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# Empirical Investigation of the Relationship between Fast Food and Obesity in the Context of Sustainable Development

*Artur Harutyunyan and Karel Janda\**

## Abstract

This paper is dealing with the presence of overweight and obesity in different countries and their relation to the number of McDonalds outlets in the selected countries. We are dealing with the following two research questions. What are the effects of large food manufacturers' activities on the economy of the country, in terms of it's health factors (BMI index)? Is the emergence of a large international food manufacturer beneficial for the physical condition of the inhabitants of a country? Based on our regression results, we can say that fast-food producers in our sample do not have a significant statistical effect on the increase in the BMI index of the inhabitants of the countries. Since a significant statistical relationship between the number of outlets in the fast-food industry and the BMI index was not found, it is impossible to say unequivocally what effect the first factor has on the second.

**Key Words:**Fast food, obesity, nutrition.

**JEL codes:** D12, I14, Q18

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# 1 Introduction

This paper is dealing with the presence of overweight and obesity in different countries and their relation to the number of McDonalds outlets in the selected countries. We are dealing with the following two research questions:

1. What are the effects of large food manufacturers' activities on the economy of the country, in terms of it's health factors (BMI index)?
2. Is the emergence of a large international food manufacturer beneficial for the physical condition of the inhabitants of a country?

Because of the lack of information on the number of McDonalds outlets, our sample size is limited both in terms of timeline and countries included. (24 countries for 2016 year). Therefore, in order to test the hypothesis on a larger sample, and to be able to examine the association over time, we have decided also to include data on the number of enterprises in Food and beverage service activities (NACE Division I.56) and it's subgroup – number of enterprises in Restaurants and mobile food service activities. The countries were selected based on the available data, in order to maximize the sample size.

All models include Ordinary Least Squares regression analysis (OLS), however as it might be the case that the real causal relationship is that people in countries with higher prevalence of overweight and obesity have higher demand for fast food outlets and other food and beverage service enterprises, I have included Instrumental Variable (IV) analysis, with the degree of economic freedom as the instrument, which also allows to examine the possible impact of market deregulation on the prevalence of overweight and obesity among the country's population.

The dataset also includes 9 social and economic parameters, such as GDP per capita PPP (expressed logarithmically in constant 2017 international dollars), portion of population living in urban areas, GINI index, openness to trade, foreign direct investment, number of people using internet and number of mobile cellular subscriptions, prevalence of insufficient physical activity among adults, Prevalence of moderate or severe food insecurity in the population.

This study is obviously not the first one dealing with this topic. The first study that needs to be cited for comparison is The effect of fast food restaurants on obesity and weight gain study conducted in 2009 by researchers Janet Currie, Stefano Della Vigna, Enrico Moretti and Vikram Pathania. This study can be considered a key one in the study of obesity and fast food. Researchers have collected a huge database to conduct a comprehensive study and obtain reliable results. This research is based on micro-data, rather than national level macro data that is used in our research: the exact location of restaurants, and their proximity to municipal organizations or other strategic social points, such as schools has been used as the independent variable.

Another positive characteristic of this model is that this model includes not only McDonald's, but also other fast-food establishments (10 largest fast food chains in total), for example, Pizza Hut, KFC, Subway and others.

Another study to point out for comparison is Are Restaurants Really Supersizing America? from 2007, from researchers Michael Anderson and David A. Matsa. In this study, as in the study presented in this paper, no correlation was found between the number of restaurants and obesity. However, researchers in the first study mentioned in the text above have explained a potential reason why no statistically significant correlation was found. In the research Are Restaurants Really Supersizing America? Anderson and Matsa use the data on the number of restaurants on the interstate highways, which is a rural area, as a proxy. While the researches in study number 1 in the text above (by researchers Janet Currie, Stefano Della Vigna, Enrico Moretti and Vikram Pathania), came to the conclusion that there is no correlation between the restaurants and obesity in rural areas, and the statistically significant relationship was found only for the urban areas.

This can also explain the results of our study, since we investigated the presence and number of restaurants in general on a national level, without specifying their location or other parameters. Therefore our study includes restaurants both in urban and rural areas.

The following two studies are those on which the analysis of this paper is based. First study: „'Globesization': Ecological evidence on the relationship between fast food outlets and obesity among 26 advanced economies” from researchers Roberto De Vogli and Anne Kouvonen. They used data on the number of Subway restaurants, while our study analyzes McDonald's and other catering facilities. The main difference between their study and mine is that their study analyzes 26 advanced economies. The datasets and the countries they have

chosen are linked not by regional criteria, but by the criteria of their economic development. Therefore, the analysis includes countries such as USA, Japan, Canada, Norway, and so on. However, these countries differ in their cultural backgrounds and attitudes towards nutrition. Moreover, in Japan, obese people are required to pay an additional tax called “Fat tax”. This is how the country educates its citizens. In this study, a statistically significant correlation was found in contrast to our study, but the main parameter that differs greatly in the study is the dataset of countries.

The latest study, which our model is in many ways similar, is “The influence of market deregulation on fast-food consumption and Body Mass index: a cross-national time series analysis by Roberto De Vogli, Anne Kouvonen and David Gimenez.” This study is a bulletin of the World Health Organisation. The researchers took the Instrumental variables approach as well, and they also use mostly the same set of covariates as in our analysis. The difference is that in this study, the researchers take 25 high-income OECD countries, as in the earlier analysis example. Also, a high priority of this study is that researchers use data on fast food transactions per capita, rather than the number of restaurants. This information has been taken from the Global Market Information Database, which we had no access to. These data help to investigate the relationship between the volume of food sold in fast food restaurants and obesity better than just the number of restaurants,

It can be stated that the research presented in this paper is limited by the fact that macro data was used as micro data could not be found due to limited time, personal and financial resources. However, we would strongly suggest future researches to gather micro data as in research The effect of fast food restaurants on obesity and weight gain study conducted by researchers Janet Currie, Stefano Della Vigna, Enrico Moretti and Vikram Pathania, and conduct the analysis on city, even district level. Although, another potential issue that we see in models which study the proximity of the restaurants to the residences is that in the recent years delivery services such as Uber Eats have become very popular, so people could order a meal from a fast food outlet delivered to their door even if they do not live nearby. To tackle this problem we would suggest using the fast food transactions per capita as the explanatory variable, which from our point of view should better demonstrate how much fast food do people consume, rather than the number of restaurants.

## **2 Data Description**

### ***Dependent variables***

In order to examine the impact of the fast-food restaurants on obesity, we have selected the prevalence of overweight and obesity among adults as our dependent variables. Data on those variables was taken from the World Health Organization Database, where overweight prevalence is defined as proportion of adults with body mass index (BMI)  $\geq 25$  Kg/m<sup>2</sup>, while the obesity prevalence is the proportion of adults with body mass index (BMI)  $\geq 30$  Kg/m<sup>2</sup>.

### ***Independent Variables***

#### **Density of McDonalds Outlets**

Firstly, it has been decided to take the density of the McDonalds outlets in the selected countries as the main explanatory variable. In order to calculate the density, the data on number of McDonalds outlets in 24 countries was taken from the McDonalds website and Statista website, while data on the population of the selected countries taken from The World Bank was used in order to determine the density of McDonalds outlets per 100,000 people. This value was then transformed into a natural log indicator. The reason, why McDonalds brand is selected as proxy on the number of fast food outlets is that it is the leading and most popular fast food chains in the selected countries, and it also has the largest number of outlets.

#### **Density of enterprises in Food and beverage service activities**

As it might be the case, that McDonalds solely does not fully represent the food industry, we have also examined the density of enterprises in Food and beverage service activities (NACE Division I.56). This division consists of three subgroups: Event catering and other food service activities, Restaurants and mobile food service activities, Beverage serving activities.

The data on the number of enterprises was taken from Eurostat, while the density was calculated in the same manner as for the density of McDonalds outlets, using the population of the country.

### **Density of enterprises in Restaurants and mobile food service activities**

We have also separately used the density of enterprises in Restaurants and mobile food service activities as another possible explanatory variable. This is one of the subgroups mentioned above.

The data on the number of enterprises was taken from Eurostat, while the density was calculated in the same manner as for above mentioned variables.

## ***Covariates***

### **Prevalence of insufficient physical activity among adults**

This indicator shows whether adults living in the country have enough physical activities and sports. Physical activity and sports are compensation for the office life and long sitting hours.

The data was taken from the WHO database and is limited for 2016 year only. There are no datasets of the same data for the later period.

### **Prevalence of moderate or severe food insecurity in the population**

This indicator means that adults of young children are faced with food insufficiency or necessity to cut costs on food. That may be the reason of low food quality and insufficient quantity of nutrients.

The data was taken from the WHO database and is limited for 2016 year only. There are no datasets of the same data for the later period.

### **GDP per capita PPP (expressed logarithmically in constant 2017 international dollars)**

This indicator shows, which part of the total GDP can be counted on every inhabitant of the country. The indicator is calculated by dividing the GDP on total population in the country.

The data was taken from the World Development Indicators database of the The World Data Bank.

### **Portion of population living in urban areas**

This indicator shows the total urbanization of the society. It may also have effect on the total BMI index, as urban life is quite different from the country life. The indicator is calculated by dividing the total population of the people living in the urban zones.

The data was taken from the World Development Indicators database of the The World Data Bank.

### **GINI index**

The Gini index shows how income is distributed in a country. The Gini index can reach values in the range from -1 to 1, the lower the value, the less fair the division of income in the state is considered, respectively, the less social the state is.

The data was taken from the World Development Indicators database of the The World Data Bank.

### **Openness to trade**

This indicator shows how the country is opened to international trade and the total engagement to the international trade system. This index is calculated as the ration of the sum of exports and imports on the total GDP of the country.

The data was taken from the World Development Indicators database of the The World Data Bank.

### **Foreign direct investment**



This indicator shows the total amount of money which foreign enterprises or other countries invest to another country. In particular, this indicator shows the overall conditions in the country for foreign investments.

The data was taken from the World Development Indicators database of the The World Data Bank.

### **Number of people using internet**

Internet penetration is also a very interesting indicator, which shows the overall progress in the country. This is usually called digitalization index.

The data was taken from the World Development Indicators database of the The World Data Bank.

### **Mobile Cellular Subscription**

Mobile phone usage is another index, which shows the level of digitalization of the country as well as the stage of its development. It can also show the stage of the overall development of the country not only in terms of digitalization.

The data was taken from the World Development Indicators database of the The World Data Bank

### ***Instrumental Variable***

For the Instrumental variable regression, additional variable should be added as an instrument, which should be correlated with the endogenous variable (the density of the restaurants) and not directly correlated with the dependent variable (prevalence of overweight and obesity). Therefore, after preliminary correlation tests, two following variables have been selected.

### **Index of economic freedom (market deregulation)**

This indicator shows how free relations and rules in the economy are for entrepreneurs and free trade. The freer the economy of a state is, the more developed a country is.

The data was taken from the World Development Indicators database of the The World Data Bank.

### **Ease of doing business index**

This indicator shows how easy it is to open and run a business in the country. The index is considered complex because it considers many different factors, including administrative conditions, taxes, and business freedom.

The data was taken from the World Development Indicators database of the The World Data Bank.

## **3 Model and Regression Results**

### **McDonads restaurants density model**

#### **Description of the model**

First OLS regression model contains BMI25 (overweight) and BMI30 (obesity) as dependent variables, density of McDonalds restaurants as the main explanatory variable and 9 covariates which are GDP per capita PPP (expressed logarithmically in constant 2017 international dollars), portion of population living in urban areas, GINI index, openness to trade, foreign direct investment, number of people using internet, number of mobile cellular subscriptions, prevalence of insufficient physical activity among adults, and prevalence of moderate or severe food insecurity in the population.

The full regression equations are the following:

#### **Overweight:**

$$\text{BMI25} = \beta_0 + \beta_1 * \text{rest.dens} + \beta_2 * \log(\text{GDP}) + \beta_3 * \text{UrbanPopulation} + \beta_4 * \text{GINIIndex} + \beta_5 * \text{Trade} + \beta_6 * \text{FDI} + \beta_6 * \text{Internet} + \beta_7 * \text{Mobile.cellular.subscriptions} + \beta_8 * \text{Food.insecurity} + \beta_9 * \text{Insufficient.activity} + \varepsilon_i$$

**Obesity:**

$$\text{BMI30} = \beta_0 + \beta_1 * \text{rest.dens} + \beta_2 * \log(\text{GDP}) + \beta_3 * \text{UrbanPopulation} + \beta_4 * \text{GINIIndex} + \beta_5 * \text{Trade} + \beta_6 * \text{FDI} + \beta_6 * \text{Internet} + \beta_7 * \text{Mobile.cellular.subscriptions} + \beta_8 * \text{Food.insecurity} + \beta_9 * \text{Insufficient.activity} + \varepsilon_i$$

The same dataset was used to conduct Instrumental Variable Regression (IV), with the Ease of Doing Business index as the instrument.

The equations for the IV regressions are the following:

**Overweight:**

$$\text{BMI25} = \beta_0 + \beta_1 * \text{rest.dens} + \beta_2 * \log(\text{GDP}) + \beta_3 * \text{UrbanPopulation} + \beta_4 * \text{GINIIndex} + \beta_5 * \text{Trade} + \beta_6 * \text{FDI} + \beta_6 * \text{Internet} + \beta_7 * \text{Mobile.cellular.subscriptions} + \beta_8 * \text{Food.insecurity} + \beta_9 * \text{Insufficient.activity} + \varepsilon_i$$

$$\text{Rest.dens} = \beta_0 + \beta_1 * \text{Ease.of.Doing.Business} + \beta_2 * \log(\text{GDP}) + \beta_3 * \text{UrbanPopulation} + \beta_4 * \text{GINIIndex} + \beta_5 * \text{Trade} + \beta_6 * \text{FDI} + \beta_6 * \text{Internet} + \beta_7 * \text{Mobile.cellular.subscriptions} + \beta_8 * \text{Food.insecurity} + \beta_9 * \text{Insufficient.activity} + \varepsilon_i$$

**Obesity:**

$$\text{BMI30} = \beta_0 + \beta_1 * \text{rest\_dens} + \beta_2 * \log(\text{GDP}) + \beta_3 * \text{UrbanPopulation} + \beta_4 * \text{GINIIndex} + \beta_5 * \text{Trade} + \beta_6 * \text{FDI} + \beta_6 * \text{Internet} + \beta_7 * \text{Mobile.cellular.subscriptions} + \beta_8 * \text{Food.insecurity} + \beta_9 * \text{Insufficient.activity} + \varepsilon_i$$

$$\text{Rest.dens} = \beta_0 + \beta_1 * \text{Ease.of.Doing.Business} + \beta_2 * \log(\text{GDP}) + \beta_3 * \text{UrbanPopulation} + \beta_4 * \text{GINIIndex} + \beta_5 * \text{Trade} + \beta_6 * \text{FDI} + \beta_6 * \text{Internet} + \beta_7 * \text{Mobile.cellular.subscriptions} + \beta_8 * \text{Food.insecurity} + \beta_9 * \text{Insufficient.activity} + \varepsilon_i$$

The total sample size of this model includes 24 observations – 24 countries for 2016 year. The main limitation for enlarging the dataset is the data on the number of McDonalds outlets, which is considered confidential data for some countries.

Table 1: Summary statistics

Summary Statistics					
Statistic	N	Mean	St. Dev.	Min	Max
BMI25	24	58.638	2.259	54.300	62.300
BMI30	24	22.708	2.156	19.700	26.400
Restaurant.Density	24	1.149	0.609	0.213	2.232
logGDP	24	10.555	0.389	9.898	11.614
Ease.of.Doing.Business.Index	24	75.934	4.301	66.900	84.500
Urban.population	24	73.161	12.520	53.900	97.919
GINI.index	24	31.771	3.899	24.800	40.600
Mobile.cellular.subscriptions	24	122.247	13.133	102.041	145.513
Openness.to.Trade	24	122.863	70.818	55.368	390.663
Foreign.direct.investment	24	9.347	16.236	-7.316	54.239
Moderate.or.severe.food.insecurity.in.the.p opulation	24	8.625	3.735	3.800	16.600
Individuals.using.the.Internet	24	79.232	10.571	59.504	98.137
Insufficient.activity	24	32.108	6.282	16.560	43.400

Source: own processing

Table 2: Regression results

Regression Results				
	<i>Dependent variable:</i>			
	BMI25	BMI30	BMI25	BMI30
	<i>OLS</i>		<i>Instrumental variable Ease of Doing Business</i>	
	(1)	(2)	(3)	(4)
Restaurant.Density	-2.045*	-1.974	-0.513	1.847
(std. er.)	(1.045)	(1.325)	(3.564)	(5.359)

logGDP	0.100	-1.582	-1.660	-5.972
(std. er.)	(1.847)	(2.342)	(4.365)	(6.564)
Urban.population	0.078**	-0.008	0.099	0.044
	(0.035)	(0.044)	(0.060)	(0.090)
GINI.index	0.207*	0.267*	0.151	0.129
(std. er.)	(0.107)	(0.135)	(0.168)	(0.252)
Mobile.cellular.subscriptions	- 0.096***	-0.069*	-0.082*	-0.033
(std. er.)	(0.029)	(0.037)	(0.044)	(0.067)
Openness.to.Trade	0.005	0.008	0.010	0.022
(std. er.)	(0.009)	(0.011)	(0.015)	(0.023)
Foreign.direct.investment	0.031	0.028	0.029	0.024
(std. er.)	(0.034)	(0.043)	(0.036)	(0.055)
Moderate.or.severe.food.insecurity.in.the.popul ation	-0.303**	-0.252	-0.209	-0.018
(std. er.)	(0.136)	(0.172)	(0.254)	(0.382)
Insufficient.activity	-0.101	-0.099	-0.104	-0.108
(std. er.)	(0.061)	(0.077)	(0.066)	(0.099)
Individuals.using.the.Internet	-0.158**	-0.017	-0.181*	-0.074
(std. er.)	(0.064)	(0.081)	(0.086)	(0.129)
Constant	76.860** *	47.586*	92.605* *	86.846
(std. er.)	(18.032)	(22.858 )	(39.814 )	(59.867 )
Observations	24	24	24	24
R <sup>2</sup>	0.776	0.605	0.739	0.351
Adjusted R <sup>2</sup>	0.603	0.300	0.538	-0.147
Residual Std. Error (df = 13)	1.423	1.804	1.536	2.310
F Statistic (df = 10; 13)	4.497***	1.987		
Note:	* p<0.1; ** p<0.05; *** p<0.01			

Source: own processing

The only model, where the McDonalds Restaurant Density is a significant variable, is the OLS model with the BMI25 (prevalence of overweight) as the dependent variable. However, the correlation is negative, which should be interpreted as the rise of the density of McDonalds restaurants corresponds to reduction in the prevalence of overweight. There are three more negatively correlated significant variables in the same model, which are the

number of mobile cellular subscriptions, prevalence of moderate or severe food insecurity in population and number of individuals using the internet.

There are 2 positively correlated significant variables, which are the percentage of urban population and GINI index, which are also significant at BMI30 model (prevalence of obesity).

In the Instrumental Variables model, there are no significant variables for BMI30 model, while the only significant variables in the BMI25 model are the number of mobile cellular subscriptions and the number of individuals using Internet, both negatively correlated. Nevertheless, the results should be treated carefully, due to the low number of observations.

To sum up, based on the above data, we cannot confirm that the presence of fast-food chains is associated with the rise of the BMI.

### ***Restaurant and mobile food service activities models***

#### **Description of the model**

The first panel data regression models include BMI25 (overweight) and BMI30 (obesity) as dependent variables, the density of the enterprises in restaurant and mobile food service activities, as the main explanatory variable, and 7 covariates which are GDP per capita PPP (expressed logarithmically in constant 2017 international dollars), portion of population living in urban areas, GINI index, openness to trade, foreign direct investment, number of people using internet and number of mobile cellular subscriptions.

The regression equations are the following:

#### **Overweight:**

$$\text{BMI25} = \beta_0 + \beta_1 * \log(\text{rmfsa.dens}) + \beta_2 * \log(\text{GDP}) + \beta_3 * \text{UrbanPopulation} + \beta_4 * \text{GINIIndex} + \beta_5 * \text{Trade} + \beta_6 * \text{FDI} + \beta_6 * \text{Internet} + \beta_7 * \text{Mobile.cellular.subscriptions} + \varepsilon_i$$

#### **Obesity:**

$$\text{BMI30} = \beta_0 + \beta_1 * \log(\text{rmfsa.dens}) + \beta_2 * \log(\text{GDP}) + \beta_3 * \text{UrbanPopulation} + \beta_4 * \text{GINIIndex} + \beta_5 * \text{Trade} + \beta_6 * \text{FDI} + \beta_6 * \text{Internet} + \beta_7 * \text{Mobile.cellular.subscriptions} + \varepsilon_i$$

The sample size consists of 272 observations.

The Instrumental Variable regression with the Index of Economic Freedom as an instrument has the following equations:

**Overweight:**

$$\text{BMI25} = \beta_0 + \beta_1 \cdot \log(\text{rmfsa.dens}) + \beta_2 \cdot \log(\text{GDP}) + \beta_3 \cdot \text{UrbanPopulation} + \beta_4 \cdot \text{GINIIndex} + \beta_5 \cdot \text{Trade} + \beta_6 \cdot \text{FDI} + \beta_6 \cdot \text{Internet} + \beta_7 \cdot \text{Mobile.cellular.subscriptions} + \varepsilon_i$$

$$\log(\text{rmfsa.dens}) = \beta_0 + \beta_1 \cdot \text{IEF} + \beta_2 \cdot \log(\text{GDP}) + \beta_3 \cdot \text{UrbanPopulation} + \beta_4 \cdot \text{GINIIndex} + \beta_5 \cdot \text{Trade} + \beta_6 \cdot \text{FDI} + \beta_6 \cdot \text{Internet} + \beta_7 \cdot \text{Mobile.cellular.subscriptions} + \varepsilon_i$$

**Obesity:**

$$\text{BMI30} = \beta_0 + \beta_1 \cdot \log(\text{rmfsa.dens}) + \beta_2 \cdot \log(\text{GDP}) + \beta_3 \cdot \text{UrbanPopulation} + \beta_4 \cdot \text{GINIIndex} + \beta_5 \cdot \text{Trade} + \beta_6 \cdot \text{FDI} + \beta_6 \cdot \text{Internet} + \beta_7 \cdot \text{Mobile.cellular.subscriptions} + \varepsilon_i$$

$$\log(\text{rmfsa.dens}) = \beta_0 + \beta_1 \cdot \text{IEF} + \beta_2 \cdot \log(\text{GDP}) + \beta_3 \cdot \text{UrbanPopulation} + \beta_4 \cdot \text{GINIIndex} + \beta_5 \cdot \text{Trade} + \beta_6 \cdot \text{FDI} + \beta_6 \cdot \text{Internet} + \beta_7 \cdot \text{Mobile.cellular.subscriptions} + \varepsilon_i$$

The sample size consists of 263 observations.

Table 3: Summary statistics

Summary Statistics					
Statistic	N	Mean	St. Dev.	Min	Max
BMI25	420	56.479	3.360	47.700	66.800
BMI30	420	20.725	3.049	14.000	32.100
rmfsa.density	281	178.105	94.496	8.073	466.521
fbsa.density	365	305.699	178.099	13.111	831.505
ief	404	68.303	6.775	48.800	82.600
logGDP	420	10.440	0.486	9.146	11.656
Urban.population	420	71.506	13.220	43.965	97.919

GINI.index	388	31.849	4.059	23.700	42.900
Mobile.cellular.subscriptions	420	115.681	19.807	42.343	172.122
Openness.to.Trade	420	113.326	62.272	45.419	408.362
Foreign.direct.investment	418	13.679	42.884	-58.323	449.083
Individuals.using.the.Internet	420	66.900	19.147	15.460	98.240

Source: own processing

Table 4: Regression Results

<b>Regression Results</b>				
	<i>Dependent variable:</i>			
	BMI25	BMI30	BMI25	BMI30
	<i>OLS</i>		<i>Instrumental variable</i>	
			<i>IEF</i>	
	(1)	(2)	(3)	(4)
Rmfsa.Density	-0.0004	-0.002**	-0.001	0.017*
(std. er.)	(0.001)	(0.001)	(0.005)	(0.010)
logGDP	0.758***	1.153***	0.706	-0.708
(std. er.)	(0.247)	(0.268)	(0.522)	(1.085)
Urban.population	0.218***	0.197***	0.211***	0.150***
(std. er.)	(0.024)	(0.026)	(0.027)	(0.055)
GINI.index	-0.015	-0.008	-0.020*	-0.025
(std. er.)	(0.011)	(0.012)	(0.012)	(0.025)
Mobile.cellular.subscriptions	-0.002	-0.004**	-0.001	-0.009*
(std. er.)	(0.002)	(0.002)	(0.002)	(0.005)
Openness.to.Trade	0.003**	0.002	0.003**	-0.001
(std. er.)	(0.001)	(0.001)	(0.001)	(0.003)
Foreign.direct.investment	0.002***	0.001*	0.002***	0.001
(std. er.)	(0.001)	(0.001)	(0.001)	(0.001)
Individuals.using.the.Internet	0.017***	0.006	0.017***	0.013
(std. er.)	(0.004)	(0.004)	(0.004)	(0.009)
Observations	272	272	263	263
R <sup>2</sup>	0.368	0.315	0.341	0.009



Adjusted R <sup>2</sup>	0.225	0.160	0.190	-0.218
F Statistic (df = 8; 221)	16.076***	12.694***	112.940***	26.361***
Note:	*p<0.1; **p<0.05; ***p<0.01			

Source: own processing

In this regression there is a contradiction in the correlation of the density of enterprises in restaurant and mobile food service activities, as the OLS regression shows a positive significant correlation, while the IV model represent a negatively correlated significant outcome. However, it should be noted that the last model (4) has a negative adjusted R<sup>2</sup> and therefore shows overall unreliability of this model.

LogGDP variable has the biggest magnitude in the OLS models for both overweight and obesity, while the number of urban population has second largest coefficient and is significant in all models. Other significant variables are Openness to trade, foreign direct investment and number of individuals using internet. Gini Index and number of mobile cellular subscription are significant only in one of the models.

### ***Food and beverage service activities models***

#### **Description of the model**

The second panel data model uses the same data, however instead of the density of enterprises in the restaurant and mobile food service activities, the density of enterprises in food and beverage service activities is used.

Therefore, the equations for the panel data OLS regression is the following.

#### **Overweight:**

$$\text{BMI25} = \beta_0 + \beta_1 * \log(\text{fbsa.dens}) + \beta_2 * \log(\text{GDP}) + \beta_3 * \text{UrbanPopulation} + \beta_4 * \text{GINIIndex} + \beta_5 * \text{Trade} + \beta_6 * \text{FDI} + \beta_6 * \text{Internet} + \beta_7 * \text{Mobile.cellular.subscriptions} + \varepsilon_i$$

#### **Obesity:**

$$\text{BMI30} = \beta_0 + \beta_1 * \log(\text{fbsa.dens}) + \beta_2 * \log(\text{GDP}) + \beta_3 * \text{UrbanPopulation} + \beta_4 * \text{GINIIndex} + \beta_5 * \text{Trade} + \beta_6 * \text{FDI} + \beta_6 * \text{Internet} + \beta_7 * \text{Mobile.cellular.subscriptions} + \varepsilon_i$$

This model has the total sample size of 355 observations.

While the equations for the IV with the same instrument as in the previous model are as below.

**Overweight:**

$$\text{BMI25} = \beta_0 + \beta_1 * \log(\text{fbsa.dens}) + \beta_2 * \log(\text{GDP}) + \beta_3 * \text{UrbanPopulation} + \beta_4 * \text{GINIIndex} + \beta_5 * \text{Trade} + \beta_6 * \text{FDI} + \beta_6 * \text{Internet} + \beta_7 * \text{Mobile.cellular.subscriptions} + \varepsilon_i$$

$$\log(\text{fbsa.dens}) = \beta_0 + \beta_1 * \text{IEF} + \beta_2 * \log(\text{GDP}) + \beta_3 * \text{UrbanPopulation} + \beta_4 * \text{GINIIndex} + \beta_5 * \text{Trade} + \beta_6 * \text{FDI} + \beta_6 * \text{Internet} + \beta_7 * \text{Mobile.cellular.subscriptions} + \varepsilon_i$$

**Obesity:**

$$\text{BMI30} = \beta_0 + \beta_1 * \log(\text{fbsa.dens}) + \beta_2 * \log(\text{GDP}) + \beta_3 * \text{UrbanPopulation} + \beta_4 * \text{GINIIndex} + \beta_5 * \text{Trade} + \beta_6 * \text{FDI} + \beta_6 * \text{Internet} + \beta_7 * \text{Mobile.cellular.subscriptions} + \varepsilon_i$$

$$\log(\text{fbsa.dens}) = \beta_0 + \beta_1 * \text{IEF} + \beta_2 * \log(\text{GDP}) + \beta_3 * \text{UrbanPopulation} + \beta_4 * \text{GINIIndex} + \beta_5 * \text{Trade} + \beta_6 * \text{FDI} + \beta_6 * \text{Internet} + \beta_7 * \text{Mobile.cellular.subscriptions} + \varepsilon_i$$

The sample size for the IV model has 319 observations, due to the lack of data on Index of Economic Freedom on some of the selected countries.

Table 5: Regression results

<b>Regression Results</b>				
	<i>Dependent variable:</i>			
	BMI25	BMI30	BMI25	BMI30
	<i>OLS</i>		<i>Instrumental variable</i>	
			IEF	
	(1)	(2)	(3)	(4)
Fbsa.Density	-0.0001	-0.001	-0.0003	0.005***
(std. er.)	(0.0004)	(0.0004)	(0.001)	(0.002)
logGDP	0.693***	0.687***	0.799***	0.219

(std. er.)	(0.233)	(0.260)	(0.275)	(0.398)
Urban.population	0.235 <sup>***</sup>	0.189 <sup>***</sup>	0.226 <sup>***</sup>	0.200 <sup>***</sup>
(std. er.)	(0.018)	(0.020)	(0.020)	(0.029)
GINI.index	-0.025 <sup>**</sup>	-0.025 <sup>**</sup>	-0.033 <sup>***</sup>	-0.034 <sup>**</sup>
(std. er.)	(0.011)	(0.012)	(0.012)	(0.017)
Mobile.cellular.subscriptions	-0.002	-0.006 <sup>***</sup>	-0.001	-0.006 <sup>**</sup>
(std. er.)	(0.002)	(0.002)	(0.002)	(0.003)
Openness.to.Trade	0.003 <sup>**</sup>	0.004 <sup>***</sup>	0.003 <sup>***</sup>	0.003
(std. er.)	(0.001)	(0.001)	(0.001)	(0.002)
Foreign.direct.investment	0.001 <sup>**</sup>	0.001	0.002 <sup>**</sup>	0.002 <sup>**</sup>
(std. er.)	(0.001)	(0.001)	(0.001)	(0.001)
Individuals.using.the.Internet	0.015 <sup>***</sup>	0.002	0.016 <sup>***</sup>	0.006
(std. er.)	(0.003)	(0.004)	(0.004)	(0.005)
Observations	355	355	319	319
R <sup>2</sup>	0.441	0.346	0.409	0.113
Adjusted R <sup>2</sup>	0.342	0.231	0.296	-0.056
F Statistic (df = 8; 301)	29.638 <sup>***</sup>	19.890 <sup>***</sup>	185.824 <sup>***</sup>	83.124 <sup>***</sup>
Note:	* p<0.1; ** p<0.05; *** p<0.01			

Source: own processing

In the last regression, there is significant positive correlation of the density of enterprises in food and beverage service activities, however, again the adjusted R<sup>2</sup> value is negative, which represents not effectiveness of the selected model. The largest coefficients are again the logGDP and Urban population as in the previous model. GINI index has a significant negative correlation compared to the previous model, where the result was not significant.

To sum up, based on the conducted analysis, we again cannot confirm that the density of the enterprises in food and beverage industry is positively correlated with the rise of overweight and obesity among population on a country level.

## **Conclusions**

This work is devoted to the investigation of one particular aspect of the large issue of how large food manufacturers affect the sustainable development of the country and its population. Since the topic of the work is very wide, it was narrowed down to the area of studying the influence of large manufacturers in the field of fast food and catering establishments on the physical condition of the country's inhabitants. Physical condition in the context of this work was measured in the BMI index, which measures a person's body mass index.

The main assumption before writing this paper and conducting the analysis was that fast food and other large food manufacturers lead consumers to overweight, that is, to the risk of health problems. The task of the work was to answer the question whether this hypothesis is really true, that is, whether the presence and number of fast-food restaurants really affects the average body mass index in the country.

The initial hypothesis is that the number of fast-food outlets affects the body mass index. At the same time, before the analysis, it was assumed that there is a direct correlation between the number of outlets in restaurant establishments such as fast food and the BMI index (the more establishments, the higher the BMI index in the population). The index was considered in two variations: BMI 25 (the highest limit of the permissible value, which, according to the WHO interpretation, means overweight) and BMI 30 (according to the WHO interpretation, it is obesity).

Under the definition of fast food, the study on the number of McDonald's outlets was originally conceived, since McDonald's is the largest representative of the fast-food sector and has the largest number of outlets around the world.

However, the limitation to this analysis was that we had limited data. According to the search results, information about the McDonald's restaurant chain was available from 2016 onwards, and information on body mass index was available until 2016. That is, the only segment of the study could be exactly 2016, but this would not be enough for the study.

Therefore, the analysis has been expanded to NACE Division I.56 - Food and Beverage sector. The data for this sector has been added to provide a comprehensive analysis and relevant results.

More countries and longer period of time (2008-2018) were taken for the analysis. But since the area of food and beverage includes many different substructures, the area of Restaurants and mobile food activities was taken separately as a subdivision of the NACE Division I.56. Each model was investigated based on OLS analysis and instrumental variables.

Instrumental variables were used in the analysis because it was suggested that the correlation is two-sided. That is, not only the number of fast-food restaurants directly affects the value of the BMI index in the country, but also vice versa, the number of fast-food restaurants increases with a high BMI in the country. The assumption arose on the basis that in a country with a higher BMI there will be an increased demand for fast food restaurants, which motivates large manufacturers to open more restaurant outlets in such countries. Thus, not only was the correlation carried out, but also, we tried to show the causality.

In addition to the dependence of the two mentioned indices, the ease of doing business index was also added, since it is logical to assume that the easier the conditions for opening a new business in the country, the more outlets and branches will be opened in different areas of business, including food and beverage.

The second variable under study is the index of economic freedom. This variable is similar to the previous variable, but this index also reflects the government's actions in doing business in the country.

As a result of the analysis, it was revealed that there is no significant statistical relationship between the selected variables and the BMI index in the country. This analysis is indicative only for the selected variables and for the given sequence of analysis. With different data or time periods, the analysis might show a higher correlation.

Also, in the context of the analysis, it is worth noting that other studies were previously analyzed that were conducted in order to identify the relationship between the development of the fast-food industry and the BMI index in countries, but they were carried out for a different list of countries and for other variables.

As part of a recommendation for future research, it is also worth noting that it would be more accurate to carry out the analysis based not on national level macro data, but by specific cities and districts.

In the introduction to this paper two research questions have been stated:

3. What are the effects of large food manufacturers' activities on the economy of the country, in terms of its health factors (BMI index)?

As a result of the research, we can say that based on our data large producers, such as fast-food producers, do not have a significant statistical effect on the increase in the BMI index of the inhabitants of the countries.

4. Is the emergence of a large international food manufacturer beneficial for the physical condition of the inhabitants of a country?

Since a significant statistical relationship between the number of outlets in the fast-food industry and the BMI index was not found, it is impossible to say unequivocally what effect the first factor has on the second.

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