

ASSESSING THE IMPACT OF POPULATION ON EMPLOYMENT IN UKRAINE: AN ECONOMETRIC APPROACH TO HETEROSCEDASTICITY

OSTASHOVA A.V., Master's Degree Student

Ivan Franko National University of Lviv, Lviv, Ukraine

The study of the relationship between employment and the permanent population allows for the identification of causal links between demographic processes and economic growth, which is crucial for the development of effective economic policies. It helps to understand how demographic changes impact the structure of the economy, labor demand, unemployment rates, and the social sphere. Furthermore, it facilitates the development of more accurate forecasts regarding demographic changes and their economic consequences, which are necessary for long-term country development planning. The study also allows for the assessment of potential risks related to population aging and depopulation, as well as the formulation of mitigation measures.

Econometric approaches are frequently used in macroeconomic modeling (for studying the impact of deposits attracted by banks on the macroeconomic situation) [1], statistical analysis (for modeling unemployment) [2], simultaneous models (for modeling economic performance) [3], cluster analysis (for modeling regional differentiation) [4], ARIMA (for white price modeling) [5] and key interest rate modeling [6].

The study of the relationship between the employed and permanent population will enhance our understanding of demographic trends and the influence of population on the economy. Statistical data on the number of employed and permanent population in Ukraine for the period 2000-2022 were obtained from the State Statistics Service of Ukraine [7].

First, we constructed a bivariate linear correlation-regression model:

$$\tilde{y} = -14139,6073 + 0,7285x + \varepsilon, \quad (4.1)$$

where $\tilde{y}$ represents the employed population,
 x represents the permanent population,
 e represents the random error.

The coefficient of determination for this model is 0.8127, indicating a strong relationship between the variables. However, there are reasons to suspect the presence of heteroscedasticity in the model. Based on the sample correlation-regression model, we computed the theoretical values of the dependent variable $\tilde{y}$, random deviations e , and squared random deviations e^2 . This resulted in the following graphical representation (Figure 4.1).

Since the distribution of points in Figure 4.1 is uneven, this suggests the presence of heteroscedasticity.

To confirm the presence of heteroscedasticity, we also performed the Park test. For this, we used the previously constructed bivariate linear correlation-regression model (1) and calculated the squared random deviations.

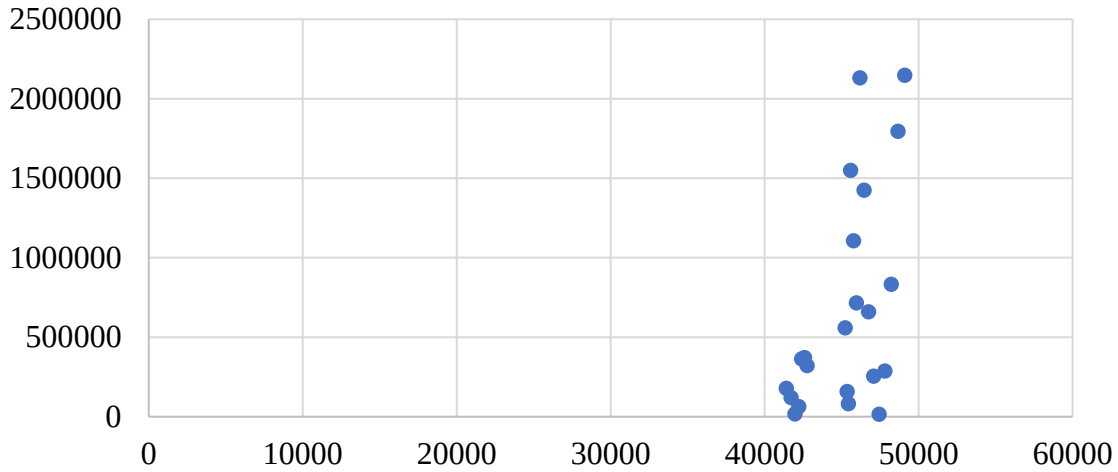


Figure 4.1 – Dependence of squared random deviations on the corresponding values of the permanent population

We then constructed a new bivariate linear correlation-regression model where $z = \ln(e^2)$ is the dependent variable, and $u = \ln(x)$ is the independent variable:

$$z = -119,8 + 12,37u; R^2 = 0,22 \quad (4.2)$$

The standard errors of the regression parameters were calculated as follows:

- Regression coefficient b: $S_b = 5,18$
- Intercept a: $S_a = 55,47$

We tested the statistical significance of the parameters using t-statistics. The empirical values of the t-statistics were:

$$t_a^{em} = -2,159, t_b^{em} = 2,389.$$

From the Student's t-distribution tables, for a significance level $\alpha = 0.05$ and degrees of freedom $v = 22 - 2 = 20$, the critical t-value is 1.72. Since the calculated empirical t-statistics for each parameter exceed the critical t-value, we can conclude with a probability of $p = 0.95$ that heteroscedasticity is present in the sample.

To eliminate heteroscedasticity, we employed the weighted least squares (WLS) method. We began by constructing a new correlation-regression model without the intercept but with an additional explanatory variable z and random error v :

$$y^* = -14654,9z + 0,7398x^* + v, \quad (4.3)$$

where $y^* = \frac{y}{\sqrt{x}}, z = \frac{1}{\sqrt{x}}, x^* = \sqrt{x}$.

In this model, the variance of the transformed error vv is constant, meaning that the assumption of homoscedasticity holds. We can now proceed to the classical regression model.

The t-statistics for the parameters of this correlation-regression model were calculated as follows:

$$t_{\beta 0}^{em} = -4,233, t_{\beta 1}^{em} = 9,664.$$

Both parameters are statistically significant since they exceed the critical t-value $t_{\alpha}^{kp} = 1,72$. The coefficient of determination $R^2=0$, which indicates that heteroscedasticity has been successfully eliminated.

The detection of heteroscedasticity demonstrates that the simple linear regression model cannot adequately describe the relationship between employment and the permanent population without accounting for heteroscedasticity. Therefore, addressing heteroscedasticity using the weighted least squares method improves the accuracy of model estimates. This enables the generation of more reliable and precise employment forecasts based on the permanent population. These results can be useful in planning economic policies, developing employment strategies, and formulating social programs.

The results of the study showed that to eliminate heteroscedasticity, it is better to use the model (3) with the weighted least squares method, as it offers better explanatory power than the initial model.

Thus, based on the econometric analysis of the relationship between employment and the permanent population in Ukraine, we confirm a strong correlation between employment and the permanent population. The model's coefficient of determination ($R^2 = 0.998$) indicates a significant dependence of employment levels on the population size. The study also found the presence of heteroscedasticity in the model, as the residual analysis revealed heterogeneity in variance, which impacts parameter estimate accuracy. Ignoring heteroscedasticity may lead to incorrect conclusions and ineffective predictions, so it must be addressed. The use of the weighted least squares method eliminated heteroscedasticity and improved the model's accuracy. The findings of this study can be applied to the development of effective economic policies aimed at regulating the labor market and ensuring population employment, such as evaluating the impact of demographic changes on the need for social services and developing appropriate programs.

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