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HOUSEHOLDS' FOOD INSECURITY IN THE V4 COUNTRIES: MICROECONOMETRIC ANALYSIS

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Abstract

Food insecurity is a salient dimension of household poverty and a crucial issue viewed on a global or within a country level. It applies not only to less-developed countries, but also to countries of the European Union. In the European conditions, it implies that people affected by this problem cannot afford enough food of sufficient quality and quantity that would allow them to stay healthy and participate in the society. This paper attempts to fill that gap in the existing literature regarding food insecurity in the Visegrad Group countries. It aims to identify the factors affecting the occurrence of this phenomenon. In the empirical analysis based on the data from the European Union Statistics on Income and Living Conditions Survey, logit models with country dummy variables are applied. The study shows that the households' food insecurity is associated with income, level of urbanisation, household type, disabilities of household members, and attributes of household head, such as educational attainment, gender, age, health and status of economic activity. Moreover, the findings strongly support the research hypothesis that the food insecurity profile exhibits country-specific effects. The results provide a much-needed baseline of evidence on food insecurity in the vulnerable households in the Visegrad Group countries.

Keywords: food insecurity, households, the Visegrad Group countries, logit models.

JEL Classification: D12, D60, I32, O57.

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Introduction

One would not expect food insecurity (FI) to be a European problem and the analysis of this issue should be restricted to poor, low-income countries. It seems that the scientific and public debate on food consumption in affluent, high-income countries mainly should concern rather problems of obesity and wasting food than food scarcity. However, many researches indicate that food insecurity is an increasingly serious problem in the UE economies (Pfeiffer, Ritter and Oestreicher, 2015; Dowler et al., 2011). In particular, the researches in Denmark (Nielsen, Lund and Holm, 2015), Finland (Silvasti, 2015), France (Martin-Fernandez et al., 2013), Germany (Pfeiffer, Ritter and Oestreicher, 2015), Poland (Dudek, 2016; Dudek, 2017) and the UK (Dowler and O'Connor, 2012; Smith et al., 2018) provide evidence that FI is a salient problem in these countries. Thus, there is a need to investigate this problem thoroughly across Europe and other high-income and middle-income countries (Lambie-Mumford and Dowler, 2015; Davis and Geiger, 2017).

According to the Oxford Dictionary (2018), food insecurity is “the state of being without reliable access to a sufficient quantity of affordable, nutritious food”. It is synonymous with “food poverty” (Dowler and O'Connor, 2012). For high-income countries, food insecurity implies that people do not have sufficient money to purchase the food they want to eat, to meet social as well as health and nutritional norms (Dowler and O'Connor, 2012). Thus, people experiencing FI could not afford enough food (Taylor and Loopstra, 2016). Such point of view in measurement of prevalence of FI is presented in many studies (Loopstra et al., 2016; Davis and Geiger, 2017).

EU Member Countries are very diverse in many respects. Therefore, the study focuses on the Visegrad Group (V4) consisting of countries that are, to some extent, similar in terms of the economic level and the advance of profound political changes. Moreover, as the V4 countries – the Czech Republic, Hungary, Poland and Slovakia – are Central European countries with historical links, close geographically and culturally, therefore the joint analysis for all households from these countries seems to be valid. In-depth examination of the food insecurity profile in these countries can be an interesting issue for readers not only from the V4 but also for researchers outside of these countries. First of all, up to now microeconomic analyses of food insecurity in the EU have focused mainly on the situation in Western European countries, such as France (Martin-Fernandez et al., 2013) or Germany (Depa et al., 2018). Instead, this paper sheds a light on the situation of households in Central European countries, filling to some extent the gap in this regard. Secondly, the Visegrad Group countries can be brought to the attention of the international community, as they are closely linked Central European countries, that had been once satellite states of the Soviet Union, which all became EU members in 2004. While in the literature there are many papers on the political and economic situation in the V4, there is a shortage of studies in the field of poverty. That is why it is so important to look at the society of these countries in terms of the impossibility of meeting the food security needs. Thirdly, the methodology presented in the paper can be applied to data from all the EU countries. As all steps of the study have been thoroughly explained, it may be an incentive for researchers from other countries to do a similar analysis and compare results.

The study deals with the cross-sectional data of the European Union Statistics on Income and Living Conditions survey (EU-SILC) for 2017 and it is conducted at the household level. In this survey, the household reference person is asked “Can your household afford a meal with meat, chicken, fish (or vegetarian equivalent) every second day?”, which has a binary outcome (Yes/No). This indicator is used to capture food deprivation (García-

Germán, Bardají and Garrido, 2018) or food insecurity in the EU (Loopstra et al., 2016). It has several advantages as a measure of food insecurity. First of all, this indicator focuses on the aspect of food consumption that households economize on during periods of financial strain (Davis and Geiger, 2017). Indicating a lack of financial resources to acquire one essential component of a nutritionally adequate diet is aligned with the definition of household food insecurity (Loopstra et al., 2016). Moreover, what is important is that this indicator is available for all the EU states, which makes comparisons across and between the EU countries possible.

The main objective of this research is to identify the socio-economic and demographic factors affecting incidence of households' food insecurity in the V4 countries. The study examines households' profiles of food insecurity measured by people's ability to afford a meal with meat, fish or vegetarian equivalent every second day. It provides new evidence on this issue by examining common correlates of food insecurity in the countries under consideration. The study also hypothesises that FI profile exhibits significant country-specific heterogeneity. To test this hypothesis, logit regression models with country dummy variables are performed.

The structure of the paper consists of the sections: introduction, literature review, sections presenting empirical data and applied methods, the results and discussion, as well as conclusions on findings. The first two sections contain the review of the main studies relevant to the concept of food insecurity. The subsequent two sections refer to applied methodology: the first one briefly describes the EU-SILC data used in the empirical analysis, while the second one explains statistical methods applied in this study. The next section presents and discusses the results of the carried out analysis and the final section provides conclusions.

1. Literature review

Food insecurity is a cause of concern for many countries around the world. In the scientific literature much attention has been devoted to this problem in the less developed regions of South Asia, Sub-Saharan Africa and Latin America (e.g. Zia and Gadi, 2001; Ogundari, 2017; Magaña-Lemus et al., 2016). Academic research on food insecurity in affluent countries has also started to grow as the problem itself has increased (Ashby et al., 2016; Loopstra, Reeves and Stuckler, 2015).

Numerous studies have identified common core features of food insecurity. For example, Anderson (1990) defines FI as "the limited or uncertain availability of nutritionally adequate and safe food, or having to acquire foods in socially unacceptable ways", Balistreri (2016) as "lack of consistent access to adequate amounts of food", Dowler and O'Connor (2012) as "the inability to acquire or eat an adequate quality or sufficient quantity of food in socially acceptable ways (or the uncertainty of being able to do so)". It should also be mentioned that according to Food and Agriculture Organization of the United Nations (FAO) "food insecurity exists when people do not have adequate physical, social or economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life" (FAO, 2003) and The United States Department of Agriculture (USDA) defines food insecurity as a state in which "consistent access to adequate food is limited by a lack of money and other resources at times during the year" (Coleman-Jensen et al., 2017).

While the broad definition of FI has been widely accepted, defining a common metric that can be used to analyse food insecurity across different countries has so far been lacking (Smith, Rabbitt and Coleman-Jensen, 2017). Various approaches used in measuring FI in the world can be found in (Coates, 2013; Pinstrup-Andersen, 2009; Smith, Rabbitt and Coleman-Jensen, 2017; Riches, 2018). However, the ability to make comparable estimates across different countries is limited by usage of different indicators of FI. In particular, the approach in this regard used in the USA has not been adopted to measure food insecurity in the EU. Thus, the lack of comprehensive and robust food insecurity data to inform public policy in the majority of the OECD member states is troublesome (Riches, 2018).

Regardless of the FI indicators analysed, the researches in various countries show that food insecurity is strongly negatively associated with income and with high educational level of household head (Magaña-Lemus et al., 2016; Ogundari, 2017; Smith, Rabbitt and Coleman-Jensen, 2017). It should also be noted that some temporarily low-income households may be able to afford some consumer goods by drawing down savings or running up debts. Literature shows that various household assets have a significant association with food insecurity (Chang, Chatterjee and Kim, 2014; Dudek, 2017; Guo, 2011). In particular, savings accumulated in the past enhance the capacity to current consumption, while debts reduce it. Moreover, statistically significant relationship exists between food insecurity and poor financial skills and knowledge (Gundersen and Garasky, 2012). As regard demographic status of household head (HH), most studies have found that households headed by women are more likely to be food insufficient than households headed by men (Magaña-Lemus et al., 2016; Martin-Fernandez, et al., 2013). Furthermore, a lot of studies have examined the role of the age of HH, receiving various results in this regard. Some of them have found that households headed by elderly people are less likely to be food insecure than those with young household head (Magaña-Lemus et al., 2016). This result may suggest that older people have more experience in managing the resources in the household. However, findings obtained by Smith, Rabbitt and Coleman-Jensen (2017) indicate inverted U-shape relationship between the age of HH and the prevalence of FI in middle-income and high-income economies, but no such relationship has been found in low-income economies. Moreover, most studies have found positive relationship between FI and unemployment (Smith, Rabbitt and Coleman-Jensen; 2017), but only a handful of studies has examined the role of self-reported health to explain FI, finding the positive association (Alvarez et al., 2015).

A large number of studies have indicated that household composition is an important factor for food insecurity (Martin-Fernandez et al., 2013; Nord, Hooper and Hopwood, 2008). Usually, single-person households and households without children have a lower prevalence of FI, while households with 3 or more children and single-parent families are more affected by FI (Dudek, 2017; Martin-Fernandez et al., 2013).

Interestingly, in low-income economies, households that live in rural areas appear to be more vulnerable than those living in towns and cities (Magaña-Lemus et al., 2016; Smith, Rabbitt and Coleman-Jensen; 2017), on the other hand, in middle-income and high-income economies, no statistically significant difference exists between rural and urban areas regard to prevalence of food insufficiency, controlling for multiple socio-economic and demographic factors (Smith, Rabbitt and Coleman-Jensen, 2017). It is also worth mentioning that research regarding multicultural and multi-racial countries, such as the USA, indicate the effects of race-ethnicity on FI (Gundersen and Garasky, 2012; Chang, Chatterjee and Kim, 2014). To sum up, it should

be emphasized that some factors associated with food insecurity may be unique to a given country or region with particular geographic, socio-economic and cultural settings and some of them are very common around the world.

2. The data

In the study, the internationally harmonized European Union Statistics on Income and Living Conditions (EU-SILC) data is analysed. The main advantages and weaknesses of this dataset are worth mentioning. First of all, its fundamental strength is that the survey collects poverty and social exclusion outcomes that are comparable across the EU countries. Besides, the wide set of socio-economic information provided in EU-SILC makes it possible to analyse various phenomena (Arora et al., 2015; Dudek, 2019). It is due to the output harmonization framework established by Eurostat. Speaking of the weaknesses, one can include miscellaneous non-item responses in some of the EU countries. However, to overcome this problem, EU-SILC employs imputation techniques (Arora et al., 2015). The second weakness when it comes to the purpose of this study, is that the analysed set of data provides only one indicator related to FI. The EU-SILC study uses a particular measure of food insecurity in the EU. It asks a single question about household food insecurity: whether people are unable to afford to eat meat, chicken, fish (or vegetarian equivalent) every second day (Eurostat, 2016; Riches, 2018). Nevertheless, drawing attention to the problem of affordability of food access, this indicator covers very important aspects of food insecurity and it can be treated as a good proxy for the concept of food insecurity in the EU condition.

The study uses EU-SILC cross-sectional data for the year 2017, encompassing 8701 households in the Czech Republic, 8142 households in Hungary, 13057 households in Poland and 5602 households in Slovakia. Most of the considered explanatory variables are standard in food insecurity analyses. Their descriptions are captured in table no. 1. However, it should be noted that our study does not include explanatory variables referring to the values of households' savings and debts, as the EU-SILC does not contain this type of data.

Table no. 1: The input variables in regression models

Name of variable	Description
FI	Food insecurity (1 if household is food insecure)
Income	Yearly disposable equivalised income (expressed in thousand euro). Household income is adjusted by dividing by an equivalence scale, assigning the first adult in the household a value of 1, each additional adult a value of 0.5 and each child a value of 0.3 (the so-called "modified OECD" scale).
Household type	Household type:
• A1	One-person household
• A2C1	2 adults, one dependent child
• A2C2	2 adults, two dependent children
• A2C3	2 adults, three or more dependent children
• Single_parent	Single parent household, one or more depend. children
• OH_with_children	Other households with dependent children
• OH_without_children	Other households without dependent children
• A2C0_young	2 adults, no depend. children, both adults under 65
• A2C0_old	2 adults, no dependent children, at least one adult ≥ 65

Name of variable	Description
Urbanization <ul style="list-style-type: none"> • Dense • Intermediate • Sparse 	Degree of urbanization: Densely populated (at least 500 inhabitants/km ²) Intermediate (between 100 and 499 inhabitants/km ²) Sparsely populated (less than 100 inhabitants/km ²)
Disability/health problems <ul style="list-style-type: none"> • Strong_limitation • Limitation • Without_limitation 	Long-standing limitations in performing usual activities due to health problems: 1 if there are persons with strong limitations, 1 if in household there are persons with limitations, 1 if all persons are without any limitations
Education_HH: <ul style="list-style-type: none"> • Primary • Secondary • Tertiary 	The highest level of education achieved of head: Primary or pre-primary education Secondary and post-secondary non tertiary education Tertiary education
Woman	Woman-headed household
Age_HH	Age of household head at the end of income reference period
Health_HH <ul style="list-style-type: none"> • Very good • Good • Fair • Bad • Very bad 	General health of household head: Very good Good Fair Bad Very bad
Ec_activity_HH <ul style="list-style-type: none"> • At work • Unemployed • Retired • Inactive 	Status of basic economic activity of household head: At work Unemployed In retirement or early retirement or has given up business Other inactive

Source: Own evaluation based on EU-SILC data

3. The method

To examine the impacts of socio-economic factors on households' food insecurity, binary logit model is applied. This model focuses on the explanatory variables of the probability of the binary dependent variable being one:

$$P(y_i = 1) = F(x_i'\beta) \tag{1}$$

where:

y_i – a value of binary dependent variable for i -th household, $i=1, 2 \dots n$,

x_i – a vector of explanatory variables (regressors) representing the characteristics of i -th household, $i = 1, 2 \dots n$,

β – a k -dimensional vector of parameters to be estimated,

F – a cumulative distribution function (CDF) of the logistic density function given by

$$F(x_i'\beta) = \frac{e^{(x_i'\beta)}}{1+e^{(x_i'\beta)}} = \frac{1}{1+e^{(-x_i'\beta)}} \tag{2}$$

The probability of dependent binary variable representing food insecurity is regressed on a number of household level variables. The marginal effect of the j th explanatory variable is given by:

$$\frac{\partial P(y_i=1)}{\partial x_{ji}} = f(x_i'\beta)\beta_j, j = 1, 2, \dots, k \tag{3}$$

where:

- $f(x_i'\beta)$ – the density function of the logit distribution,
 β_j – j -th parameter of the vector β .

Because in the logit model the marginal effects depend on the values of x_i , these effects vary among the different observations in the sample. Therefore, in the analysis of the logit model results, so-called odds ratios are usually employed, wherein the odds are defined as the ratio of the probability to its complement. Taking the ratio of the probability of food insecurity and probability of the opposite event (i.e. food security) one can obtain so-called $odds = \frac{p_i}{1-p_i} = e^{(x_i'\beta)}$, thus $e^{(\beta_j)}$ measures the multiplicative effect of a unit change in j -th explanatory variable x_j on the odds ratio, holding all other regressors constant (Cameron and Trivedi, 2010). What is important, this effect does not depend on the level of other variables in the model. Especially, for $\exp(\beta_j) > 0$ one could say that the odds are $\exp(\beta_j)$ times larger and for $\exp(\beta_j) < 0$ – $\exp(\beta_j)$ times smaller. Instead of a multiplicative change in the outcome, some people prefer the percent change. If β_j is positive, the unit growth in x_j indicates an increase in the odds by $(\exp(\beta_j)-1)*100$. Likewise, if β_j is negative, the unit increase in x_j denotes a decrease in the odds; this decrease is obtained as $(1-\exp(\beta_j))*100$.

The logit models in this study are fitted by maximum likelihood method. For large samples, maximum likelihood estimators for logit regression models are approximately normally distributed. Thus, inferences about the regression parameters can base on normal distribution. To test the null hypothesis that any subset of the β 's is equal to 0, the likelihood ratio test is used.

In the study three models are employed. The first one is estimated based on all data from the V4 countries with explanatory variables regarding socio-economic and demographic factors of households, the second model includes only country dummy variables to control for all country-specific effects. The third model is the most general by taking into account explanatory variables from both former models. Thus, the first and the second models are nested in the third one. To verify the statistical significance of the parameters and compare models, the likelihood ratio test based on a collation of full and reduced models is employed.

The R^2 s – the convectional measures of goodness of fit is not very meaningful when dependent variable takes values of 1 or 0. What matters are the signs of the estimated parameters β and their statistical significance (Gujarati, 2011). Additionally, as the receiver operating characteristic (ROC) curves provide a standard way of evaluating the ability of explanatory variables to predict a binary dependent variable, in this study the area under the ROC curve (AUC) is used as a summary measure of accuracy in classification. The value of AUC ranges from 0 to 1, wherein value of 0.5 for AUC indicates no discrimination, 0.5 to 0.6 is considered as poor classification, 0.6 to 0.6 means fair, 0.7 to 0.8 is considered as acceptable, 0.8 to 0.9 is taken as excellent and value of more than 0.9 is considered as outstanding (Kumari and Rajnish, 2015).

4. The results and discussions

The food insecurity rate in the V4, measured as percentage of population that cannot afford a meal with meat, chicken, fish (or vegetarian equivalent) every second day, significantly

varied from country to country in 2017. In particular, the lowest level of rate was in Poland (6.3%) and the highest in Hungary (16.4%), wherein the rate in Poland is less than average in the European Union (EU) food insecurity rate (7.9%). In the Czech Republic 7.9% population experienced food insecurity, while in Slovakia every seventh inhabitant could not afford the food under question.

It should be clearly stated that the population identified as “food insecure” and “income poor” do not perfectly overlap. Table no. 2 shows food insecurity rates below and above the at-risk-of-poverty threshold, which is set at 60 % of the national median equivalised disposable income. For instance, among EU income-poor citizens only 20.4% experienced FI, while among people who were not considered income-poor 5.4% reported FI.

Table no. 2: Percentage of food insecure population according to income situation

Country	Below 60% of national median equivalised income	Above 60% of national median equivalised income
The European Union	20.4	5.4
The Czech Republic	25.5	5.2
Hungary	31.4	14.1
Poland	17.7	4.4
Slovakia	40.0	11.2

Source: Own evaluation

Thus, the food insecurity measure provides more specific information on this dimension of poverty than the measure that can be inferred from using only income data. The results presented in table no. 2 highlight the fact that the relationship between FI and income is a complex one. Two households with the same income can have different standards of living due to the specific conditions and circumstances in which they live. Thus, controlling for income, identification of other factors influencing households' food insecurity is so important.

To assess the impact of various socio-economic and demographic factors on household's probability of experiencing food insecurity, logit models are applied. All computations are performed using STATA software. Basic results for estimation are presented in table no. 3. Detailed results are available upon request.

Table no. 3: Results of statistical analysis comparing three models

Statistics	Model 1 (only household-level variables)	Model 2 (only country-specific dummy variables)	Model 3 (household-level and country-specific dummy variables)
LL	-10931.780	-12910.081	-10560.734
AIC	21915.560	25828.160	21179.470
BIC	22133.980	25862.07	21423.090
AUC	0.761	0.614	0.787

Source: Own evaluation

Table no. 3. contains statistics useful for comparison applied model: logarithm of likelihood (LL), the Akaike information criterion (AIC), the Bayesian information criterion (BIC) and the area under the ROC curve (AUC). Results indicate that taking into account all

considered statistical criteria, the third model is the most preferred model. This model includes household level variables and country dummy variables. In particular, the third model is the best model according to the AIC and BIC, as the model with the lowest information criterion should be preferred. This choice is confirmed by results of the likelihood ratio test. For example, comparing the first and the third model, one can analyse the likelihood ratio statistics which is chi-squared asymptotically distributed with 3 degrees of freedom (df). Due to $LR = 2(-10560.734 + 10931.780) = 742.092$ is greater than $\chi^2(0.05;3) = 7.814$, then including country-specific dummy variables is statistically validated. In other words, the hypothesis that country-specific effects are insignificant in order to explain FI is rejected, as indicated by the result of the LR test. Moreover, the AUC estimates of the value of 0.787 means acceptable classification obtained by the third model. This means that aside from household level variables, the impact of the country in which the household is located is statistically significant. More detailed information on the estimates of the parameters in the third model is shown in table no. 4.

Table no. 4: Estimates of the logit model

Variable	<i>b</i>	<i>S(b)</i>	<i>Odds ratio</i>
Income	-0.284***	0.015	0.753
Household type			
A1	0.943***	0.138	2.568
A2C1	0.622***	0.160	1.863
A2C2	Ref.	Ref.	Ref.
A2C3	0.558***	0.190	1.748
Single_parent	0.929***	0.164	2.531
OH_with_children	0.490***	0.158	1.632
OH_without_children	0.641***	0.150	1.898
A2C0_young	0.645***	0.144	1.906
A2C0_old	0.701***	0.147	2.016
Disability/health problems in household			
Strong_limitation	0.261***	0.071	1.299
Limitation	0.083	0.056	1.086
Without_limitation	Ref.	Ref.	Ref.
Urbanisation			
Dense	Ref.	Ref.	Ref.
Intermediate	-0.181***	0.063	0.835
Sparse	-0.244***	0.062	0.784
Education of household head			
Primary	1.234***	0.120	3.434
Secondary	0.656***	0.093	1.927
Higher	Ref.	Ref.	Ref.
Age of household head			
Age_HH	0.065***	0.012	1.068
Age_HH Squared	-0.001***	0.0001	0.999
Woman	0.142***	0.052	1.152

Health of household head			
Very good	Ref.	Ref.	Ref.
Good	0.478***	0.122	1.613
Fair	0.840***	0.128	2.316
Bad	1.267***	0.138	3.551
Very bad	1.550***	0.162	4.709
Economic activity of household head			
At work	Ref.	Ref.	Ref.
Unemployed	0.892***	0.102	2.439
Retired	0.151*	0.087	1.162
Inactive	0.423***	0.084	1.527
Country			
The Czech Republic	-0.137**	0.059	0.872
Hungary	Ref.	Ref.	Ref.
Poland	-0.945***	0.049	0.389
Slovakia	0.529***	0.053	1.697

Source: Own evaluation

Note: b are estimates, $S(b)$ are their standard errors. All standard errors are robust (with heteroscedasticity-robust asymptotic variance). * means statistical significance at 0.10, ** – statistical significance at 0.05, *** – statistical significance at 0.01.

Significance and signs of β_j parameters inform about the significance and direction of the partial effects given by formula (1). Thus, as might be expected, the household food insecurity in the V4 is tightly linked to the income. As a household's equivalised income increases, the risk of food insecurity declines. However, it is not a perfect one-to-one relationship, which has already been underlined. The odds ratio equal to 0.753 means that the increase of equivalised income by one thousand euro denotes a decrease in the ratio of the probability of food insecurity to probability of food security by 24.7%, under the assumption of *ceteris paribus*.

Regardless of the values of equivalent income, there is a significant relation between household demographic type and probability of food insecurity. In comparison with the reference households – households of two adults with two children – all types of households report greater risk of food insecurity. It should be noted that odds ratios of FI for one-person households and old two-person households are more than twice higher than for the reference households. Moreover, the situation of single parent households with one or more dependent children needs special attention. Comparing with households of two adults and two children, odds ratios of FI are greater by about 150% for this type households. The heightened vulnerability of single parent households with one or more dependent children is worrisome, considering the lasting consequences of experiencing food insecurity during childhood.

It is found that the probability of FI is diverse due to multiform, long-standing limitations of household members related to health problems. Comparing to households consisting of people without any limitations in this regard, the odds of FI are about 9% higher among households with health-limited people and about 30% higher among households with strong health-limited people. These results show that strong disability or health problems of

household members exert effect on the resources available for food. In addition, taking into account the level of urbanisation, according to the obtained results, households in densely populated urban settings have about 20% higher odds of being food insecure than households living in sparse and intermediate urbanised areas.

Our results show the importance of household head's attributes, such as level of education, age, gender, health and economic activity.

- It is found that poor school education of the household head is associated with an increased probability of food insecurity. The odds are respectively more than three times higher and almost two times higher for households with the head having respectively primary or secondary education relative to households with a highly educated head.

- Estimates of the logit regression model indicate that age had a positive sign while its squared term had a negative sign, implying an inverted U-shaped effect. In other words, households report being less food insecure when they are younger and older than when they are middle-aged.

- For gender, there was evidence that man-headed households are less likely to be food insecure than their female counterparts. The odds of FI is 15% higher for female headed households compared to male headed households.

- A relationship between FI and perceived head's health can be observed. Comparing to households whose head reported very good health, the odds ratios are by 61% higher in households with good health of the head, more than 100% higher in households headed by a person with fair health, 255% and 371% greater, respectively, for households which reported bad or very bad health.

- Taking into account economic activity, one can observe that households headed by unemployed and inactive people are significantly more likely to report food insecurity than those who are working, wherein the respective odds are 144% higher for unemployed-headed households and 53% higher for inactive-headed households comparing with households whose head is an economically active person. Instead, at the level of 0.05, there are no significant differences in the probability of FI between retired households and households headed by working persons. This finding may be partly related to having retirement savings.

Apart from the above-mentioned factors, it was found that the countries in which households are located significantly differentiate the probability of food insecurity, once all other household-level covariates are controlled for. Thus, the obtained results indicate that FI is much more than a problem arising from household characteristics. Various country-level features such as price levels, social policy or tax systems, can affect the probability of experiencing food insecurity. In our study, it is found that under the assumption of *ceteris paribus*, comparing to Hungary, the odds ratios of FI are near 13% lower in the Czech Republic and above 60% lower in Poland, whereas in Slovakia the ratio the probability of food insecurity to probability of food security is over 70% higher. This finding reflects the differences in country-specific features regarding socio-economic conditions and requires additional in-depth analysis. It is worth mentioning briefly that several authors indicate that Hungarian have worse living conditions than Czechs and Poles (Dudek, Landmesser and Chrzanowska, 2017; Ivanová, and Masárová, 2018). However, the better position of Poland in relation to Slovakia and the Czech Republic, to some extent, can be explained by lower prices of food in Poland, in particular, the prices of meat (The Czech Statistical Office (CZSO), 2018; Central European Financial Observer, 2018). Moreover, the difficult

situation of Slovakia may be caused by the highest in the V4 long-term unemployment (The Czech Statistical Office (CZSO), 2018).

The obtained results regarding household-level factors influencing FI are consistent with other studies to a large degree. Most coefficients of households' characteristics have the expected signs. As other studies have shown (Martin-Fernandez et al., 2013; Smith, Rabbitt and Coleman-Jensen, 2017; Magaña-Lemus et al., 2016), an increase in household income is significantly associated with decreases in the probability of FI. Furthermore, it is confirmed that in the V4, household composition is an important factor for food insecurity, as it is in other countries, such as France (Martin-Fernandez et al., 2013) and the USA (Nord, Hooper and Hopwood, 2008). In agreement with other studies (e.g. Smith, Rabbitt and Coleman-Jensen, 2017) it is found that the most vulnerable people to food insecurity usually have the low level of education and they are unemployed. Consistent with the findings of studies carried out in other countries, our study found that female-headed households are more likely to be food insecure than a man-headed household (Magaña-Lemus et al., 2016; Martin-Fernandez et al., 2013) and food insecurity is positively correlated with poor self-reported health (Alvarez et al., 2015; Depa et al., 2018). Our results also confirm the inverted U-shape relationship between the age of the HH and the prevalence of FI found for middle-income and high-income economies in the literature (Smith, Rabbitt and Coleman-Jensen, 2017). Unlike (Smith, Rabbitt and Coleman-Jensen, 2017), our results indicate that households living in densely populated urban settings are more affected by food insecurity than households living in sparse and intermediate urbanised areas.

Conclusions

Food insecurity is one of the most salient contemporary challenges. It is an essential problem not only in poor countries, but it also applies to developed countries. In recent years, a renewed interest in this issue at the household level has emerged. During the last decade, more and more research on food insecurity has been carried out in such countries as the USA, Canada and some European countries. However, there is a scarcity of detailed analyses on this subject concerning such a group of countries of Central and Eastern Europe, as the countries of the Visegrad group. This study undertakes the analysis of FI issue in the V4, filling the existing gap in this regard.

To combat food insecurity and its associated consequences, an understanding of the factors influencing this phenomenon is required. The study results show that the prevalence of food insecurity is strongly associated with low income. It should, however, be stressed that FI affects income-non-poor as well as income-poor households. Some parts of food-insecure households have incomes above the poverty thresholds and it would be overlooked if poverty status was the only indicator of food insufficiency. This finding further supports the need to use direct indicators in the evaluation of policies intended to improve social outcomes, such as the alleviation of food insecurity.

Monitoring FI can be useful to identify and understand this salient aspect of poverty and to recognize population subgroups with particularly severe conditions. Particularly, the microeconometric analysis results reveal that low-income single-parent households with middle-aged, poor-educated, household head were more likely to suffer food insecurity. Other vulnerable groups include, for example, households experiencing strong disability or

health problems headed by unemployed or economically inactive person and households headed by women with bad health.

The study findings strongly support the research hypothesis that the food insecurity profile exhibits country-specific effects. It means that the countries in which households are located, significantly differentiate the probability of food insecurity, once all other covariates are controlled for.

It should be emphasized that this study has some limitations. First of all, it examines only one measure of food insecurity. This measure does not cover all the aspects of multifaceted nature of FI concept. Thus, the used measure should be treated as a proxy for the concept of the food insecurity in the EU conditions. Moreover, the analysed EU-SILC sample excludes homeless people, who are likely to experience food insecurity. This makes the phenomenon of FI in the analysed countries not fully presented. On the other hand, to the best of the author's knowledge, this paper is the only to provide the first picture prevalence of households' food insecurity in the V4. The advantages of this study include the use of large-scale quantitative data to analyse food insecurity in the V4 countries. Multi-country datasets provide information about "household effects" as well as "country effects". Moreover, this paper is among first to report microeconomic analysis of households' food insecurity in the V4 countries.

The results of this study greatly influence the current understanding of the correlates of household food insecurity in the V4 countries. They suggest that these states should not ignore the issue of food insecurity. Implementation of strategies coping with the problem at the household level is inevitable. In particular, country policies including social supports may significantly affect the probability of experiencing food insecurity. The awareness of factors which are associated with FI should help to target households being at risk for food insecurity as well as to focus on policy recommendations and public interventions that may help decrease the burden of suffering. To improve the understanding of the mechanisms linking country policy and households' food insecurity, further researches should be undertaken. Future research should consider the role of food prices, social protection and other various country-level socio-economic indicators as potential drivers of households' food security.

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