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SPATIAL MICROSIMULATION ANALYSIS OF PROPORTION OF OUT-OF-POCKET PHARMACEUTICAL EXPENDITURES IN HOUSEHOLD INCOME IN POLAND IN THE YEARS 2010–2018

1. INTRODUCTION

Health care is a key sector in every economy and is of great medical, social, and economic importance to all citizens. It is also one of the most diverse sectors in the world, especially in the aspect of financing. In Poland health care is mostly publicly funded. Generally, 70% of funding is state-based, which has been the case at least since the beginning of the 21st century. In Poland there is practically no indirect funding covered by medical insurance, with the exception of insurance offered by employers in large. Therefore, the remaining 30% (one of the highest fractions in EU and OECD states) mostly includes out-of-pocket expenditures, either formal or not, that due to the system's inefficiency tend to increase.(Skrzypczak 2010.a, pp. 109–110) This fraction has a strong negative impact on households' socioeconomic status. (Żółtaszek, Jewczak 2011, pp. 151–152).

Generally expenditures can be divided into: ambulatory, hospital, unofficial, and pharmaceutical. On the micro level the first three are highly random, and therefore difficult to model and predict. On the other hand pharmaceutical expenses are observed in almost every household as due to healthcare system deficiency patients often turn to self-medication. Moreover, expenditures on medicine and other pharmaceuticals are a substantial fraction of total expenditures on healthcare. In Poland almost 30% of total funding covers medicinal costs, being one of the highest proportions in OECD and EU countries and since 1995 their value per person has risen by more than 500%. (Skrzypczak 2010.b, pp. 34–38). Thus the aim of this study was to apply a microsimulation to analyze the future proportion of direct pharmaceutical expenditures in household income in Poland. The results were used to perform a spatial analysis over provinces in Poland in the years 2010–2018. Therefore the main hypothesis states that: relative pharmaceutical expenditures in Poland in years 2010–2018 will be heterogeneous across provinces. To verify this statement microeconometric and microsimulation methodologies have been incorporated. The paper presents the process and results of the construction, estimation, and validation of a microeconometric panel model of households income per capita and the proportion of pharmaceutical

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expenditures in total net income. Subsequently, the construction of microsimulation model MESMEZ and the design of the experiment are described. Finally, spatiotemporal results of the research are being analyzed and presented.

2. MICROECONOMETRIC PANEL MODEL

The core of the microsimulation model is the microeconometric health economic model. It has been designed to calculate a household's monthly net real income per person and the proportion of pharmaceutical expenditures in total net income, as it is necessary to project these endogenous variables over time. The empirical data used for the estimation of coefficients are from a short panel for 1809 households observed in 2003, 2005, and 2007. It has been constructed of two separate but interdependent datasets from the Social Diagnosis: individual and household database.

The first equation explains net income per person in 1000 PLN[1]. The second one estimates the quotient of pharmaceutical expenditures in income, where the former is real value[2]of the average monthly expenditures from the last three months in PLN and the latter is the total net monthly real income of household (prices from 2011) in PLN. As the microeconometric model is an integral part of the microsimulation model the construction process is limited due to technical constraints of the projection procedure. The set of exogenous variables is restricted to demographic characteristic of households, as only these variables can be simulated over time based on probability parameters

An assumption set is needed for data and the microeconometric model: (1) data are reliable, they represent true situations of individuals and households at a given point in time, (2) private health care expenditures are evenly distributed throughout the year, (3) households were indifferent to the health care system's reform on a macro and regional level from 2003 to 2007, (4) specification of each equation represents the reality well, (5) there are no other interdependences between variables than those specified in the model, (6) the model is isolated, (7) the person with the highest education reflects the household's education level (or that person can influence other household members).

The income equation is a linear panel model and since the households are numerous random effects are applied. (Baltagi 2005, p. 17)Therefore it needs to be assumed that (8) the random individual effect is independent of exogenous variables. (Cameron, Trivedi 2005, p. 700). The general model can be presenter as:

$$I_{it} = \alpha_{0r} + \alpha_{1r} \cdot t + \alpha_{2r} \cdot NA_{it} + \alpha_{3r} \cdot NC_{it} + \alpha_{4r} \cdot NW_{it} + \alpha_{5r} \cdot E3_{it} + \alpha_{6r} \cdot E4_{it} + \varepsilon_{it}, \qquad (1)$$

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[1] The nominal values of the Social Diagnosis were changed to real by CPI (consumer price index) for prices of 2011.

[2] Values denominated by CPI for prices of 2011 only for health category products with slightly faster increase of prices than the general CPI.

where: t – time id, i – household id, r – region (province, voivodship) id (r=1,…16), I_{it} – net monthly real income per person, NA_{it} – number of adults, NC_{it} – number of children, NW_{it} – number of women, $E3_{it}$, $E4_{it}$ – binary variables of highest education in household (secondary and university respectively), ε_{it} – random error, and $\alpha_{0r},\ldots,\alpha_{6r}$ – coefficient varying by region, $\alpha_{2r} \cdot \alpha_{3r} = 0$ (ensuring that only one of these variables enters the model).

Since Polish provinces are heterogeneous, economically assuming that the strength and significance of variables' influence on income is constant across regions is unjustified. Therefore the parameters have been estimated separately for each region and the best fitted specification with only statistically significant variables was chosen. (see Table 1) The feasible generalized least squares (FGLS) method was applied to obtain parameters' values.

Table 1. Coefficients' estimates of income model and selected statistics by province

Province	**Const.**	**Time**	**No. adults**	**No. children**	**No. women**	**Second. Edu.**	**Higher Edu.**	**$R^2_{between}$ $R^2_{overall}$ [in %]**	**Wald χ^2**	**B&P χ^2**
DOL	**1.18** (12.5)	**0.024** (2.5)	**– 0.12** (– 3.9)	X	**– 0.14** (– 3.8)	**0.19** (3.6)	**0.4** (5.3)	**43** 36	**57.7**	**100.4**
KUJ	**0.88** (9.4)	**0.031** (2.2)	X	**– 0.09** (– 3.4)	**– 0.17** (– 4.6)	**0.23** (2.4)	**0.43** (4.2)	**31** 25	**51.8**	**190.6**
LBL	**0.91** (9.9)	**0.022** (2.8)	**– 0.05** (– 1.8)	X	**– 0.09** (– 2.1)	X	**0.2** (2.7)	**22** 19	**33.5**	**170.2**
LBS	**1.05** (8.9)	**0.04** (2.9)	X	**– 0.11** (– 2.5)	**– 0.19** (– 2.8)	X	**0.16** (1.8)	**23** 23	**53.0**	**114.0**
LOD	**1.15** (7.6)	**0.026** (2.6)	**– 0.07** (– 2.4)	X	**– 0.25** (– 2.6)	**0.25** (3.4)	**0.65** (3.4)	**37** 32	**46.4**	**99.1**
MAL	**1.09** (10.5)	**0.041** (4.1)	**– 0.09** (– 3.2)	X	**– 0.12** (– 2.9)	X	**0.31** (3.0)	**35** 39	**58.9**	**75.7**
MAZ	**1.04** (7.8)	**0.042** (4.9)	**– 0.09** (– 2.3)	X	**– 0.13** (– 2.4)	**0.2** (2.7)	**0.47** (3.4)	**20** 19	**39.5**	**274.7**
OPO	**1.14** (17.0)	X	X	**– 0.1** (– 2.4)	**– 0.2** (– 5.2)	**0.3** (2.9)	**0.43** (2.9)	**32** 23	**45.4**	**29.0**
PDK	**0.85** (10.5)	**0.033** (4.4)	**– 0.14** (– 5.7)	X	X	**0.24** (2.9)	**0.35** (3.7)	**34** 30	**45.1**	**128.9**
PDL	**1.14** (9.4)	**0.044** (4.6)	**– 0.13** (– 4.1)	X	**– 0.12** (– 2.5)	X	**0.21** (2.7)	**28** 27	**53.1**	**122.5**
POM	**0.92** (12.2)	**0.047** (3.8)	X	**– 0.12** (– 2.6)	**– 0.1** (– 2.6)	X	**0.25** (3.2)	**26** 21	**99.2**	**76.5**
SLA	**1.24** (12.3)	**0.043** (6.2)	**– 0.12** (– 4.3)	X	**– 0.18** (– 5.5)	**0.13** (2.1)	**0.2** (2.1)	**20** 20	**114.4**	**188.9**
SWI	**1.16** (12.14)	X	**– 0.09** (– 2.6)	X	**– 0.15** (– 4.3)	**0.2** (2.9)	**0.41** (5.0)	**41** 29	**58.6**	**38.3**
WAR	**0.98** (11.4)	**0.045** (4.0)	**– 0.1** (– 3.9)	X	**– 0.14** (– 4.9)	**0.22** (3.8)	**0.38** (4.5)	**30** 28	**47.9**	**104.9**

Table 1 (cont.).

Province	**Const.**	**Time**	**No. adults**	**No. children**	**No. women**	**Second. Edu.**	**Higher Edu.**	**$R^2_{between}$ $R^2_{overall}$ [in %]**	**Wald χ^2**	**B&P χ^2**
WLK	**0.97** (12.8)	**0.04** (4.1)	X	**– 0.05** (– 2.3)	**– 0.19** (– 5.0)	**0.1** (2.1)	**0.38** (4.1)	**32** 27	**52.9**	**139.6**
ZPO	**0.92** (12.0)	**0.04** (3.4)	X	**– 0.08** (– 2.9)	**– 0.21** (– 6.2)	**0.18** (3.2)	**0.5** (5.2)	**38** 30	**132.8**	**66.7**

Source: own calculations based on STATA estimation. (X – variable is not in the specification, in brackets under estimates Student's t-test statistics are presented) (Polish provinces' abbreviations: DOL – Dolnoslaskie, KUJ – Kujawsko-pomorskie, LBL – Lubelskie, LBS – Lubuskie, LOD – Lodzkie, MAL – Malopolskie, MAZ – Mazowieckie, OPO – Opolskie, PDK – Podkarpackie, PDL – Podlaskie, POM – Pomorskie, SLA – Slaskie, SWI – Swietokrzyskie, WAR – Warminsko-mazurskie, WLK – Wielkopolskie, ZPO – Zachodniopomorskie).

The constant value represents the expected value of the individual effect distribution, the highest in Slaskie province – over 1200 PLN, and the lowest in Podkarpackie – 850 PLN. It can be observed that the expected income per person is above 1000 PLN in 8 provinces.[3] It does not however reflect the general division into Southern and Eastern Poland as the poorest regions in comparison to the rest of the country or Mazowieckie as the voivodship with the highest salary. Therefore the income per person mirrors the combined economic and demographic characteristics of each province. Moreover, an increase over time of income per person can be observed in most regions by 22 (Lubelskie) – 42 (Pomorskie) PLN every year. Only in Opolskie and Swietokrzyskie does the change have no significant influence on the income level per capita.

For each province 2 models were verified with either the number of adults or children in household and the better fitted one has been chosen. In most cases the number of adults had better explanatory properties. Only in Kujawsko-pomorskie, Lubuskie, Opolskie, Pomorskie, Wielkopolskie, and Zachodniopomorskie was the number of children a superior alternative. In each of these provinces the coefficient was negative, which means that the more children the lower the income per person. The strongest impact was observed in Pomorskie (120 PLN decrease with every child) and the weakest in Wielkopolskie (50 PLN per child). The negative sign of α_3 is intuitively correct, as children do not contribute to the household income level. However, α_2 has values below 0, which is surprising. Each adult decreases the income per person by 50 (Lubelskie) to 140 (Podkarpackie) PLN. This suggests that a high fraction of households' members over 18 years old do not generate income, either being students or unemployed. Not only the age of household members is significant but also their

[3] Dolnoslaskie, Lubuskie, Lodzkie, Malopolskie, Mazowieckie, Opolskie, Podlaskie, Slaskie, Swietokrzyskie.

gender. With every woman the income per capita declines by 90 (Lubelskie) to 250 (Lodzkie) PLN. The effect is not observed only in Podkarpackie. Educational level is also an important factor. Generally differences between (1) primary or lower and (2) middle school or technical are statistically insignificant. The (3) secondary school and (4) university diploma as the highest level of members' education have an impact on the income level. Commonly, the higher the maximal education the more substantial the income per person. Households with secondary education had the income per capita higher by 100 (Wielkopolskie) to 250 (Lodzkie) PLN than primary or middle school level. In Lubelskie, Lubuskie, Malopolskie, Podlaskie, and Pomorskie the $E3_{it}$ variable was insignificant. A university education meant an income increase by 160 (Lubuskie) to 650 (Lodzkie) PLN compared to the 2 lowest levels of education. Each model was verified for goodness-of-fit, parameter significance, and random effects. Since STATA software does not offer a determination coefficient fitted for a random effects model, it is advised to take into consideration $R^2_{ovearll}$ measuring total fit to empirical data and $R^2_{between}$ incorporating households' individual effects (both fixed and random).(see STATA manual p. 448) In terms of microeconometric models all 16 equations are fairly well fitted to estimate the empirical data. The Student's t-test confirmed the significance of each variable at the significance level of 10% and the Wald test proved the overall significance of each set of exogenous variables at 1% significance level. In every province the random effect model was better than a pooled model, which was established by applying the Breusch and Pagan Lagrangian multiplier test for random effects, for a significance level of 1%.

The second equation was designed to estimate the burden of pharmaceutical expenditures on the household budget. Drug expenses are dependent on medical, social, and economic factors. Due to lacking information on health status economic aspect represented by household's income per capita and social side included be education level, gender, age, and disability of household's members are core variables in the specification. Since Poland has a unified health policy, one model was introduced and estimated. The quotient of expenditures and total income generate small numbers, and should be estimated as a panel Tobit model with random effects, truncated left sided at 0. The coefficients have been estimated by the maximum likelihood (ML) method in STATA. (see: Owczarczuk, 2010, p. 197) The estimated equation can be presented as follows:

$$\begin{aligned} PE_{it} = \underset{(12.4)}{0.054} - \underset{(-9.9)}{0.017} \cdot I_{it} - \underset{(-3.2)}{0.012} \cdot E2_{it} - \underset{(-3.9)}{0.013} \cdot E3_{it} - \underset{(-4.2)}{0.016} \cdot E4_{it} + \\ + \underset{(4.9)}{0.023} \cdot W_{it} + \underset{(10.5)}{0.036} \cdot D_{it} + \underset{(9.1)}{0.03} \cdot EL_{it} + e_{it} \end{aligned} \qquad (2)$$

where in brackets under coefficient values Student's t-test statistics are given and: PE_{it}– proportion of pharmaceutical expenditures in total net income, $E2_{it}$– binary variable of the highest education level in household (1 if middle school or technical), W_{it} – fraction of women, D_{it} – fraction of disabled, EL_{it} – fraction of elderly, e_{it} – residuals.

The average individual effect is 5.4% The main destimulants of the pharmaceutical expenditures in household income are income per person and education level. If the income per person rises by 1000 PLN, then the isolated change of the budget burden would decrease by 1.7%. It means that the income rises slower than the value of pharmaceutical expenditures. The higher the maximum education level, the lower the proportion. Households with primary school or lower education had the fraction higher by 1.2%, 1.3%, and 1.6% than those with middle school or technical, secondary school, and university diploma, respectively. The stimulants of medicinal expenditures in household income are fraction of women, elderly and disabled in the total number of household members. If the fraction of women rises by 10% then the isolated change of the endogenous variable would increase by 0.23%. If the fraction of disabled, certified or self-proclaimed went up by 10%, the proportion would increase by 0.36%. Also an increase of the fraction of elderly by 10% would cause a rise of the pharmaceutical expenditures in household income by 0.3%.It is intuitive that elderly and disabled, who not only generate higher but also systematic drug expenses, experience a bigger budget burden due to their expenditures on medicine. The model was verified for goodness-of-fit, parameter significance, and random effects. The Akaike Information Criterion (AIC) was the main statistic for the goodness-of-fit and its value (– 12 387) confirms that the model is well fitted to empirical data. Each parameter is statistically significant at the significance level of 10%, which was verified by Student's t-test. The likelihood ratio (LR) test proved that the set of exogenous variables is well specified (χ^2=443.9) for the significance level of 1%. The random effects model is better than the pooled model, which was checked (significance level 1%) by the LR test (χ^2=362.9).

3. MICROSIMULATION MODEL

To enable estimation of the income per person and the proportion of pharmaceutical expenditures in total income for the period 2010–2018 based on the microeconometric model, values of exogenous variables need to be established beforehand. A microsimulation is a method allowing demographic variables to be projected over time and based on these outcomes the dependent variables to be calculated. To perform an experiment a microsimulation model reflecting probable micro level changes must be employed. In Poland there are very few microsimulation models, none of which has been designed for long-term health economic analysis. Therefore it was necessary to construct an appropriate model for the purpose of this research. MESMEZ (*pol. Mikrosymulacyjny Ekonomiczno-Społeczny Model Ekonomii Zdrowia*) or Microsimulation Socio-economic Model for Health Economics is an interdisciplinary model design to project the starting population set over years 2010–2018. MESMEZ is a: dynamic[4], stochastic[5], time-based[6], closed[7], one-module[8] model programmmed in MS Visual Studio C++. (Żółtaszek 2011, pp. 182–185). The entry population is a representative sample of the Polish population of 2009 and the starting microdatabase has been derived from the Social Diagnosis individual set. The information for 37 777 people includes sex, age, disability status, education level, and the household ID.

As in case of any model MESMEZ is a simplification of a fragment of reality; therefore additional assumptions must be stated: (9) no events other than those incorporated into MESMEZ may occur, (10) MESMEZ parameters are constant over the period of the simulation, (11) the demographic and economic tendencies are constant in time and space, unless parameters state differently, (12) there is no interaction with the exterior world. The parameter set of the microsimulation model is based on the demographic distribution for Poland in 2009 or 2010. Every person in each year of simulation is subjected to the possibility of deterministic and stochastic alterations. The age is a deterministic variable which increases by 1 every year. Education level is partly deterministic and partly stochastic. Primary, middle, and secondary school education changes automatically when a person turns 12, 15, and 18, respectively, as schooling is compulsory until adulthood. Afterwards starting a university education is stochastic based on sex and province. Completing higher education first after 3 then 5 years is random, also sex and province dependent. Babies are born, the probability distribution is based on province and mother's age, while the baby's sex is random (probability of being female is 0.48). Disability status changes to invalid with probability determined by sex and age and back to healthy with arbitrary 0.01. There are no data available to calculate this value, but it seems inconsistent to omit such a possibility. Mortality is the final event based on sex, age, and province. Most probabilities (education, mortality, birth) represent demographic tendencies in Poland and are assimilated from Central Statistical Office Local Data Bank for the year 2010. Only disability status has been estimated from the Social Diagnosis 2009. After all events and changes for a given year occur individual variables are aggregated to household level and values of microeconometric explanatory variables can be obtained. Subsequently the endogenous income per person and the proportion of pharmaceutical expenditures in total income are calculated. These outcomes are averaged to province level.

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[4] The microeconometric model incorporates the time variable and exogenous variables are simulated.

[5] Demographic characteristics change according to given probability distributions.

[6] All persons are simulated for each year before going to the next period.

[7] There is no interaction with exterior objects.

[8] All functions and parts are incorporated in a single programming unit.

Since the starting population is a representative sample of Poland's population and stochastic parameters reflect Polish demographic distribution the projection should produce reliable macro level results.

4. RESULTS

A microsimulation experiment has been performed using MESMEZ, including the microeconometric model of income per person and proportion of pharmaceutical expenditures in total income, on the starting population of 37 777 objects being a representative sample of Poland's population of 2009. The process was conducted until we obtained a projection over the years 2010–2018.

4.1 INCOME PER PERSON

Generally the households' net real income per capita should increase every year in almost every province. The slowest increment and even contemporary declines can be expected in Opolskie and Swietokrzyskie. In 2010 the average (over provinces) is 820 PLN. The "poorest provinces" are clustered in Eastern Poland, while the "richest ones" are Opolskie, Dolnoslaskie and the Central voivodships (see: Fig. 1). The outcomes are consistent with common knowledge about the spatial income distribution. Over the next 7 years of projection the average income per person should increase from 857 PLN in 2011 to 1211 PLN in 2017. From 2010 to 2012 the smallest values of income per capita can be observed in Podkarpackie, then till 2017 in Lubelskie. The highest income per person in 2010 and 2011 is Opolskie, in 2012 Lodzkie, and then until 2018 in Mazowieckie. In 2018 the average income per person will be around 1253 PLN, with the lowest value in Swietokrzyskie and the highest in Mazowieckie (see:Fig. 1). The spatial distribution of net real income per person will change over time. At the end of the projection period the Eastern regions will remain economically disadvantaged, but the worst situation can be expected in the South–East. The richest provinces besides Mazowieckie will be Lodzkie, Slaskie but also Northern Pomorskie and Zachodniopomorskie.(see Fig. 1).

These changes in income per person spatial distribution can be attributed to differences in provinces' demographics in starting population, heterogeneity of microsimulation model parameters, and the estimates of econometric model coefficients.

The change rate, measured by the income chain index, shows that the highest increment can be observed in 2011 in Zachodniopomorskie and in 2012–2018 in Warminsko-mazurskie.

The smallest increases or contemporary decreases, by no more than 0.3%, may occur in Opolskie and Swietokrzyskie. The average change, defined as the geometric mean of chain indexes over time, shows that the highest change rate can be expected in Warminsko-mazurskie and Podlaskie of Eastern Poland, as well as Pomorskie and Zachodniopomorskie in the North–West (see: Fig. 2).

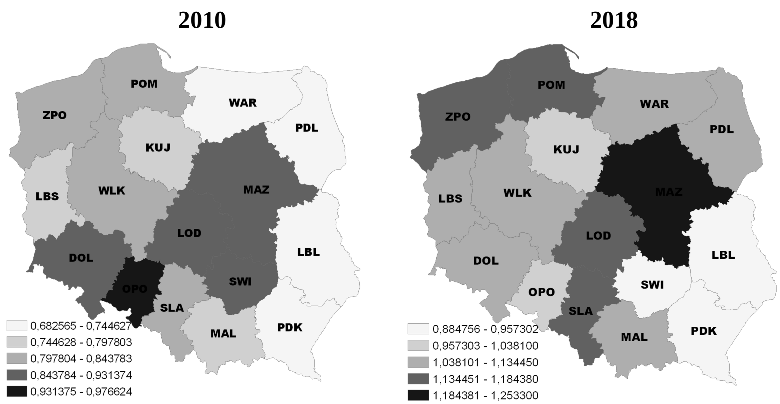

Figure 1. Spatial distribution of income per person in 2010 and 2018

Source: own calculations based on MESMEZ results, maps generated in ArcMap 9.3.

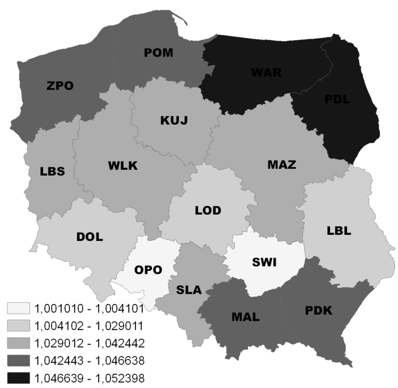

Figure 2. Geometric mean of net real income per person chain indexes over years 2011–2018 by province

Source: own calculations based on MESMEZ results, map generated in ArcMap 9.3.

4.2 PROPORTION OF PHARMACEUTICAL EXPENDITURES IN TOTAL NET INCOME

The proportion of pharmaceutical expenditures in the total net income is resultant on both the value of expenses on medicine and income. The average fraction will rise constantly from 5.8% in 2010 to 6.8% in 2018. The growth can be expected in every province each year, with the exception of Warminsko-mazurskie in 2017 and Pomorskie in 2018, when it may decline by 0.4% and

0.3% respectively. From 2010 to 2014 the lowest proportion should be observed in Mazowieckie, then in 2015–2018 in Wielkopolskie. The highest fraction should occur in Lubelskiefrom 2010 to 2017 and in Swietokrzyskie in 2018. The spatial distribution of the proportion of pharmaceutical expenditures in total net income varies over time. In 2010 the highest proportion (over 6%) can be observed in Podlaskie and Lubelskie in Eastern Poland and in Lubuskie in the West. The lowest values are in Mazowieckie and Wielkopolskie, below 5.6%. Until 2018 the biggest proportion (over 7.2%) will remain in Lubelskie but Opolskie and Swietokrzyskie will join this quintile. The smallest proportions below 6.5% are expected in Wielkopolskie and Mazowieckie as well as Pomorskie and Zachodniopomorskie (see: Fig. 3).

The change rate, measured by the proportions of pharmaceutical expenditures in the total net real income chain index, indicates that the highest increase can be observed most often in Opolskie, except in 2011 and 2014 in Swietokrzyskie, and in 2017 in Podkarpackie. The smallest increments or contemporary decreases, by no more than 0.4%, may occur in Zachodniopomorskie in 2011, Lubuskie in 2012, 2013 and 2016, Malopolskie in 2014, Wielkopolskie in 2015, Warminsko-mazurskie in 2017, and Pomorskie in 2018.

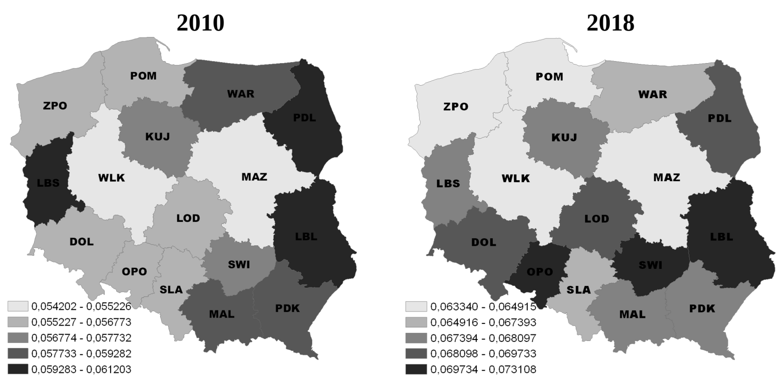

Figure 3. Spatial distribution of the proportion of pharmaceutical expenditures in total income in 2010 and 2018

Source: own calculations based on MESMEZ results, maps generated in ArcMap 9.3.

The average change, defined as the geometric mean of chain indexes over time, shows that the highest change rate can be expected in Opolskie and Swietokrzyskie and the lowest in Lubuskie. Generally Poland is divided diagonally into North–West with lower relative increments and South–East with higher ones (see: Fig. 4).

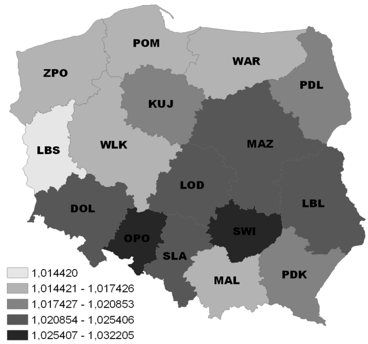

Figure 4. Geometric mean of the proportion of pharmaceutical expenditures in total income chain indexes over years 2011-2018 by province

Source: own calculations based on MESMEZ results, map generated in ArcMap 9.3.

Some of the results for the proportion of pharmaceutical expenditures in total net income may be attributed to the changes in income value. In 2010 both the lowest income per person and the highest proportions can be observed in the Eastern provinces of Warminsko-mazurskie, Podlaskie, Lubelskie and Podkarpackie, while Mazowieckie has one of the biggest incomes and smallest proportions of pharmaceutical expenditures. In 2018 the highest proportions should occur in the South–East in the provinces with the lowest income per capita. In Pomorskie, Zachodniopomorskie, and Mazowieckie the highest income is paired with the lowest quotient of pharmaceutical expenditures and income. In these regions economic determinants influence the proportion of pharmaceutical expenditures. In others income is not the key factor for medicinal expenses, especially Wielkopolskie, where the income per person and the fraction of drug expenditures over the whole period of 2010–2018 are not high.

5. CONCLUSIONS

The microsimulation based on MESMEZ and the microeconometric panel model allowed two variables to be projected – household net real income per person and proportion of pharmaceutical expenditures in total net income – over the period of 2010–2018. The outcomes aggregated over provinces present a spatial distribution of both categories. They are based on the information in the starting point of the microsimulation (2009) for a representative sample of Poles, demographic structure of Poland's population in 2010, and interdependencies observed from 2003 to 2007; therefore the macro level results can be generalized for the whole population and treated as a possible scenario of events.

Generally, income level will increase systematically; however, this will not diminish the economic disproportion among provinces currently present in Poland. Simultaneously, proportions of pharmaceutical expenses will continue to increase in each region. This means that values of medicinal expenditures tend to rise more rapidly than income does. Moreover, since income per person, total income, and pharmaceutical expenditures are real values in 2011, the increase of proportions is most likely caused by a rise in consumption of medicine and supplements and not the price changes. The constant growth of absolute and relative drug expenses is indicated not only by this research but also others concerning Poland (Skrzypczak 2010.a, pp. 109–112) and other countries (Skrzypczak 2010.b, pp. 34–39; Luffman 2005, p.5) which may cause a global problem in coming years.

In Poland Mazowieckie will remain the leader in the income value and therefore the impact of pharmaceutical expenditures will be relatively small. The poorest Eastern and South–Eastern provinces will have to deal with the heaviest burden of medicinal expenses and this will have a negative impact on households' socioeconomic status. These disproportions, confirming the spatial heterogeneity hypothesis, should be addressed in the policy making process, to ensure equal comfort of citizens in every province.

REFERENCES

Baltagi, B. H. (2005), *Econometric Analysis of Panel Data*, John Wiley and sons Ltd.

Cameron A., Trivedi P. (2005), *Microeconometrics. Methods and Applications*. Cambridge University Press, New York.

Luffman, J.(2005), *Out-of-pocket spending on prescription drugs*, Statistics Canada, Catalogue no. 75-001-XIE.

Owczarczuk, M., (2010), *Modele zmiennych ograniczonych*, (w:) Mikroekonometria. *Modele i metody analiz danych indywidualnych*, red. Gruszczyński, M., Oficyna a Wolters Kluwer business, Warszawa.

REPORT „Finansowanie ochrony zdrowia w Polsce- Zielona Księga II", wersja trzecia Ministerstwo Zdrowia, Warszawa, 29 August 2008.

Skrzypczak, Z. (2010.a), *Skala obciążeń polskiego społeczeństwa wydatkami na ochronę zdrowia*, (w:) Zdrowie publiczne 120 (2), s. 109–110.

Skrzypczak, Z. (2010.b), *Lekomania globalna*, (w:) Menedżer zdrowia 2/2010, s. 34–38.

STATA manual: STATA longitudinal data/panel data reference manual release 11 s. 448.

Żółtaszek (2011), *Mikrosymulacje – podstawy teoretyczne i wybrane zastosowania*, (w:) Mikroekonometria w teorii i praktyce.

Żółtaszek, A., Jewczak, M. (2011), *Spatial and dynamic analysis of healthcare expenditures in OECD countries*, (in:) Spatial econometrics and regional economic analysis, Suchecki, B. (ed.), Folia Oeconimica 252, Wydawnictwo Uniwersytetu Łódzkiego, Lodz.

http://www.stat.gov.pl/bdlen/app/strona.html?p_name=indeks
http://stats.oecd.org/Index.aspx
http://www.ecosante.org/OCDEENG/411000.html

Agata Żółtaszek

SPATIAL MICROSIMULATION ANALYSIS OF PROPORTION OF OUT-OF-POCKET PHARMACEUTICAL EXPENDITURES IN HOUSEHOLD INCOME IN POLAND IN THE YEARS 2010–2018

In Poland 30% of healthcare expenditures are directly covered by households. This high fraction has a negative impact on households' socioeconomic status. Analyzing current and future individual expenditures on healthcare is crucial and microsimulation may be useful for forecasting health economic variables. The aim of this research was to apply a microsimulation to analyze the proportion of direct pharmaceutical expenditures in household income in Poland in the years 2010–2018. The results were used to perform a spatial analysis over provinces in Poland.

PRZESTRZENNA ANALIZA MIKROSYMULACYJNA UDZIAŁÓW BEZPOŚREDNICH WYDATKÓW FARMACEUTYCZNYCH W DOCHODACH GOSPODARSTW DOMOWYCH W POLSCE W LATACH 2010–2018

W Polsce aż 30% finansowania ochrony zdrowia pochodzi bezpośrednio od gospodarstw domowych, co wpływa negatywnie na ekonomiczno-społeczne aspekty ich funkcjonowania. Niezbędne jest badanie zarówno bieżących jak i przyszłych wydatków indywidualnych na świadczenia medyczne. Narzędziem wspomagającym prognozowanie wartości zmiennych z zakresu ekonomiki zdrowia mogą okazać się mikrosymulacje.

Celem badania jest zastosowanie eksperymentu mikrosymulacyjnego do analizy przyszłych udziałów prywatnych bezpośrednich wydatków farmaceutycznych w dochodzie gospodarstw domowych w Polsce. Uzyskane wyniki posłużą do przeprowadzenia przestrzennych analiz według województwach w latach 2010–2018.