximum of natural fertility) [Coale, 1969].

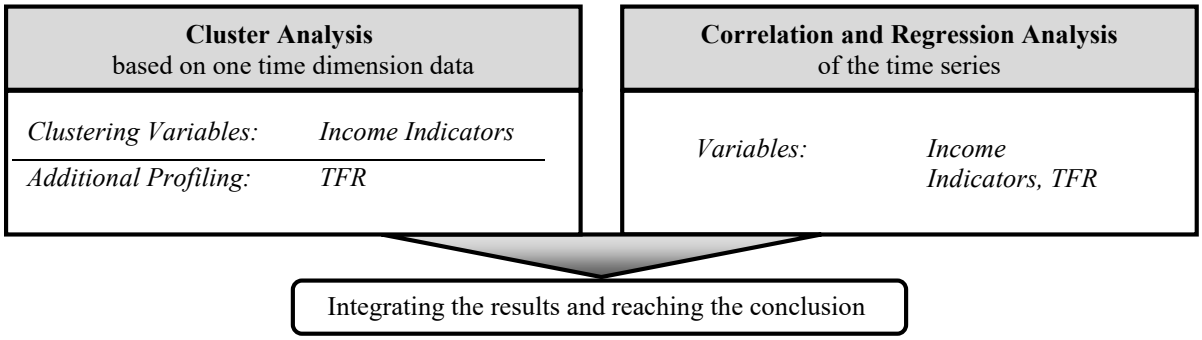
Correlation and regression analysis provides an opportunity to investigate a wider spectrum of fertility determinants. The analysis is based on either the data of one time dimension (e.g., the correlation of income and birth rates in different countries at the particular period of time) or time series data (e.g., the examination of relationship between fertility and income time series in the particular country). Yet, country-wide indices, used in such studies, are not always valid. For instance, Russian regions are historically different in both fertility level and population income. This vital distinction may lead to the fact, that mean country-wide indices reveal an abstract, non-relevant for the majority of regions situation. Thus, in the case of fertility determinants research it is imperative to employ an approach, which both considers regional peculiarities and neglects possibly invalid mean indices.

The aim of the paper is to present an original approach to the analysis of relationship between economic factor and fertility. The approach simultaneously considers socio-economic differentiation of Russian regions and assesses both static and dynamic natures of the discrepancy.

# 1 Data and Methods

1. In the course of our research, we used an original approach which presupposes an integrity analysis of the relationship between population income and fertility based on two types of data, namely, one time dimension and time series (Fig. 1).

**Fig. 1: Original Approach to the fertility determinants analysis**




Firstly, we consider the cluster analysis of Russian regions as a way to test hypotheses for the possible indicators relationship. Historical socio-economic differentiation of Russian regions and their considerable number offer an opportunity to applied the aforementioned type of analysis and expose homogeneous segments sufficient in size. We believe it is reasonable to cluster regions on the basis of interrelated indicators which describe the independent variables (in our case these are regional economic indicators). Profiling of clusters identified may be based on those variables which are not involved in clustering, though are dependent ones (in our case it is birth rate). The differencies revealed in the cluster centroids will apparently prove the relationship between independent and dependent variables.

Secondly, we assume that it is necessary to add the analysis of historical trends to the results of one time dimension analysis in order to have a clearer notion of fertility determinants. We suggest using a correlation and regression analysis of the time series, which illustrate dynamics of both income and birth rate. It should be taken into consideration that indicators dynamics may reveal a trend (e.g., the TFR in Russia saw an annual increase from 2010 to 2015 (Total Fertility Rate, 2010-2015) and cyclical and seasonal variations (we have previously discussed seasonal variation in birth rate, e.g., see Shubat & Bagirova, 2014). To that end, it is necessary to perform the analysis of relationship between the time series on the basis of their preliminary decomposition as well as either correlation analysis of trends deviation or regression analysis of data which is not exposed to seasonal variations with the temporal factor included in the model.

2. For the clyster analysis, we used official Russian statistics relevant for 2016. Clustering was performed on the basis of income indicators and those of income inequality. We used the following indicators:

- Gross Regional Product (GRP) per capita;
- poverty rate (i.e., the share of people with income lower than the subsistence level);
- ratio between average per capita income and subsistence level;
- Gini coefficient;
- decile dispersal ratio (Population Incomes, 2016).

For the additional profiling of clusters discovered, we used the Total Fertility Rate (Total Fertility Rate, 2016).

Hierarchical clustering is based on Euclidian distance and Ward method. By these means we arrived at a clear division of the regions into homogeneous segments. In the course of analysis we also conducted a study of cluster centroids, namely, mean and median values of clustering variables were measured for each group of regions and tests for statistical significance of differences were performed.

3. For the correlation and regression analysis of income and birth rate, we used data sourced from World Bank and Russian Federal State Statistics Service from 2010 to 2016. The following indicators were included in the analysis:

- GDP per capita (in 2010 US dollars) (GDP per capita, 2010-2016);
- consumer confidence index (i.e., a generalised index calculated by the Russian Federal State Statistics Service on the basis of public evaluation of current and upcoming nationwide changes) (Population Incomes, 2010-2016);
- decile dispersal ratio (Population Incomes, 2010-2016);
- coefficient Gini;
- TFR (Total Fertility Rate, 2010-2016).

Consequently, we studied the relationship between fertility and both objective and subjective indicators of population income, and then examined one between fertility and level of income inequality.

For the time series relationship analysis we have used Pearson correlation and Spearman's rank correlation calculated for trends deviations and estimated multiregression models, where the temporal factor serves as one of the explanatory variables. To analyse the

relationship, the synchronous and one- and two-year lagged data was applied. We assume, that changes in income level may affect birth rate with delay (e.g., one- or two-year time lag).

## 2 Results

1. The original approach to the study proposed features Russian regions clustering. It is reasonable, because, as the analysis carried out previously proves, levels of variables under study differ essentially by region; their minimax values vary from 1.3 to 15.1 (Tab. 1). The variability enables to detect groups of Russian regions with the similar level of population income.

**Tab. 1: Minimal and Maximal Values for Clustering Variables**

| Clustering Variable | Minimal Value | Maximal Value | Ratio of Maximum to Minimum |
|---|---|---|---|
| GRP per capita (rubles) | 109523.4 | 1651995.9 | 15.1 |
| Poverty rate (%) | 7.5 | 42.1 | 5.6 |
| Income-subsistence level ratio (%) | 174.8 | 482.2 | 2.8 |
| Gini coefficient | 0.334 | 0.426 | 1.3 |
| Decile dispersal ratio | 4.7 | 7.7 | 1.6 |

Source: own study

2. Hierarchical cluster analysis revealed 3 clusters of regions with the similar income issues. Characteristics of cluster centroids are presented in Table 2. Figure 2 shows the clustering dendrogram. Parametric and non-parametric tests proved the statistically significant difference in mean and median values of variables in each cluster.

**Tab. 2: Cluster Centroids**

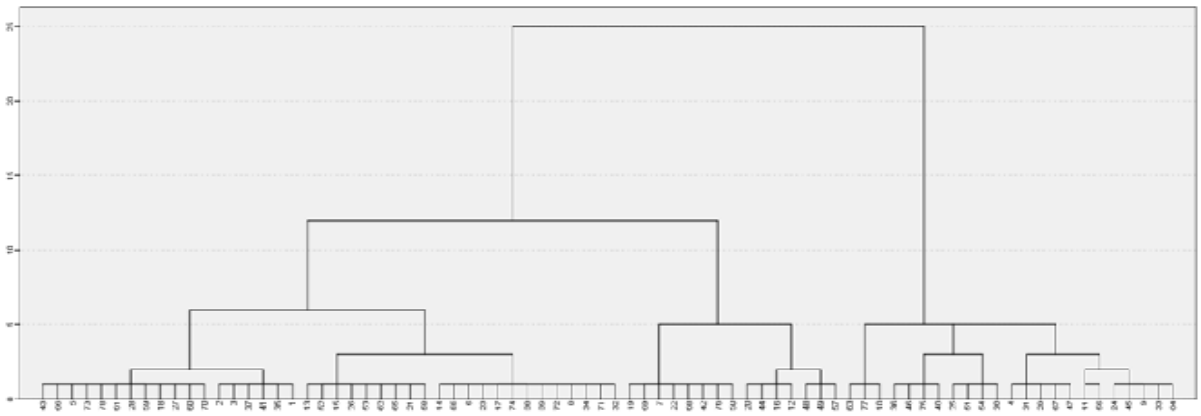
| Variables | Cluster 1 | | Cluster 2 | | Cluster 3 | |
|---|---|---|---|---|---|---|
| | mean | median | mean | median | mean | median |
| GRP per capita (rubles) | 573423.1 | 459812.1 | 264211.9 | 225921.3 | 321413.1 | 321036.7 |
| Poverty rate (%) | 12.0 | 10.4 | 22.8 | 19.0 | 14.9 | 14.5 |
| Income-subsistence level ratio (%) | 379.6 | 384.9 | 230.4 | 234.7 | 295.4 | 292.3 |
| Coefficient Gini | 0.403 | 0.403 | 0.350 | 0.350 | 0.373 | 0.373 |
| Decile dispersal ratio | 6.8 | 6.8 | 5.1 | 5.1 | 5.8 | 5.8 |

Source: own study

23 Russian regions comprise cluster 1, which we entitled “High Income and Its Inequality.” Within cluster 1 we observe the lowest poverty rate and highest GRP per capita and ratio between income and subsistence level. Similarly, there exposed the highest level of income inequality.

Cluster 2 is the complete opposite to cluster 1. It unites 15 regions and is referred to as “Low Income and Low Level of Its Inequality”. The regions of this cluster demonstrate the highest poverty rate and the lowest GRP per capita and ratio between income and subsistence level. Additionally, there revealed the lowest level of income differentiation.

**Fig. 2: Dendrogram of Clustering Regions by Income Level**



Cluster 3 occupies an intermediate position. It is comprised of 40 Russian regions.

3. Clusters profiling based on the TFR revealed, that fertility rates are not statistically different in three clusters (Tab. 3). Parametric and non-parametric tests for mean and median value did not prove the significance of differences revealed.

**Tab. 3: Mean and Median Values of Fertility Rates within Clusters**

| Cluster | Total Fertility Rate | |
|---|---|---|
| | Mean | Median |
| 1 | 1.849 | 1.830 |
| 2 | 1.919 | 1.760 |
| 3 | 1.741 | 1.720 |

Source: own study

Thus, the results of the one time dimension study based on the cluster analysis of Russian regions did not prove the relationship between birth rate and both income indicators and level of its inequality.

4. The historical trends analysis of the fertility-income relationship (i.e., based on 2010-2016 time series data) is presented in one of our studies in close detail (see Shubat & Bagirova, 2018). The following are the most considerable results of the analysis.

Firstly, the relationship between TFR and GDP per capita was proved by neither synchronous data nor one- and two-year lagged data. The analysis was based on both regression models study and that of trend deviations correlation for two time series under consideration. Parameters of the models were statistically insignificant. Similarly, Pearson and Spearmen correlations were both low and statistically insignificant.

Secondly, the analysis did not prove, that subjective perceptions of income and economic conditions hypothetically affect fertility. For instance, consumer confidence indices in Russia did not develop unidirectionally from 2000 to 2016. Before 2007, consumer confidence had seen rather steady growth, however afterwards it experienced volatility and was prone to steep decline. Despite the unstable and multidirectional dynamics of consumer sentiment, Russia experienced an annual birth rate increase, which eliminates any relationship between these indices.

Thirdly, the level of income inequality was not proven to affect fertility. The decile dispersal ratio time series and those of coefficient Gini did not develop unidirectionally from 2000 to 2016 in Russia. In particular, the level of income inequality had seen a rise until 2007, yet later it remained stable and experienced a decline afterwards. Taking the continuous growth of TFR in the same time period into consideration, we cannot prove the relationship between fertility and income inequality.

In conclusion, the analysis based on the original approach proposed did not prove the relationship between fertility and population income in Russia as well as its objective level, subjective perception and inequality.

## 3 Discussions and Conclusion

The scope of demographic problems in Russia obliges governmental bodies to introduce more incentives, aimed at overcoming negative tendencies. To offer an example, the national project referred to as “The Demographics” was introduced in 2018. One of its objectives is to increase TFR up to 1.7 until 2024 (Passports of national projects, 2018). To that end, there has been developed a number of activities, most of which presuppose to increase financial support for families at the birth of children, including the following:

1) child birth benefit (including maternity capital);

2) monthly payments to needy families for the first child birth or adoption;

3) monthly payments for a third child;

4) subsidised mortgages for families with two and more children;

5) an increased number of in vitro fertilisation cases, funded by mandatory medical insurance system.

It is worth noting, that the previously existed Concept of Russia's Demographic Policy put an emphasis on economic measures as well. The results obtained during our research demonstrate, that demographic policy in Russia, aimed primarily to increase the population income, may be inefficient.

We believe it is necessary to take a set of informational, legal and infrastructural measures in policy planning and implementation. In particular, the greater influence on birth rate may be caused by subjective perception of parenthood and parenthood status, opportunities to establish a strategy of co-operation in professional and parental labour, the accessibility of modern kindergartens and education centres, etc. rather than objective economic indicators.

In conclusion, the original approach proposed to study the relationship between fertility and economic indicators provides an opportunity for a deeper analysis of determination phenomenon, as it suggests taking into account both current situation and historical trends. To continue the study, the approach proposed may be used to analyse other groups of fertility indicators.

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