MODEL OF DEPRIVED AREAS IN ENGLAND

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Abstract: *nowadays there are lots of areas, which are considered deprived all over the world. Each government has special programs – both on national and local levels – aiming to tackle deprivation. For example, the government of United Kingdom often uses the Index of Multiple Deprivation, to find out these regions and then to target funding to the most deprived ones. The model considered factors such as income, employment, health, education, skills and training and crime. It also looked at disability, access to housing and the built environment in cities and towns in England and Wales. I suppose that it will be useful for each government to have this index to help tackle deprivation.*

Keywords: *deprived areas, index of deprivation, econometric model.*

МОДЕЛЬ ДЕПРИВАЦИИ В АНГЛИИ

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Аннотация: *в настоящее время существует множество районов, которые считаются неблагополучными во всем мире. У каждого государства есть специальные программы - как на международном, так и на местном уровне, - направленные на борьбу с депривацией. Например, правительство Соединенного Королевства использует индекс депривации, чтобы распознать эти регионы, а затем определить целевое финансирование. Модель включает в себя такие факторы, как доход, занятость, здравоохранение, образование, навыки и профессиональная подготовка и преступность. Она также включает инвалидность, доступность жилья в городах и пригородах Англии и Уэльса.*

Ключевые слова: *неблагополучные районы, индекс депривации, эконометрическая модель.*

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The Index of Multiple Deprivation, commonly known as the IMD, is the official measure of relative deprivation for small areas in England. It is the most widely used of the Indices of Deprivation .The Index of Multiple Deprivation ranks every small area in England from 1 (most deprived area) to 32,844 (least deprived area)[8]. The English Index of Deprivation is based on 37 separate indicators, poverty indicators.

This Index is very useful, because it could help us to:

1. compare small areas across England;
2. identify the most deprived small areas;
3. explore the domains (or types) of deprivation;
4. compare larger areas e.g. local authorities;
5. look at changes in relative deprivation between versions (i.e. changes in ranks).

I have constructed the econometric model analysis of the dependence of economic parameters (Income rank, Employment rank, Education rank, Health rank, Crime rank, Barriers to housing and services rank and living environment rank) on Index of Deprivation of different districts of England. All data is taken from official governmental website of UK www.gov.uk. To be more precisely, I have used Statistics on relative deprivation in small areas in England. The English index of deprivation measure relative deprivation in small areas in England called lower-layer super output areas. The data are performed for different districts of UK for 2015. This is a direct link: https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015.

The initial form of the model is:

$$\begin{cases} Y_t = a_0 + a_1 \cdot X_{1t} + a_2 \cdot X_{2t} + a_3 \cdot X_{3t} + a_4 \cdot X_{4t} + a_5 \cdot X_{5t} + a_6 \cdot X_{6t} + a_7 \cdot X_{7t} + \varepsilon_t \\ a_1, a_2, a_3, a_4, a_5, a_6, a_7 > 0 \\ E(\varepsilon_t) = 0 \\ \sigma(\varepsilon_t) = const \end{cases}$$

where, Y_t –Index of Multiple Deprivation (IMD) Rank

X_{1t}– Income Rank

X_{2t}– Employment Rank

X_{3t}– Education, Skills and Training Rank

X_{4t}– Health Deprivation and Disability Rank

X_{5t} – Crime Rank

X_{6t} – Barriers to Housing and Services Rank

X_{7t} – Living Environment Rank

ε_t – disturbance term

To construct the good econometric model and understand that these economic parameters really have influence on Index of Deprivation, I made the following tests of this model.

The first step of investigation was the construction the correlation matrix.

Table 1. Correlation matrix

	Y	***X1***	***X2***	***X3***	***X4***	***X5***	***X6***	***X7***
Y	1,00							
X1	0,97	1,00						
X2	0,94	0,95	1,00					
X3	0,81	0,81	0,84	1,00				
X4	0,76	0,73	0,83	0,64	1,00			
X5	0,62	0,57	0,54	0,44	0,35	1,00		
X6	0,11	0,05	-0,12	-0,09	-0,27	0,09	1,00	
X7	0,48	0,41	0,35	0,21	0,33	0,17	-0,07	1,00

Source: https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015 Calculation made by the author.

According to the table, it can be seen that the first four parameters (Income rank, Employment rank, Education rank, Health rank) have strong positive linear relationship with Index of Multiple Deprivation (IMD) Rank. Crime Rank (X5) has weak linear relationship, and the rest have not linear relationships at all.

The next step of my investigation was to cover the regression analysis so that we could get the estimated form of this econometric model.

Estimated form of model

$$\begin{cases} Y_t = -5129{,}16 + 0{,}27 \cdot X_{1t} + 0{,}32 \cdot X_{2t} + 0{,}14 \cdot X_{3t} + 0{,}13 \cdot X_{4t} + 0{,}11 \cdot X_{5t} + 0{,}16 \cdot X_{6t} + 0{,}18 \cdot X_{7t} + \varepsilon_t \\ \quad (743{,}4) \quad (0{,}08) \quad (0{,}08) \quad (0{,}04) \quad (0{,}04) \quad (0{,}02) \quad (0{,}02) \quad (0{,}02) \quad (1211{,}46) \\ R^2 = 0{,}98 \; F = 343.84 \; F_{crit} = 2{,}23 \\ T_{crit} = 2{,}02 \; df_1 = 7 \;\; df_2 = 43 \end{cases}$$

Now instead the parameters $a_0, a_1, a_2, a_3, a_4, a_5, a_6, a_7$their estimates are presented in the equation: -5129; 0,27; 0,32; 0,14; 0,13; 0,11; 0,16; 0,18 correspondingly. Besides this, the system includes the standard deviations of parameters and disturbance term (numbers in round brackets) the values of R^2, F and F_{crit}.

R^2-TEST

Concerning this test everything is rather simple and not go beyond the analysis of R^2. According to this test if R^2 is close to 1 means that model is constructed very good because this parameter shows $X_{1t}, X_{2t}, X_{3t}, X_{4t}, X_{5t}, X_{6t}, X_{7t}$influence on the Y_t variable by linear regression. In our case R^2=0,98, so the model is constructed well because 98% of var. $X_{1t}, X_{2t}, X_{3t}, X_{4t}, X_{5t}, X_{6t}, X_{7t}$ describes var. Y by linear regression model.

F-TEST

This test also requires calculating the F-crit and compares it with F given in regression analysis. F-test results are presented below:

$$F_{crit} = 2{,}23 \; F = 343{,}84$$

This test checks the whole specification whether its quality is high or low and if R^2 is random variable or not. $If \; F_{crit} > F$, the quality of specification is low and R^2 is random. Otherwise, vice versa.

In our case according to the calculation$F_{crit} < F$, so I conclude that the quality of specification is high and R^2 is non-random variable.

T-TEST is held for checking a significance of coefficients. The following table provides significant information concerning with t-test.

Table 2. T-test

	$\lvert t_{stat} \rvert$	t_{crit}	**Significance**
a_0	-6,90	2,02	Yes
a_1	3,46	2,02	Yes
a_2	3,85	2,02	Yes
a_3	3,69	2,02	Yes
a_4	3,74	2,02	Yes
a_5	4,67	2,02	Yes
a_6	7,44	2,02	Yes
a_7	7,15	2,02	Yes

Source: https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015 Calculation made by the author.

THE CONFIDENCE INTERVAL AND THE ADEQUACY OF THE MODEL

Next step of my investigation was the estimation of the adequacy of model. For that I constructed confidence interval. Confidence interval consists of two boundaries: low and upper boundary. First of all I calculate theoretical point. $y^{\wedge} = a_0 + a_1 * X_1 + a_2 * X_2 + a_3 * X_3 + a_4 * X_4 + a_5 * X_5 + a_6 * X_6 + a_7 * X_7$. $y^{\wedge} = 1518{,}97$.

Then, I construct confidence interval:

$(Y_{52} - t_{crit} * S; Y_{52} + t_{crit} * S)$ = (1518,97 – 2,02*1211,46; 1077,06 + 2,02*1211,46)

= (-924,17; 3962,12)

So we can see that Y_{real52} = 1229, so it belongs to the confidence interval. This means that then with probability 98% my model is adequate.

GOLDFIELD-QUANT TEST

To verify the possibility of using method of ordinary least square it is necessary to check the premises of Gauss-Markov theorem. As a result of this test, we find out, if the residuals are homoscedastic or not and if we may use ordinary square to estimate parameters.

1. Finding the sum of the Absolute values of independent variables. In the model we have 7 independent variables, so in order to find abs of them I create the extra columns: $= ABS(X_1) + ABS(X_2) + ABS(X_3) + ABS(X_4) + ABS(X_5) + ABS(X_6) + ABS(X_7)$

As the number of observations is equal to 52, so it is possible to divide data in 3 parts: first part contains 20 observations; second – 12; and third – 20;

2. Building of regression models for first and third parts. After constructing regression models, using the SS_1 (green part) and SS_2 (blue part) we obtain Goldfield – Quant coefficient.

GQ=$\frac{SS_1}{SS_2}$=0,45;

1/GQ= 2,22

3. Comparing GQ and 1/GQ numbers with F_{critGQ}. If

$$\begin{cases} GQ < F_{critGQ} \\ 1/GQ < F_{critGQ} \end{cases},$$

this condition is fulfilled, residuals are homoscedastic and we may use ordinary square to estimate parameters or coefficients of the model; otherwise, residuals are heteroschedastic and we can't use ordinary square to estimate parameters or the coefficients of the model.

In the model I obtained F_{critGQ} = 2,91, as I can see 0,45<2,91 and 2,22<2,91 so residuals in this model are homoscedastic and I can use ordinary list square to estimate parameters of coefficients of the model.

DURBIN-WATSON TEST

Durbin-Watson test is used to check if there is an autocorrelation between nearest residuals. To calculate DW constant the following formula is applied:

$$DW = \frac{\sum (e_t - e_{t-1})^2}{\sum e_t^2} = 1.94$$

In model there are seven coefficients and number of observations is equal to 52, so n=52 and k =7. Using table of values for Durbin-Watson criteria I find values dl= 1.134 and du= 1.685. Then I make a table with intervals:

Table 3. Test of Durbin-Watson

0	dl	du	2	4-du	4-dl	4
0	1.081	1.692	2	2.308	2.919	4

Source: https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015Calculation made by the author.

If DW lies in red intervals there is an autocorrelation between two nearest residuals. The third Gauss-Markov condition was not confirmed and we can not use ordinary list square.

If DW lies in green interval there is no autocorrelation. Third condition of Gauss-Markov theorem is confirmed, I can use ordinary list square for estimated coefficients.

In my case DW=1.94, DW lies in green interval. It means that there is no autocorrelation between two nearest residuals and third condition of Gauss-Markov theorem is confirmed, I can use ordinary list square for estimated coefficients.

And finally, I made Interpretation of coefficients. If income will rise by one rank, the IMD will increase by 0,27 rank. If employment will rise by one rank, the IMD will increase by 0,32 rank. If Education, Skills and Training will rise by one rank, the IMD will increase by 0,14 rank. If Health Deprivation and Disability will rise by one rank, the IMD will increase by 0,13 rank. If Crime will rise by one rank, the IMD will increase by 0,11 rank. If Barriers to Housing and Services will rise by one rank, the IMD will increase by 0,16 rank. If Living Environment will rise by one rank, the IMD will increase by 0,18 rank.

CONCLUSION

In conclusion, it should be mentioned that this econometric model shows, that economic parameters have real impact on Index of Deprivation of different districts of England. It means that if district of England goes up by one position at income rank, the IMD will also increase by 0,32 rank. So, it may be conclude that if country uses this index to tackle deprivation, it will help the government to identify the critical social areas that the government should focus on it. By identifying these problematic areas government may accumulate all forces to enhance the economic parameter, like unemployment, education and crime rates.

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