CHARLES UNIVERSITY

FACULTY OF SOCIAL SCIENCES

Institute of Economic Studies

Trends and Patterns of Meat Consumption in The European Union

Bachelor's Thesis

Prague 2021

CHARLES UNIVERSITY

FACULTY OF SOCIAL SCIENCES

Institute of Economic Studies

Trends and Patterns of Meat Consumption in The European Union

Bachelor's Thesis

Author of the Thesis: Matěj Teiml

Study programme: Economics and Finance

Supervisor: Petr Pleticha M.Sc.

Year of the defence: 2021

Length of the Thesis: 47 863

Declaration

1. I hereby declare that I have compiled this thesis using the listed literature and resources only.
2. I hereby declare that my thesis has not been used to gain any other academic title.
3. I fully agree to my work being used for study and scientific purposes.

In Prague on 4. 5. 2021 Matěj Teiml

Abstract

The goal of this thesis is to research the consumption of meat in the European Union and to look for trends and patterns regarding the consumption. We will take advantage of the panel data structure and use our own balanced panel data set to properly verify and quantify the relationship of macroeconomic, microeconomic, and country specific variables with annual meat consumption per capita. We used data covering the consumption of meat in the European Union member countries in the year of 2018, with data ranging from 2000 to 2018. All data in our thesis are annual and aggregated at the level of single European Union member countries. We used standard panel data analysis tools to reach statistically significant results and concluded that individual propensity to consume meat varies between countries of the European Union and found evidence suggesting that urbanization and labour force participation impact meat consumption significantly.

Abstrakt

Cílem této práce je prozkoumat spotřebu masa v Evropské Unii a pokusit se zmapovat její vzorce a trendy. Využijeme strukturu panelových dat a použijeme vlastní panelový data set, k řádnému ověření a kvantifikaci vztahu makroekonomických, mikroekonomických a pro jednotlivé země specifických proměnných s roční spotřebou masa na obyvatele. Zkoumali jsme spotřebu masa v členských zemích Evropské unie pro rok 2018, přičemž jsme využili data v letech 2000 až 2018. Všechna data v naší práci jsou roční a agregovaná na úrovni jednotlivých členských zemí Evropské unie. K dosažení statisticky významných výsledků jsme použili standartní nástroje pro panelovou analýzu, dospěli jsme k závěru, že individuální sklon ke konzumaci masa se mezi zeměmi Evropské unie liší a našli jsme důkazy naznačující, že urbanizace a účast pracovních sil významně ovlivňují spotřebu masa.

Keywords

Meat, Bovine meat, Poultry meat, Pig meat, demand of meat, panel data analysis

Klíčová slova

Maso, Hovězí maso, Drůbeží maso, Vepřové maso, Poptávka po mase, Panelová analýza dat

Title

Trends and Patterns of Meat Consumption in The European Union

Název práce

Trendy a vzorce ve spotřebě masa v EU

Table of Contents

Introduction

During 2018 residents of the European Union consumed 41 585 000 tonnes of meat. The goal of this thesis is to research the consumption of meat in the European Union and to look for trends and patterns regarding the consumption. We will take advantage of the panel data structure and use our own balanced panel data set to properly examine the relationship of macroeconomics, microeconomics, and country specific variables with annual meat consumption per capita. The thesis will start with literature review and then introduce our data set. Then we will explain the theory behind our estimation framework and move to the part with empirical results. At short discussion chapter before conclusion will be present.

1. Literature review

Palaeontology suggests that most of the food consumed by earliest humans living in hunter-gatherer societies was meat and that their survival was dependant on properly hunting animals. Great factor influencing the availability of meat was domestication of animals, which can be trace back to the climax of last glacial period, which is believed to be happening ca. 10 000 years AD[1] or a bit later ca. 8 000 years AD[2].

Humans consume a lot of different meat types coming from a lot of numerous animal species.[3] The most interesting animals eaten in a significant volume are: Horses[4], Dogs, Cats[5], Guinea Pigs[6], Whales and Dolphins[7]. The type of meat consumed is based on a lot of factors, for example culture, geological location, income, accessibility and convenience.[8]

Even though meat production is one of the oldest industries regarding human diet, it is still evolving and reacting on consumer demand for meat. Animals that were not eaten in the past, are now being massively farmed because they are more suitable for our consumption because of their huge amount of muscles examples being: antelopes, zebras, camels and buffalos.[9]

Until 20th century, meat was a stable part of human diet with exception being some religion practices, in the 20th century it became a big debate topic and meat probably became the most controversial part of human diet.[10] Topics discussed with relationship to meat are for example health, environment and ethics.

Huge multinational level study European Prospective Investigation into Cancer and Nutrition (EPIC) with 521 000 test subjects suggests significant relationship of

[1] Lawrie, Ledward, *Lawrie's Meat Science - 7th Edition*.
[2] 'Domestication Timeline | AMNH'.
[3] Lawrie, Ledward, *Lawrie's Meat Science - 7th Edition*.
[4] Alan, *The Oxford Companion to Food*.
[5] Podberscek, 'Good to Pet and Eat: The Keeping and Consuming of Dogs and Cats in South Korea'.
[6] 'A Guinea Pig for All Tastes and Seasons'.
[7] 'WHALING IN LAMALERA-FLORES'.
[8] Gehlhar and Coyle, 'Global Food Consumption and Impacts on Trade Patterns'.
[9] Lawrie, Ledward, *Lawrie's Meat Science - 7th Edition*.
[10] Buscemi, *From Body Fuel to Universal Poison: Cultural History of Meat: 1900–The Present.*

meat consumption and mortality caused by cancer and cardiovascular diseases.[11]Recent Q&A released by the World Health Organization (WHO) presents evidence that consumption of processed meat causes colorectal cancer.[12] Metanalysis from five studies reported mortality ratios for: fisheaters (0,82), vegetarians (0,84), occasional meat eaters (0,84), regular meat eaters (1,00), and vegans (1,00) suggesting that consuming either a lot of meat or almost no meat is tied to bigger mortality rate.[13]

Rapid increase of meat consumption is also suspected to be the reason behind imbalanced intakes of meat and cholesterol of humans.[14]

Meat consumption accounts for 14.5% - 51% of the world's greenhouse gas emissions caused by humans. Bovine meat produces the biggest volume of emissions (41%), followed by pigs, buffaloes and chickens. The capacity to lower meat consumptions emission's is large, technologies that reduce emissions exist, but are not used by most meat producers. Acquisition of those technologies by the majority of meat producers could lead to significant decrease of emissions. [15]

Another way in which meat consumption affects environment is use of land, almost 75% of deforested land on earth is used for livestock pastures.[16]

Fraction of population refuses to eat meat, this practice is called vegetarianism. Their reasons might be ethical (objection against killing animals), health, religion or environmental.

Meat stands out in one interesting thing compared to other types of food. The general perception of meat is that it is not gender-neutral. Meat consumption is associated with men and masculinity. This believe has been assigned by the traditional male gender role in which men are associated with killing animals for food. In modern societies men tend to consume more meat than women. Women tend to prefer fish and chicken unlike men which tend to prefer red meat.[17]

Meat consumption is believed to be tied to standard of living.[18] York and Gossard found clear positive effect of GDP per capita on meat consumption.[19]

People living in cities has strong relationship with people consuming more meat, people living in cities tend to have different lifestyles and diets. Data from eight European countries suggest that urbanisation is strongly correlated with increase in meat consumption namely Poultry and Pig. Bovine meat consumption seems to be unaffected by the degree of urbanization. [20]

Regmi and Gehlhar (2001) assessed the relationship of age and meat consumption, saying that old people tend to eat less meat than young people. They linked meat consumption negatively with higher levels of education.[21]

The unemployment rate could also impact meat consumption, unemployed people are expected to have less money available. Another work related demographic variable is women's labour force participation, the relationship is that the more women

---

[11] *European Prospective Investigation into Cancer and Nutrition*.
[12] WHO, 'Cancer: Carcinogenicity of the Consumption of Red Meat and Processed Meat'.
[13] Timothy J., 'Mortality in Vegetarians and Nonvegetarians: Detailed Findings from a Collaborative Analysis of 5 Prospective Studies'.
[14] Horowitz, *Putting Meat on the American Table*.
[15] Gerber and Food and Agriculture Organization of the United Nations, *Tackling Climate Change through Livestock*.
[16] *The Global Industrial Complex*.
[17] Buscemi, *From Body Fuel to Universal Poison: Cultural History of Meat: 1900–The Present.*
[18] Kanerva, 'Meat consumption in Europe: issues, trends and debates'.
[19] York and Gossard, 'Cross-National Meat and Fish Consumption: Exploring the Effects of Modernization and Ecological Context'.
[20] Kanerva, 'Meat consumption in Europe: issues, trends and debates'.
[21] Regmi and Gehlhar, 'Consumer Preferences and Concerns Shape Global Food Trad'.

work the less time and means they have for preparation of more complicated foods containing meat.[22]

2. Data

2.1. Meat

The key segment of data regarding sales of meat was obtained from Food and Agriculture Organization Corporate Statistical Database (FAOSTAT) maintained by the Food and Agriculture Organization (FAO). FAOSTAT provides data in a time-series format, starting from 1961, for 245 countries. The data was taken from the food balances section, which tracks detailed information about country's food supply in a specified time period.

Although sales themselves are not part of the data, we decided to calculate them using other variables from the food balances section. Sales were calculated in the following way:

$$Sales = Production + Imports - Exports + changes\ in\ stock - losses$$

Losses are the amount of the commodity lost as waste during all stages between production and households.

This approximation of sales data is sufficient for my thesis. There are some imperfections regarding this approach for example the fact, that FAO did not collect data about losses at the consumption stage until recent years, so the real figures of sales are lower than the data we will be using. Another issue is that FAO includes even inedible parts of animals such as bones in its figures, so approximately 15% should be deducted to get the actual volume of eaten meat. we assume that all data are impacted in the same magnitude by these issues and will use the figures obtained by methodology stated above.

2.2. Population

To obtain the data regarding per capita consumption, it was necessary to obtain accurate population values. we decided to use The United Nations Economic Commission for Europe (UNECE) as my source for population figures, because it captures the values, we need at all points in time for all of the countries in my research. Since the countries we study did not undergone any major change regarding their population structure during the years, we can use this data without any approximations.

2.3. Unemployment rate

Unemployment rate is the share in percentages of the unemployed in the labour force. we used UNECE as my source for unemployment rate because the data was easily accessible and without missing values. UNECE compiles data regarding unemployment using national and international official sources such as European Statistical Office (EUROSTAT) or Organisation for Economic Co-operation and Development (OECD).

[22] Kanerva, 'Meat consumption in Europe: issues, trends and debates'.

2.4. Labour force participation rate

Standardly labour force participation rate is calculated as the labour force divided by the total working-age population. we decided that we will use a slightly different definition in my thesis, because we believe that it will lead to more interesting results and could explain meat consumption more precisely. we calculated my labour force participation rate as the labour force divided by the total population. we wanted this variable to express the rate of "people participating in labour force" divided by "people that consume meat". All data we used to obtain the values were from UNECE, namely from Labour force & Wages section.

2.5. Female labour force participation rate

Female labour force participation rate tells us the share of woman actively participating in the labour force. we used UNECE as my data source. Namely their huge gender pay gap section.

2.6. Meat budget

Meat budget is my own variable designed to reflect the changes in gross wages and meat price over time. It expresses how much USD could a person spend on meat if the only thing they purchased was meat by multiplying the Gross Average Wage by Harmonised index of consumer prices regarding total meat. This approximation is not perfect, but it will be enough to factor in the changes of wages and prices over time.

2.6.1. Gross Average Wage

Gross Average Wage covers total monthly wages and salaries before any tax deductions and social security contributions. we used UNECE as my data source because it covered most of my needed values unlike other data sources such as OECD or EUROSTAT. Wages cover total economy and are expressed per full-time equivalent employee.

There were a few missing observations regarding gross average wage, we decided to approximate the missing values, because we did not want to omit any countries of the European Union from this thesis. we decided to approximate the missing values from the growth of gross domestic product (GDP) between the missing year and the closest not missing value. This solution is not the most accurate one, but it will prevent me from omitting up to five countries from my thesis.

2.6.2. Harmonised index of consumer prices (HICP)

The Harmonised index of consumer prices (HICP) is an indicator of inflation and price level used by European Central Bank (ECB). This indicator measures the over time changes of prices of consumer goods and services acquired by households. we will use harmonised index of consumer prices regarding meat taken from EUROSTAT with base year of 2015.[23]

[23] 'Harmonised Index of Consumer Prices (HICP) (Prc_hicp)'.

2.7. Obesity

We expressed Obesity as my own dummy variable, that we obtained using the obesity rate data from UNECE. The reason behind the transformation to dummy variable was the number of missing variables. Even though the obesity rate changes during the years, it is still possible to compare countries and objectively say which countries deserve to be titled as obese. For example, Italy´s obesity rate goes from 9,9% in 2005 to 10,5% in 2017 and the United Kingdom´s obesity rate goes from 21,2% in 2000 to 25,6% in 2014. My benchmark for flagging a country as obese was 16% average obesity rate or higher.

2.8. Religion

Unfortunately, we did not manage to find a reliable data source regarding religion. We think that religion might have a notable impact on the overall meat consumption, because some religions forbid the consumption of certain meats or encourage their followers to consume meat in certain times of celebration. As It is safe to assume that Religion did not change rapidly during the years in question and will be one of the variables that we cannot observe such as historical development or culture.

2.9. Urbanization

We expressed urbanization as my own dummy variable, that we obtained using the EUROSTAT dataset regarding the distribution of population by degree of urbanisation. The Data set was slightly incomplete but using the same principles as with obesity we calculated the values of Urbanization, we decided to flag countries with low share of population living in rural areas as "notrural". The benchmark for flagging a country as notrural was 30% average share of population living in rural places or lower.

3. Methodology and Empirical Models

3.1. Panel Data Introduction

Thanks to the nature of the available data and to the fact that we for sure have no control over all significant variables regarding meat consumption, we decided to use panel analysis to reach consistent and unbiased estimators. [24] We assume correlation over time for given individuals (countries) with independence over individuals. Models estimating panel data work around the differences of observed individuals and control the unobserved heterogeneity.

My dataset is a data series with length equal to:

*Number of Countries (28) * Number of Years (19)*

We made sure that my dataset will be balanced, meaning that every combination of Country and Year has a value for every variable used in the model.

The general form of panel data model can be written as:

[24] Wooldridge, *Introductory Econometrics : A Modern Approach*.

$$Y_{it} = x_{it}\beta + c_i + u_{it} \qquad t = 1, 2, \dots, T$$

Where β are coefficients of variables with cross-sectional observations, c_i are country specific unobserved components and u_{it} are idiosyncratic errors.

There are 3 types of models we can employ when working with panel data – Pooled OLS model, Fixed Effects (FE) model and Random Effects (RE) model, their properties will be described in the upcoming chapters along with my tests and decision regarding choosing the correct one.

3.2. Pooled OLS model

The pooled OLS model disregards the unobserved heterogeneity across countries and the timeseries aspect of the data. The model is ideal when one selects a different sample for each time period they observe and assume that no unobserved significant variables change over time.[25] Because this is not my case, we will expect Fixed effects or random effects models to be the right choice. we will be using a simple F test to test my hypothesis if selecting FE or RE models will lead to better results.

3.3. Fixed Effects and Random Effects model

Fixed Effects and Random Effects models are results of two different treatments of unobserved components. Fixed Effects approach treats c as a parameter on the other hand Random Effects approach assumes that c is a random variable obtained by random effects estimation. Wooldridge specifies that random effect is determined by no correlation of observed explanatory variables and the unobserved effect.[26]

In the Fixed Effects model every observed individual (country in my case) has its own intercept term c_i and same slope parameters of β as other individuals. The Fixed Effects model can look like this:

$$y_{it} = c_i + x_{it}\beta + u_{it} \qquad t = 1, 2, \dots, T$$

In the Random Effects model c_i is assumed to be distributed independently of the regressors. Each individual has the same interecept term, same slope parameters of β as other individuals and a composite error term $u_{it} = c_i + e_{it}$. The Random Effects model can look like this:

$$y_{it} = x_{it}\beta + (c_i + e_{it})$$

The Fixed effects model will always give consistent estimates, but they might not be the most efficient.

The Random effects estimator is inconsistent if the appropriate model is the fixed effects model.

The Random effects estimator is consistent and most efficient if the appropriate model is random effects model.[27]

We will resolve the decision between Fixed Effects and Random Effects in the Empirical results section. We will be deciding based on the Hausman specification test introduced by Hausman (1978)[28]. The test calculates if statistically significant

[25] Wooldridge, *Introductory Econometrics : A Modern Approach*.
[26] Wooldridge, *Econometric Analysis of Cross Section and Panel Data, Volume 1*.
[27] Katchova, 'Panel Data Models'.
[28] Hausman, 'Specification Tests in Econometrics'.

difference between fixed and random effect exists. If we cannot reject the null hypothesis stated below than both models lead to consistent estimators, but Random effect estimators will be more efficient.[29] On the other hand If we reject the null hypothesis, then Random effects model is inconsistent and only Fixed effect model should be used in the analysis.
Hausman test hypothesis:

H_0: $y_{it} = \beta_1 x_{it1} + \beta_0 + \ldots + \beta_k x_{itk} + c_i + u_{it}$
Where $Cov\ (x_{itj}, a_i) = 0$, *for all* $t = 1, 2, .., T$ *and* $j = 1, 2, \ldots, k$.

H_1: $Cov\ (x_{itj}, a_i) \neq 0$

3.4. Test of poolability

A poolability test is an F test of the null hypothesis where all Fixed Effects are jointly 0.[30] The test compares the simple OLS pooled model with the Fixed model and tests whether the same coefficients apply to every observed individual.[31]

3.5. Model of total meat consumption

We are going to define my model regarding the total meat consumption per capita in the European Union. The goal of this model is to test if the propensity to consume meat changes between countries of European Union and to partially explain the meat consumption in EU.

Hypothesis #1: Individual propensity to consume meat varies between countries of the European Union.

We are going to link the variables mentioned in literature such as: meat budget, unemployment rate, labour force share, female labour force share, obesity, and urbanization to meat consumption per capita. We need to assume that cultural properties of the population such as religion or dietary trends such as veganism do not change over time.

The next table presents the description of variables used in the model.
Table 3.1. Total meat consumption variables

Variable	Description	Source	Unit	Expectation
Meat Consumption	Meat consumption per capita	FAOSTAT	t / cap / year	Dependent variable
Meat budget	Average monthly salary with respect to meat price changes	UNECE	USD	Positive Effect
Unemployment	Share of labour force without work	UNECE	%	Negative Effect

[29] Hausman.
[30] 'SAS Help Center: Poolability Test for Fixed Effects'.
[31] Croissant and Millo, 'Panel Data Econometrics in R'.

Labour force share	Labour force divided by total population	UNECE	%	Positive Effect
Female labour force share	Share of females in the labour force	UNECE	%	Negative Effect
Obesity	Obese country	Own calculation	Dummy variable	Positive Effect
Urbanization	Says if huge % of population lives in the cities	Own calculation	Dummy variable	Positive Effect

The Equation of the model:

$$Meat\ Consumption_{c,t} = \alpha + \beta_1\ Meat\ budget_{c,t} + \beta_2\ Unemployment_{c,t} + \beta_3\ Labour\ force\ share_{c,t} + \boldsymbol{\beta_4\ Obesity_{c,t}} + \beta_5\ Female\ labour\ force\ share_{c,t} + \boldsymbol{\beta_6\ Urbanization_{c,t}} + \boldsymbol{Unobserved\ effect_c} + e_{c,t}$$

The goal of this model is to assess the relationship of general properties of the population and certain country specific properties with the overall meat consumption in European Union.

Model of this specification would not be valid for fixed effects model because the highlighted properties are time invariant which is in dispute with the definition of the Fixed Effects model. We will need to omit the highlighted variables in case of rejection of H_0 of the Hausman test.

3.6. Models of distinct meat consumptions

In this part of my thesis, we are going to specify my models of distinct meat consumption in the European Union. The goal of this model will be to try to assess the relationship between consumption of poultry, bovine and pig meat. Another goal is to research the relationship of consumption of these particular meats and the general properties of the population and certain country specific properties in the European Union.

We are going to link the same variables based on literature and assume the same assumptions as in the total meat consumption model above. The main difference is that we will split the meat consumption variable into 3 new variables – PigPC, BovinePC and PoultryPC.

The next table presents the description of variables used in the model.

Table 3.2. Particular meat consumption variables

Variable	Description	Source	Unit	Expectation
PigPC	Pig consumption per capita	FAOSTAT	t / cap / year	Dependent variable*
BovinePC	Bovine consumption per capita	FAOSTAT	t / cap / year	Dependent variable*

PoultryPC	Poultry consumption per capita	FAOSTAT	t / cap / year	Dependent variable*
Meat budget	Average monthly salary with respect to meat price changes	UNECE	USD	Positive Effect
Unemployment	Share of labour force without work	UNECE	%	Negative Effect
Labour force share	Labour force divided by total population	UNECE	%	Positive Effect
Female labour force share	Share of females in the labour force	UNECE	%	Negative Effect
Obesity	Obese country	Own calculation	Dummy variable	Positive Effect
Urbanization	Says if huge % of population lives in the cities	Own calculation	Dummy variable	Positive Effect

*Dependent variable/ Positive or negative effect when used as explanatory variable.

The Equation of the models:

$$Pig/Bovine/Poultry_{c,t} = \alpha + \beta_1\ Meat\ budget_{c,t} + \beta_2\ Unemployment_{c,t} + \beta_3\ Labour\ force\ share_{c,t} + \boldsymbol{\beta_4\ Obesity_{c,t}} + \beta_5\ Female\ labour\ force\ share_{c,t} + \boldsymbol{\beta_6\ Urbanization_{c,t}} + \beta_7\ Bovine/Poultry/Pig_{c,t} + \beta_8\ Poultry/Pig/Bovine_{c,t} + \boldsymbol{Unobserved\ effect_c} + e_{c,t}$$

(model 1. always picks the first option from the …/…/…, model 2. second…)

Model of this specification would not be valid for the fixed effects model because the highlighted properties are invariant over time, which is in dispute with the definition of the Fixed Effects model. We will need to omit the highlighted variables in case of rejection of H_0 of the Hausman test.

4. Empirical Results

4.1. Model of total meat consumption

4.1.1. Pooled OLS Model of total consumption

The first model we are going to estimate is going to be estimated with dataset consisting of 532 annual observations covering period from 2000 to 2018 for 28 countries. Even though Pooled models ignore the panel structure of data especially the individual effect for given countries, leading to poor result value, it can be a useful way of checking if the underlying data is suitable for more advanced analysis.

4.1.2. All Variables Model

The first step of pooled OLS model was running the regression with all variables in our dataset with suspected effect on our dependant variable (annual meat consumption per capita).

The All Variables model could explain 32% of the model's variance. Only one Coefficient was not significantly different from 0, that being obesity. This might be caused by the way we calculated this dummy variable, or it could mean that we simply cannot explain higher or lower total meat consumption by relatively high obesity rate.

Even though, based on literature we expected Female labour force share to have a negative impact on total meat consumption, the models estimate this coefficient with enormous impact (every percentage point increase in female labour force share leads to 0,8kg decrease of per capita annual meat consumption). This could mean that the share of Female in the labour force really impacts meat consumption confirming the literature and believe that women that do not work have more time to prepare food containing meat that usually needs longer preparation. Even though this seems like a reasonable approach, upon greater inspection of this variable we concluded that the variable causes trouble in the estimation, the variable not only does change very little in individual countries during our observed time, but its level is of relatively stable magnitude between different countries (Exception being Malta with Exceptionally low value of 30%).

After weighting the facts, we decided to not use this Variable in our analysis. Unemployment rate and labour force share the scope of impact with now discarded variable female labour force share but they definitely show some variance across individual countries in time and definitely show different levels between different countries. We will continue to use the two dynamic variables in our analysis.

4.1.3. Adjusted pooled OLS Model

Our second pooled OLS model was run without the variables we decided to omit in our previous all variables model with our goal being to improve the estimates. All Variables in this model are significant on 2% statistical level. Meatbudget being the only one with p value over 0,001. Running the model again without meatbudget brings no improvement to the model and only lowers our R-Squared. we will discuss the results after obtaining better estimates using either fixed or random effects model in the next chapter.

Table 4.1. Pooled OLS model results regarding total meat consumption

Coefficient	All Variables model	Adjusted model
Intercept	0,08611 ***	0,05446 ***
Meat budget	0,000000833 .	0,00000102 *
Unemployment	-0,0005774 ***	-0,0006444 ***
Labour force share	0,0005289 ***	0,0004046 *
Female labour force share	-0,0008127 ***	
Obesity	-0,001719	
Urbanization	0,001119 ***	0,01267 ***

R-Squared	0,317	0,292

Note: . p<0,05 ; * p<0,01 ; ** p<0,001 ; *** p < 0

4.1.4. Fixed and Random Effects Model of total consumption

In the preceding part of our research, we successfully tested suitability of our data for the simple pooled OLS model. In this part we are going to test the differences of effects for individual countries using either Fixed Effects or Random Effects model using the adjusted model from previous sections.

We started by performing the Lagrange Multiplier Test (LM), first using the Honda statistic, then using the standard Breusch-Pagan test statistic. The goal of these tests is to confirm the presence of time and country individual effects in the panel model.

The LM Honda test successfully confirmed the existence of significant individual random effects. The LM Breusch-Pagan test rejected the existence of time random effects which means that there is no need to use time-fixed effects.

Our last test will be an F-test, comparing coefficients of time dependant variables from our adjusted pooled OLS model and Fixed Effects model.

The test results supported the existence of Fixed pooled effects with high statistical significance.

After evaluating our tests results, we know for sure, that Fixed effects and Random effects model both contain additional important information and should be used instead of Pooled OLS model. We are going to use the Hausman test, already discussed in preceding sections to decide which model is more suitable for our analysis. Hausman test failed to reject the null hypothesis, which means both Fixed and Random effects model are consistent. Based on the results we are going to pick the Random Effects model because the results are going to be more efficient and there will be no need to omit our time invariable variables such as urbanization.

Our Random Effects model is going to be estimated using the same variables as our adjusted pooled OLS model discussed in preceding chapter.

Random effects model equation:

$$Meat\ Consumption_{c,t} = \beta_1\ Meat\ budget_{c,t} + \beta_2\ Unemployment_{c,t} + \beta_3\ Labour\ force\ share_{c,t} + \beta_4\ Urbanization_{c,t} + (c_i + e_{it})$$

Table 4.2. Random effects model results regarding total meat consumption

Coefficient	Random effects
Intercept	0,0977 ***
Meat budget	0,00000117 *
Unemployment	-0,000751 ***
Labour force share	-0,000441 *
Urbanization	0,0115 *
R-Squared	0,133

Note: . p<0,05 ; * p<0,01 ; ** p<0,001 ; *** p < 0

The explanatory power of our Random Effects model is less than 13,5% of overall variance. All our explanatory variables are significant at least 1% statistical significance. The results are almost as expected, the only exception being the negative effect of variable Labour force share, this could be interpreted in the way that people that are participating in the labour force have less time to prepare dishes containing meat, that needs to be cooked precisely and often have longer preparation time.

We particularly like the outcome of our variable explaining urbanization, we confirmed our literatures narrative that people in towns and cities tend to consume more meat than people living in rural areas, in our case the dummy variable adds 11,5 kg per year per capita.

Our meat budget variable performed as expected with a small positive effect, in this kind of model it worked only more or less as a benchmark variable for other variables. Due to the nature of this variable, there is not much to conclude based on the results.

Country's unemployment rate performed consistently with our expectations based on literature, 10% increase in unemployment rate would lead to a decrease of 7,5 kg in annual meat consumption per capita.

4.2. Model of Pig meat consumption

4.2.1. Pooled OLS Model of Pig consumption

Our research regarding pig meat consumption will follow the same framework as our total meat consumption model chapter, the same data set consisting of 532 annual observations covering the period from 2000 to 2018 for 28 countries is going to be used. The results will give us better insight on what should our next procedure be and if our data are suitable for this problem.

4.2.2. All Variables Model

The first step of pooled OLS model was running the regression with all variables in our dataset with suspected effect on our dependant variable (annual pig meat consumption per capita).

Our all variables model could explain 23% of the model's variance. Two coefficients were not significantly different from 0, namely meat budget and unemployment rate. We are omitting these variables from our next analysis because of this.

We are going to omit female labour force share for the same reason as stated in 4.1.2.

The negative effect of obesity is interesting. We expected this variable to have a positive impact on pig meat consumption because, pig meat is one of the most calorie rich meat type.

4.2.3. Adjusted pooled OLS Model

Our next step was to run the adjusted model without the omitted variables, with goal being to improve our estimates. All Variables in this model are significant on 1%

statistical level. The coefficient of obesity stayed negative, although it´s impact had lowered. We will discuss the results after obtaining better estimates using either fixed or random effects model in the next chapter.

Table 4.3. Pooled OLS model results regarding pig meat consumption

Coefficient	All Variables model	Adjusted model
Intercept	0,05016 ***	0,01691 ***
Meat budget	0,0000001371	
Unemployment	-0,0001618	
Labour force share	0,0004495 ***	0,0003538 ***
Female labour force share	-0,0007378 ***	
Obesity	-0,003682 ***	-0,002691 **
Urbanization	0,002690 **	0,0036956 ***
BovinePC	-0,499 ***	-0,3454 ***
PoultryPC	0,393 ***	0,4153 ***
R-Squared	0,2365	0,194

4.2.4. Fixed and Random Effects Model of Pig meat consumption

In the preceding part of our research, we have successfully tested suitability of our data for the simple pooled OLS model. In this part we are going to test the differences of effects for individual countries using either Fixed Effects or Random Effects model using the adjusted model from the previous sections.

We ran the same tests as in section 4.1.4. namely the LM Honda test, then the LM Breusch-Pagan test and an F-test of coefficients of pooled OLS and Fixed effect model.

The tests confirmed the existence of significant individual random effects, rejected the need to use time-fixed Effects model. After evaluating the test results, we concluded that that Fixed effects and Random effects model both contain additional important information and should be used instead of Pooled OLS model.

We are going to use the Hausman test, already discussed in preceding sections to decide which model is more suitable for our analysis. Hausman test rejected the null hypothesis, which means that Random effects model is inconsistent. Based on the results we are going to pick The Fixed Effects model. This means that we will lose our time invariable variables such as obesity or urbanization. One way to improve this is to return our omitted variables that were time variant into our research and see if their significance increases.

Fixed effects model equation:

$$Pig\ Meat\ Consumption_{c,t} = \beta_1\ Meat\ budget_{c,t} + \beta_2\ Unemployment_{c,t} + \beta_3\ Labour\ force\ share_{c,t} + \beta_4\ BovinePC_{c,t} + \beta_5\ PoultryPC_{c,t} + Individual\ effect_c + e_{c,t}$$

Table 4.4. Fixed effects model results regarding pig meat consumption

Coefficient	Fixed effects
Meat budget	-0,000000322
Unemployment	-0,000395 ***
Labour force share	-0,000177
BovinePC	0,277 ***
PoultryPC	0,318 ***
R-Squared	0,143

Note: . p<0,05 ; * p<0,01 ; ** p<0,001 ; *** p < 0

The explanatory power of our Fixed Effects model is less than 14,5% of overall variance. Meat budget and labour force share were ruled insignificant by the model. This model outcome was expected because of the nature of data transformation. Every variable is demeaned by its country specific average.

Unemployment performed as expected, with impactful and significant negative impact. The performance of the other two meat types, is quite interesting, every tonne of bovine and poultry meat consumed per capita increases the consumption of pig meat by roughly 300kg, this leads us to believe that people see meat types as complements rather than substitutes in their diets.

Table 4.5. Top and bottom five fixed effects regarding pig meat consumption

Country	Fixed Effect
Cyprus	0,061945
Spain	0,058138
Germany	0,057169
Poland	0,056259
Austria	0,054839
…	…
Malta	0,031785
France	0,031353
Bulgaria	0,029519
Denmark	0,029023
United Kingdom	0,022857

4.3. Model of Bovine meat consumption

4.3.1. Pooled OLS Model of Bovine consumption

Our research regarding bovine meat consumption will follow the same framework as our total meat consumption model chapter, the same data set consisting of 532 annual observations covering period from 2000 to 2018 for 28 countries is going to be used. The results will give us better insight on what should our next procedure be and if our data are suitable for this problem.

4.3.2. All Variables Model

The first step of pooled OLS model was running the regression with all variables in our dataset with suspected effect on our dependant variable (annual bovine meat consumption per capita).

Our all variables model could explain 60% of the model's variance. Two coefficients were not significantly different from 0, namely our dummy obesity and unemployment rate. We are omitting these variables from our next analysis because of this.

We are going to omit female labour force share for the same reason as stated in 4.1.2.

4.3.3. Adjusted pooled OLS Model

Our next step was to run the adjusted model without the omitted variables, with goal being to improve our estimates. Labour force share lost its statistical significance, rest of the variables remained significant. We will investigate this after running the Fixed Effects and Random Effects models.

Table 4.6. Pooled OLS model results regarding bovine meat consumption

Coefficient	All Variables model	Adjusted model
Intercept	0,03952 ***	0,0106 ***
Meat budget	*0,000002827* ***	*0,00000298* ***
Unemployment	-0,0001731	
Labour force share	0,0001282 **	0,00004427
Female labour force share	-0,0006981 ***	
Obesity	0,0003163	
Urbanization	0,0009355 .	0,001947 ***
PigPC	-0,1293 ***	-0,1096 ***
PoultryPC	-0,07933 *	-0,093755 *
R-Squared	0,6111	0,531

4.3.4. Fixed and Random Effects Model of Bovine meat consumption

In the preceding part of our research, we have successfully tested the suitability of our data for the simple pooled OLS model. In this part we are going to test the differences of effects for individual countries using either Fixed Effects or Random Effects model using the adjusted model from previous sections.

We ran the same tests as in section 4.1.4. namely the LM Honda test, then the LM Breusch-Pagan test and an F-test of coefficients of pooled OLS and Fixed effect model.

The tests confirmed the existence of significant individual random effects, rejected the need to use time-fixed Effects model. After evaluating the test results we have concluded that Fixed effects and Random effects model both contain additional important information and should be used instead of Pooled OLS model.

We are going to use the Hausman test, already discussed in preceding sections to decide which model is more suitable for our analysis. Hausman test rejected the null hypothesis, which means that Random effects model is inconsistent. Based on the results we are going to pick The Fixed Effects model. This means that we will lose our time invariable variable urbanization. One way to improve this is to return our omitted variables that were time variant into our research and see if their significance increases.
Fixed effects model equation:

$$Bovine\ Meat\ Consumption_{c,t} = \beta_1\ Meat\ budget_{c,t} + \beta_2\ Unemployment_{c,t} + \beta_3\ Labour\ force\ share_{c,t} + \beta_4\ PigPC_{c,t} + \beta_5\ PoultryPC_{c,t} + Individual\ effect_c + e_{c,t}$$

Table 4.7. Fixed effects model results regarding bovine meat consumption

Coefficient	Fixed effects
Meat budget	0,0000002745
Unemployment	-0,00002402
Labour force share	-0,0004844 ***
PoultryPC	-0,1531 ***
PigPC	0,07921 ***
R-Squared	0,14581

Note: . p<0,05 ; * p<0,01 ; ** p<0,001 ; *** p < 0

The explanatory power of our Fixed Effects model is less than 14,6% of overall variance. Meat budget and unemployment rate were ruled insignificant by the model. This model outcome was expected because of the nature of data transformation. Every variable is demeaned by it's country specific average. Labour force share performed as expected with statistically significant negative output.

The variables depicting other meat consumption are both significant and interesting. Compared to pig meat, bovine meat is influenced less by the consumption of other meats. Every tonne of pig meat consumed increases bovine consumption by 79kg, this confirms our idea that people see pig meat and bovine meat as complements. On the other hand, Poultry coefficient suggests the complete opposite, with every tonne of

Poultry meat consumed decreases annual per capita bovine consumption by 153kg. This could be interpreted in a way, that people substitute bovine meat in their diet by Poultry, probably because of it's lower cost and better effect on health.

Table 4.8. Top and bottom five fixed effects regarding bovine meat consumption

Country	Fixed Effect
Luxembourg	0,062131
Denmark	0,052508
Sweden	0,047493
France	0,046676
United Kingdom	0,045300
…	…
Romania	0,030647
Croatia	0,029044
Slovakia	0,028641
Hungary	0,026817
Poland	0,024689

4.4. Model of Poultry meat consumption

4.4.1. Pooled OLS Model of Poultry consumption

Our research regarding Poultry meat consumption will follow the same framework as our total meat consumption model chapter, the same data set consisting of 532 annual observations covering period from 2000 to 2018 for 28 countries is going to be used. The results will give us better insight on what should our next procedure be and if our data are suitable for this problem.

4.4.2. All Variables Model

The first step of pooled OLS model was running the regression with all variables in our dataset with suspected effect on our dependant variable (annual bovine meat consumption per capita).

Our all variables model could explain 26% of the model's variance. Three coefficients were not significantly different from 0, namely meat budget, labour force share and female labour force share. We are omitting these variables from our next analysis because of this.

Our dummies regarding meat consumption and urbanization were quite successful, both being statistically significant and with the expected positive effect.

4.4.3. Adjusted pooled OLS Model

Our next step was to run the adjusted model without the omitted variables, with goal being to improve our estimates. All Variables in this model are significant on 1% statistical level. We will discuss the results after obtaining better estimates using either fixed or random effects model in the next chapter.

Table 4.9. Pooled OLS model results regarding poultry meat consumption

Coefficient	All Variables model	Adjusted model
Intercept	0,01168 *	0,01812 ***
Meat budget	0,00000004999	
Unemployment	-0,0002568 ***	-0,0002527 ***
Labour force share	-0,00002914	
Female labour force share	0,000156	
Obesity	0,001831 **	0,001618 **
Urbanization	0,005302 ***	0,00516 ***
PigPC	0,1632 ***	0,155 ***
BovinePC	-0,127 *	-0,1459 ***
R-Squared	0,25545	0,2515

Note: . p<0,05 ; * p<0,01 ; ** p<0,001 ; *** p < 0

4.4.4. Fixed and Random Effects Model of Poultry meat consumption

In the preceding part of our research, we have successfully tested suitability of our data for the simple pooled OLS model. In this part we are going to test the differences of effects for individual countries using either Fixed Effects or Random Effects model using the adjusted model from previous sections.

We ran the same tests as in section 4.1.4. namely the LM Honda test, then the LM Breusch-Pagan test and an F-test of coefficients of pooled OLS and Fixed effect model.

The tests confirmed the existence of significant individual random effects, rejected the need to use time-fixed Effects model. After evaluating the test results, we have concluded that Fixed effects and Random effects model both contain additional important information and should be used instead of Pooled OLS model.

We are going to use the Hausman test, already discussed in preceding sections to decide which model is more suitable for our analysis. Hausman test failed to reject the null hypothesis, which means both Fixed and Random effects model are consistent. Based on the results we are going to pick the Random Effects model because the results are going to be more efficient and there will be no need to omit our time invariable variables such as urbanization and obesity. Our Random Effects model is going to be

estimated using the same variables as our adjusted pooled OLS model discussed in the preceding chapter.
Random effects model equation:

$$Poultry\ Meat\ Consumption_{c,t} = \beta_1\ Unemployment_{c,t} + \beta_2\ \ Obesity + \beta_3\ Urbanization_{c,t} + \beta_4\ PigPC_{c,t} + \beta_5\ BovinePC_{c,t}\ (c_i + e_{it})$$

Table 4.10. Random effects model results regarding poultry consumption

Coefficient	Random effects
Intercept	0,01996 ***
Unemployment	-0,0001805 ***
Obesity	0,001692
Urbanization	0,005737 *
PigPC	0,1198 ***
BovinePC	-0,2344 ***
R-Squared	0,1217

The explanatory power of our Random Effects model is 12% of overall variance. Obesity lost its statistical significance, with the rest of the explanatory variables are significant at no less than 2% statistical significance.

The results were generally as expected. We like the performance of our dummy variable regarding urbanization, which indicates that people that live in towns and cities consume annually more poultry meat per capita.

The variables depicting other meat consumption are both significant. Every tonne of pig meat consumed increases poultry consumption by 119kg. On the other hand, Bovine coefficient suggests the complete opposite, every tonne of Bovine meat consumed decreases annual per capita poultry consumption by 234kg. This supports our previous claim that poultry meat and bovine meet act as substitutes.

5. Difficulties, Extensions, and Improvements

5.1. Difficulties Regarding Data

Missing values across multiple datasets was a major limiting factor for explanatory variables of our model, even though a lot of institutions collect data and share them with the world. Our goal was to save as many observations as possible by either approximating missing data points in time series data or transforming them into a dummy variable, while maintaining a decent explanatory power of our models.

Even though the quality of data is improving over time, which could be seen during the data preparation part of our work, we hope that future researchers will have access to better datasets with more observations, fewer discrepancies in methods used to collect data and more consistent time series data without missing variable.

One small obstacle during the data preparation process was the inconsistency of country names between individual data sets, we had to carefully match country names and unify them.

Another obstacle was the different metrics used by various datasets, we had to be careful when computing our own variables to not make any mistakes in conversions.

5.2. Possible Extensions and improvements

Possible extension of my work could be adding more information of a microeconomic character such as data regarding consumer baskets in supermarkets, where the connections between various meat types and their prices can be analysed. This data is sadly not available publicly because it could lead to other companies gaining competitive advantage on the market.

Another possibility would be to add more food items into the research, FAOSTAT collects data regarding production, import, export, change in stock and losses for over 120 items, for example relationship with the consumption of alcohol beverages or with other animal-based products such as eggs could be researched. Adding more meat types could also be interesting: fish, donkeys, horses, camels, and goats were discarded in our research, because they were usually only country specific and their explanatory power in our framework would be low.

Notable improvement would be adding more country specific variables in a time series format for example the index of urbanization or obesity that we had to transform to dummy variables by our own computations. Or to take a different approach regarding urbanization and add population density to our dataset.

Great improvement would be to obtain country specific data regarding population's culture, that we could not obtain, for example data covering religion or the trend of veganism. Another possibility regarding country specific population variables would be to merge our research with anthropology and see if meat consumption can be connected with various ethnicities.

Interesting results could be obtained by adding country specific geographical features into our research, for instance to see how the country's shore length relates to consumption of fish and other marine animals or if more pastures per square kilometre translates to increased bovine meat consumption.

6. Conclusion

Our thesis aimed to assess, verify, and quantify the link between macroeconomics, microeconomics, and country specific variables with annual meat consumption per capita. We used data covering the consumption of meat in the European Union member countries in the year of 2018, with meat consumption data ranging from 2000 to 2018.

Our random effects model regarding the total meat consumption per capita was successful in connecting several variables to annual total meat consumption per capita. Variables Meat budget, Unemployment and our own dummy regarding Urbanization performed as expected. Variable Labour force share has a negative effect on our dependant variable. We expected this variable to have a positive effect because people participating in labour force have more resources to purchase meat but the opposite is true, this can be explained in a way, that the preparation of meat is more time consuming than average meal and people participating in the labour force simply have less time to cook. This model helped to test our hypothesis stated in 3.5., we concluded

that yes, individual propensity to consume meat varies between countries of the European Union.

Our fixed effects model regarding the total annual pig meat consumption managed only to connect three variables to our dependant variable namely unemployment and consumption of the other two meat types in our research. Unemployment performed as expected with a small negative effect, this suggests that people without job have less resources to purchase pig meat and get their protein from other, cheaper sources. Positive effect of Poultry and Bovine meat tells us, that pig meat is probably a complement with Poultry and Bovine in population's average diet.

Our fixed effects model regarding the total annual bovine meat consumption managed to perform similarly to our previous model, bovine meat consumption could only be connected with labour force share and other meat type consumptions. Labour force share again had a negative impact, supporting our suspicion regarding time difficulty when preparing meat, this can be also caused by the fact that beef takes the longest time to prepare from our meat types. Pig meat consumption has positive effect on Bovine meat consumption, further supporting our claim that they most likely work as a complement in our case. Poultry meat consumption has negative effect on our dependant variable, suggesting that people might be purchasing one of the meats instead of the other.

Our random effects model regarding the total annual poultry meat consumption did not rule out our own dummy regarding Urbanization as statistically insignificant, this supports our theory that people living in cities live their life faster than people living in rural areas and prefer Poultry meat because it takes the shortest time to prepare. The model also connected the same variables as in the case of pig meat, with expected results. The pig-poultry complement relationship was further supported with this model. The model results also suggested the substitute relationship regarding poultry and bovine meat.

Bibliography

ALAN, Davidson,. *The Oxford Companion to Food*. B.m.: Oxford University Press. ISBN 0-19-280681-5.

PROFAUNA INDONESIA., 2005. WHALING IN LAMALERA-FLORES.

THE ECONOMIST., A guinea pig for all tastes and seasons. **2004**.

EUROSTAT. *Distribution of population by degree of urbanisation, dwelling type and income group* [online]. B.m.: Eurostat. Dostupné z: https://ec.europa.eu/eurostat/databrowser/view/ILC_LVHO01__custom_876950/default/table?lang=en

AMERICAN MUSEUM OF NATURAL HISTORY,. Domestication Timeline | AMNH. *American Museum of Natural History*.

IARC.,. *European Prospective Investigation into Cancer and Nutrition*. 2013. vyd. B.m.: International Agency for Research on Cancer.

FAOSTAT.,. *FAOSTAT* [online] [vid. 2021e-05-04]. Dostupné z: http://www.fao.org/faostat/en/#data
EUROSTAT.,. *Harmonised index of consumer prices (HICP) (prc_hicp)* [online]. B.m.: Eurostat, the statistical office of the European Union. Dostupné z: https://ec.europa.eu/eurostat/cache/metadata/en/prc_hicp_esms.htm

SAS INSTITUTE.. *SAS Help Center: Poolability Test for Fixed Effects* [online] [vid. 2021g-05-02]. Dostupné z: https://documentation.sas.com/doc/en/pgmsascdc/9.4_3.5/casecon/casecon_cpanel_details47.htm

UNECE.,. *Statistical Database - United Nations Economic Commission for Europe* [online] [vid. 2021h-05-04]. Dostupné z: https://w3.unece.org/pxweb/en/

BEST, Steven. *The Global Industrial Complex: Systems of Domination* [online] [vid. 2021i-05-04]. Dostupné z: https://rowman.com/ISBN/9780739136973/The-Global-Industrial-Complex-Systems-of-Domination

WHO.,. *World Health Data Platform - WHO* [online] [vid. 2021j-05-04]. Dostupné z: https://www.who.int/data

BUSCEMI, Francesko,. *From Body Fuel to Universal Poison: Cultural History of Meat: 1900–The Present.* ISBN 978-3-319-72085-2.

CROISSANT, Yves a Giovanni MILLO, 2008. Panel Data Econometrics in R: The plm Package. *Journal of Statistical Software* [online]. **27**(1), 1–43. ISSN 1548-7660. Dostupné z: doi:10.18637/jss.v027.i02

GEHLHAR, Mark a William COYLE, 2012. *Global Food Consumption and Impacts on Trade Patterns* [online]. 5. září 2012. [vid. 2021-05-04]. Dostupné z: https://web.archive.org/web/20120905083755/http://www.ers.usda.gov/media/293589/wrs011c_1_.pdf

GERBER, Pierre J. a FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, ed., 2013. *Tackling climate change through livestock: a global assessment of emissions and mitigation opportunities*. Rome: Food and Agriculture Organization of the United Nations. ISBN 978-92-5-107920-1.

HAUSMAN, J. A., 1978. Specification Tests in Econometrics. *Econometrica* [online]. **46**(6), 1251–1271. ISSN 0012-9682. Dostupné z: doi:10.2307/1913827

HOROWITZ, Roger, 2006. *Putting meat on the American table*. B.m.: The Johns Hopkins University Press; Illustrated edition. ISBN 0-8018-8241-9.

KANERVA, Minna, 2013. *Meat consumption in Europe: issues, trends and debates*. 2013. B.m.: Bremen: Universität Bremen.

KATCHOVA, Ani, 2013. *Panel Data Models* [online]. 2013. Dostupné z: https://docs.google.com/file/d/0BwogTI8d6EEiX2ZGeTRObjktOVk/edit?fbclid=IwAR1F-wsYPw6DFhTlp0IFhjV4ZGQClMKFpJXWLYI24ZeGdOWAQBzg90y1jnQ
LAWRIE, LEDWARD, nedatováno. *Lawrie's Meat Science - 7th Edition* [online]. 25th September 2006. 7 [vid. 2021-05-04]. ISBN 978-1-84569-159-2. Dostupné z: https://www.elsevier.com/books/lawrie-s-meat-science/lawrie/978-1-84569-159-2

MAEVE, Henchion, McCarthy MARY, Resconi VIRGINIA C. a Troy DECLAN,. Meat Consumption: Trends and Quality Matters.

PODBERSCEK, Anthony L, 2009. Good to Pet and Eat: The Keeping and Consuming of Dogs and Cats in South Korea. *Journal of Social Issues*. (65).

REGMI, Anita a Mark GEHLHAR, 2001. *Consumer Preferences and Concerns Shape Global Food Trad*. 2001. B.m.: Global food trade.

SIMON, D. R., 2013. *Meatonomics: How the Rigged Economics of Meat and Dairy Make You Consume Too Much—and How to Eat Better, Live Longer, and Spend Smarter* [online]. B.m.: Red Wheel Weiser. ISBN 978-1-60925-861-0. Dostupné z: https://books.google.cz/books?id=wh4fF1OeJAwC

TIMOTHY J., Key, 1999. *Mortality in vegetarians and nonvegetarians: detailed findings from a collaborative analysis of 5 prospective studies*. 1999. B.m.: The American Journal of Clinical Nutrition.

WHO,. *Cancer: Carcinogenicity of the consumption of red meat and processed meat* [online] [vid. 2021-05-04]. Dostupné z: https://www.who.int/news-room/q-a-detail/cancer-carcinogenicity-of-the-consumption-of-red-meat-and-processed-meat

WOOLDRIDGE, Jeffrey, 2010. *Econometric Analysis of Cross Section and Panel Data, volume 1*. B.m.: The MIT Press. ISBN 0x4138bee8.

WOOLDRIDGE, Jeffrey, 2012. *Introductory Econometrics : A Modern Approach*. ISBN 978-1-305-27010-7.

YORK, Richard a Marcia GOSSARD, 2004. *Cross-national meat and fish consumption: exploring the effects of modernization and ecological context*. 2004.