

Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Economics



Diploma Thesis

Analysis of Consumption and Consumers' Behaviour

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DIPLOMA THESIS ASSIGNMENT

Bc. Eliška Šuráňová

Economics and Management
European Agrarian Diplomacy

Thesis title

Analysis of Consumption and Consumers' Behaviour

Objectives of thesis

The aim of the diploma thesis is to determine and to evaluate consumption in the Czech Republic in the selected period.

The aim will be fulfilled based on the partial aims. Then, several hypotheses will be defined and verified. Based on the results of and empirical analysis the final conclusions will be introduced.

Methodology

The diploma thesis will cover both theoretical and empirical part. Theoretical part will contain theoretical background of the selected topic as well as the methodological framework. Scientific literature will be used to prepare the literature overview. The empirical analysis will be based mainly on the time series analysis. Other suitable methods will be employed as well. Based on the empirical analysis the results will be presented and some recommendations will be suggested.

The proposed extent of the thesis

60 – 80

Keywords

Consumption, consumers' behaviour, time series, econometric model.

Recommended information sources

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WARDE, A. Consumption: a sociological analysis. Palgrave Macmillan, New York 2016. ISBN 978-1137556813.

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Declaration

I declare that I have worked on my diploma thesis titled "Analysis of Consumption and Consumers' Behaviour" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the diploma thesis, I declare that the thesis does not break copyrights of any third person.

In Prague on 24. 3. 2021

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Analysis of Consumption and Consumers' Behaviour

Abstract

The diploma thesis focuses on consumption of selected commodity - beef meat - and analyses its trend in the Czech Republic as well as suggests perspectives from consumer behaviour point of view. The theoretical part offers background and principles of consumer behaviour and consumption generally and introduces the beef meat as a commodity. The practical part of the thesis consists of two chapters. The introductory part is dedicated to the beef meat analysis with an emphasis on situation in the Czech Republic. In the following chapter of this thesis an econometric model is assembled based on the formulated determinants of beef meat consumption in the Czech Republic. Within the framework of the econometric model the parameters are calculated and consequently verified. Furthermore the interpretation of resulting values is performed followed by a model application including ex-ante and ex-post analysis.

Keywords: Consumption, consumers' behaviour, supply, demand, beef meat, meat consumption, time series, time series analysis, econometric model

Analýza spotřeby a spotřebitelského chování

Abstrakt

Diplomová práce se zaměřuje na spotřebu vybrané komodity - hovězího masa - a analyzuje její trend v České republice a současně nabízí pohled z hlediska spotřebitelského chování. V teoretické části se hovoří o obecných principech spotřebitelského chování a spotřebě samotné a také je zde představena problematika hovězího masa. Praktická část práce je složena ze dvou kapitol. Úvodní je věnována analýze hovězího masa se zaměřením na situaci v České republice. V kapitole následující je sestaven ekonometrický model na základě formulovaných vlivů na spotřebu hovězího masa v České republice. V rámci ekonometrického modelu jsou vypočteny parametry, dále verifikovány a následně je provedena interpretace výsledných hodnot. Na závěr je pozornost věnována aplikaci modelu včetně ex-ante a ex-post analýzy.

Klíčová slova: Spotřeba, spotřebitelské chování, nabídka, poptávka, hovězí maso, spotřeba masa, časové řady, analýza časových řad, ekonometrický model

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1 Introduction

Beef is one of the traditionally consumed types of meat and is characterized by a brick red colour, but it depends on the age of the animal - in general, the younger, the lighter the red colour of the meat. It is also rich in essential amino acids and ferrum.

In the Czech Republic, beef consumption ranks third, after pork and poultry meat. In the 1980s, beef consumption reached its peak and has been declining sharply since the 1990s. At the same time, the popularity of poultry meat has grown. There have also been scandals related to the defect of meat imported from Poland and this has not improved the position of beef. Beef has also become the subject of debate whether it is healthy to consume it or not. The answer to this topic, much discussed by media, should rather be answered individually and should be based primarily on the principle that a person's diet should be various and colourful.

The development of consumer behaviour is also related to this situation. People react mainly to the prices of products, their availability and other factors. Recently, it may become apparent that people are interested not only in the price of products in general, but also in their quality and some consumers are ready to pay more money for the proper quality. Consumer behaviour has been and is constantly being researched, and a number of theories have arisen. One of the key points in this area is the decision-making process, which includes many important factors affecting the customer from the external environment but also from his internal space.

Marketing companies are very involved in this direction and are constantly working on new marketing strategies to attract the customer's attention as much as possible.

How is it possible to influence the decisions of consumers, what happens after the purchase and also what specific effects affect in particular the consumption of beef meat in the Czech Republic are the issues that this thesis deals with.

2 Objectives and Methodology

2.1 Objectives

The main aim of this thesis is to determine the variables that have influence on beef meat consumption in the Czech Republic and analyse their development in the chosen time period 1989-2018. The partial aims include verifying defined hypotheses about examined variables, evaluation of the influence of statistically significant variables and forecast of the development of beef consumption for the next three years. Assumptions related to the relationships between the examined variables are defined in Chapter 4.2.1.

2.2 Methodology

For the elaboration of this diploma thesis the data from databases of the Czech statistical office (CZSO) were used. Data from this source were obtained in the form of time series in the period 1989-2018. The estimation of the one-equation linear model was performed using Gretl software.

Time series analysis

Time series means a sequence of objectively and spatially comparable observations (data), which are clearly arranged in terms of time in the direction of the past - present. The analysis (and, if necessary, the forecast) of time series is then called a set of methods used to describe these series (and possibly to predict future developments).

Since visual analysis using graphs may not always be completely sufficient to understand the deeper contexts and mechanisms of the studied issue, several elementary characteristics are used such as differences of different order, growth coefficients, average growth rates, basic indices and averages of time series values. (Hindls, 2006)

Growth coefficients are often presented as a percentage. The first difference shows the rate of change of the observed indicator. The second difference can be obtained by repeating the application of the first difference to the executed first difference.

The characteristic which was used the most in this thesis:

- first absolute difference (difference of adjacent time series values)

$$\Delta y_t = y_t - y_{(t-1)}$$

Trend functions of time series

Trend means the main tendency of long-term development of values over time. The trend can be increasing, decreasing or constant. The following functions were used to determine the appropriate trend:

- Linear $T_t = a + b \cdot t$
- Quadratic $T_t = a + b \cdot t + c \cdot t^2$
- Logarithmic $T_t = a + b \cdot \log t$
- Exponential $T_t = a \cdot b^t$
- Power $T_t = a \cdot t^b$

One of the options for choosing a suitable trend function is the graph analysis of the examined time series. However, this method can be considerably subjective. Another criterion used is the index of determination. The closer the value of the index is to one, the more suitable the selected function appears.

Choosing the correct trend function is also crucial for forecasting. The more the trend function corresponds to the time series, the more accurate the predictions for the following period will be. (Hindls, 2006)

Econometric model

The term model generally covers any representation of a real phenomenon which is a real system or process. The real phenomenon is represented by a model in order to explain it, predict its behaviour and enable its control. The econometric model can be defined as an economic-mathematical model which has the character of a statistical model, specifically that it has a precisely specified functional form, while in addition random components are statistically defined, representing random errors of functional equations. (Tvrdoň, 2001)

The following types of variables are distinguished in econometric models:

Endogenous variables - variables that are explained by the model, also referred to as explained. Their values are generated by the model. They are usually denoted by the letter y with the appropriate indices allowing unambiguous identification of the variable and its value in the relevant period. The general notation y_{it} expresses the i -th endogenous variable at time t .

Exogenous variables - also called explanatory variables. They are used to explain the values of endogenous variables and their changes. The letter x is usually used to denote them. The values of exogenous variables are not determined by a model, but by an economic model.

Predetermined variables - include exogenous variables, lagged exogenous variables as well as lagged endogenous variables. They have the character of explanatory variables and their values are given by the external environment.

Stochastic variable - contains the influence of all other variables on the dependent variable, which are not included in the model. It also contains measurement errors and distortions resulting from the selection of the wrong type of function. The random variable is denoted by the letter u . (Čechura et al., 2013)

The econometric model that can be used in practice must also contain specified parameters. The derivation of structural parameters is one of the objectives of econometric modelling. Structural parameters express the direction and intensity of the impact of predetermined variables on endogenous variable. This creates a quantitative image of the described economic structure. Structural parameters are denoted by the letter γ . (Tvrdoň, 2001)

Construction of the econometric model

The construction of the econometric model can be divided into the following phases:

1. Economic theory
2. Formulation of economic model
3. Formulation of econometric model
4. Collection, processing and analysis of input data

5. Estimation of econometric model parameters
 6. Economic verification of the model
 7. Statistical and econometric verification
 8. Application of the econometric model or its rejection
- (Čechura et al., 2013)

Assumptions of linear regression model (LRM)

In order for the regression model estimate to be the best among the linear estimates, it must meet certain assumptions. According to Gujarati and Porter (2009), these assumptions include:

- the random component has zero mean
- homoscedasticity
- absence of autocorrelation of residues
- there is no perfect multicollinearity in the model
- normal distribution of the random component
- explanatory variables are non-random and fixed in repetitive selections

The model must also be specified correctly. If this presumption is not met, specification errors often occur, including:

- omission of an essential explanatory variable
- inclusion of a non-essential explanatory variable
- incorrect functional form of the model
- measurement errors

(Wooldridge, 2006)

LRM estimation - ordinary least squares method

Due to its simplicity, the ordinary least squares (OLS) method is most frequently used to estimate the parameters of the linear regression model. The essence of OLS is to find parameters minimizing the sum of squares of deviations of theoretical values of the explained variable from its real values - estimated LRM parameters are the best, unbiased and consistent if the above assumptions and the following criteria are met:

$$\min \sum_{t=1}^n (y_t - \hat{y}_t)^2$$

The relationship below represents a formula for estimating model parameters using the OLS method, where γ is a vector of estimated parameters, X is a matrix containing values of explanatory variables and y is a vector that contains values of the explained variable. (Čechura et al., 2013)

$$\gamma = (X^T X)^{-1} X^T y$$

Verification of the model

The estimated econometric model must first be verified before its application - to verify and evaluate whether all obtained estimates of parameters are primarily in accordance with the a priori limitations of the initial economic hypothesis and whether they have the required economic, statistical and econometric characteristics.

Economic verification consists in verifying the correctness of the signs and the size of the numerical values of the estimated parameters. If the obtained estimates are in line with expectations regarding the signs and values of particular parameters, they can be interpreted in accordance with theoretical economic assumptions and the estimated econometric model is an adequate, nevertheless simplified, representation of the examined economic problem or system.

Statistical verification is used to assess the statistical significance of particular estimated parameters and also the entire econometric model. The most frequently used criteria of statistical verification are standard errors of estimated parameters, coefficients of multi-level determination and then t and F tests of statistical significance of estimates.

Econometric verification consists in verifying the conditions necessary for the successful application of specific econometric methods, tests and techniques. (Hušek, 2007)

The tests used in the practical part of the thesis include:

- Breusch-Godfrey autocorrelation test
 - H0: Autocorrelation absence
 - H1: Autocorrelation presence

- White's heteroscedasticity test
 - H0: Homoscedasticity
 - H1: Heteroscedasticity
- Residual normality test
 - H0: Normality presence of random variable
 - H1: Normality absence of random variable

Ex-post and ex-ante analysis

Ex-post prediction of the explained endogenous variable can be obtained if the values of both endogenous and explanatory predetermined variables can be determined at the time of the prediction with certainty. By comparing the ex-post forecast with the actual value of the predicted endogenous variable, the prediction error is determined. This error can be used to verify the suitability of the econometric model for forecasting.

In case of ex-ante forecast, neither the value of an endogenous explanatory variable nor some (or all) of the values of the explanatory variables are known with certainty at the time of the forecast. An estimate or determination of these values based on a priori information is therefore required. An ex-ante forecast can be described as a forecast in the true sense of the word. (Hušek, 2007)

3 Literature Review

3.1 Consumer behaviour theory

Consumer behaviour represents a segment of social science which aims to understand, predict and explain buyer's behaviour. It appears to incorporate both mental decision process and physical activity. The consumer is needed to be recognised as a person learning and perceiving and therefore study of consumer as an individual is a key essential to examine. Generally, the individual behaviour is influenced by personality of the buyer, his perception, attitudes, motives and other social and cultural factors. (Tyagi, Kumar; 2004)

According to Lantos (2011), consumer behaviour refers to cultural anthropology, sociology, psychology, economics, communication theory and management science. Together with management theory, practice and research, it seeks to explain the consumption behaviour of people in a society. Consumers dispose of particular resources, such as money, time and energy, and choose how to allocate them – whether they invest into goods, services or ideas and satisfy their personal needs or desires. In today's world, people have inexhaustible options where to invest their money. Generally all people are consumers and have experience with this phenomena even maybe without realizing this fact.

3.2 Utilitarian and hedonic needs

There are two categories into which needs and wants of the consumers can be split. The first one, **utilitarian**, comprise practical, functional, concrete, rational and cognitive needs. They are able to satisfy useful needs such as save time or improve health. The buyers process the information in order to find out how to best satisfy their needs. In other words, the consumers search for the information about product's qualities which they can easily verify and simultaneously these qualities represent the essence of the particular product.

On the other side are **hedonic** needs. Hedonic needs represent almost the opposite of utilitarian needs. Including emotional, nonrational, subjective, social and aesthetic needs, they refer to the fact that every product creates a certain feeling or experience. In reaction to

these feelings, the buyer wants to try this product. Therefore, consumers buy hedonic products in order to experience fun, joy, sensory pleasure and so on. One of many examples can be Starbucks. People do not go there just for drinking a coffee, but probably more often because of friends, chatting, relaxing in comfortable armchairs. It is about the experience as a whole. (Lantos, 2011)

In context of purchasing, it has been discovered that buyers' utilitarian value is pushed by the accomplishment of the task (product acquisition) and there is a stronger link to repatronage intentions. On the other hand, it does not say much about satisfaction or retail loyalty which are the factors that most retailers seek to build with the customers. In this case, hedonic values take part in and prevalently drive the satisfaction, word of mouth and even repatronage anticipation. In a broader point of view, these results infer that there is a significant interrelationship between hedonic and utilitarian values and shopping outcomes. (Jones, Reynolds, Arnold; 2006)

3.3 Consumer behaviour in practice

Consumer behaviour is a very important area of marketing. Marketers use miscellaneous messages and media in order to inform, persuade and consequently influence consumer's decisions on a daily basis. Therefore, for every marketer it is essential to understand the consumers thinking and decisions properly and on the basis of this knowledge marketing strategies can be prepared.

In a marketing point of view, the essence is the satisfaction of customer's needs and wants with the aid of value exchange between a buyer (customer) and a seller (marketer). The marketing's main objective is to serve customers efficiently – customer manages more with using fewer resources, and effectively – producing the best options and effects for both buyer and seller. The two general type of served customers come from two specific markets: business and consumer. Business customers buy on behalf of a particular business organization. They seek to obtain goods or services which enter into the organization's production process. The second type is consumer customers (consumers). These are the people who use the products to satisfy their needs and wants (or even other people's).

The consumers buy for the final consumption, while the business buyers buy in a rather organisational context. (Lantos, 2011)

When researching how buyers react and decide on a particular product, marketers can better prepare for filling the gap in the market and determine the products which are needed to be present in the market or conversely are already obsolete. Simultaneously marketers then have more options how to present and promote products in order to generate maximum possible impact on buyers. To sum up, understanding the buyer behaviour is the key point for marketers how to reach, engage and persuade clients to make a purchase. (Radu, 2019)

3.4 Influencing consumer behaviour

These influences can be divided into three categories: decision process, sociocultural and psychological.

First, **decision process** factors influence the consumer when he is deciding about the purchase of particular product. There are also two stages which are very important during this process – level of involvement and level of decision making. Level of involvement means how important or relevant is the purchase for the buyer, it ranges from high to low. Level of decision making represents how much the consumer knows about the product or which positive or negative experience he has. This includes extensive, limited and routine decision making. Extensive means the buyer does not have experience with the product or just a little experience. Routine represents purchasing the same again, for example brand loyalty – buyer has a favourite brand and buying products from this brand is a habit for him. In addition, there are situational factors. The consumers are affected by the environment where they shop and also if they buy products for themselves or for someone as a gift.

Sociocultural factors range from culture through subculture, social class, reference groups, family or household to interpersonal relationships. In all these there are behaviour patterns, unique thoughts, and other influences that shape consumer's thinking, habits, manner and further even decisions when purchasing products.

Finally, individual **psychological** influences. How do the consumer's mental processes behave when it comes to decision making. These factors include buyer's

personality, lifestyle, motivation, perception, learning and attitude. Each of these influences can eventually create a basis for target marketing. (Lantos, 2011)

No less important are social and physical surroundings. Solomon et al. (2010) points out that social and physical environment which encloses the customers may have a substantial impact on their decision. For example number and type of other customers and overall design of store premises, decoration, smells (may increase pleasure and hedonic values in connection with shopping) and even temperature can affect buyers' choice significantly.

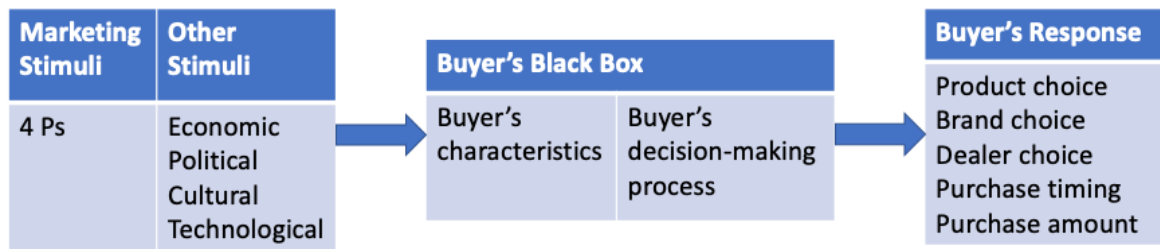
A factor which is not so often alluded is the age. According to particular French study that in addition joined three other factors influencing people most when buying clothes - price, durability and sustainability; younger participants decided to buy clothes based on rather low price, for older participants a sustainability was more important and for eldest participants a durability of clothing was the key determinant of the purchase. This result suggests changing values in different life stages. (Hervé, Mullet; 2009)

3.5 Black box model

The black box model adverts the persisting complexity of person's prediction of behaviour although relevant findings have been brought by many scientific branches. In this particular case, the customer's mind is considered to be "the black box" and the ability of perceiving its inner processes remains in the meantime limited. This model is based on the relationship stimulus - black box - response.

The starting element of the whole process is the stimulus (both external and internal). The black box in this sense represents the mental process which cannot be quantified or examined. Nevertheless, the exogenous (external) factors can be examined, quantified and some of them could be even influenced or created. From this point of view, the influence of the exogenous stimuli on the consumer behaviour and purchase decision making is interesting to be examined including all categories of these incentives. It concerns mainly socio-cultural and social influences. Regarding internal factors, these include individual influences (lifestyle, values) and psychological, such as motivation, perception, learning and so forth. (Vysekalová, 2011)

Figure 1: A generic model of consumer behaviour



Source: <http://arts.brainkart.com/article/models-of-consumer-buyer-behaviour---buyer-behaviour-877/>

3.6 Consumer's decision in purchase and follow-up evaluation of the purchase

The way how the consumer decides when it comes to the purchase behaviour depends on, among other factors, personal predispositions. But here it is important to mention that personalities differentiate among people. The outcome is that at the same offer and same incentives people react in a different way. (Vysekalová, 2011)

The whole process of decision making when purchasing can be divided into five stages:

1. **recognition of the problem** - identification of the need which will be satisfied by the purchase, it can be tangible, intangible or from the time perspective current or future; principally those needs which are identified as urgent are sought to be satisfied primarily;
2. **searching for the information** - a particular rate of information is needed for the decision making as lack of information may increase sense of risk and surplus may cause a disorientation, a form of how the information gets to the consumer is no less important, whether it is from personal sources or news media;
3. **evaluation of the alternatives** - comparing the information and selection of the optimal solution, involvement of the emotional processes;
4. **purchase decision** - after product selection, decision when accomplish the purchase;
5. **evaluation of the purchase** - customer's satisfaction with the purchase, seller should be concerned in post-purchase behaviour in order to obtain faithful customers and based on their recommendation eventually new clients.

3.7 Post-purchase satisfaction

The last point in previous chapter suggested that not only the purchase but also the real after-purchase experience with the product matter and should matter to the seller.

The satisfaction with the product can have a real impact on profitability. While conducting a study in Sweden, it has been proved that product quality influences the customer's satisfaction that further results in increased profitability among companies which offer quality products. It can be assumed that quality is more worthwhile than marketing phrases. Lately because of the growing competition in foreign markets, right the product quality maybe crucial when seeking to maintain the competitive advantage. Consumers pay attention to the process before actual purchase of the product. They study brand name, price and what might be also helpful are the reviews on the internet. Altogether with product warranties and other services provided by firms help the customers to assure themselves that they have made a good decision. (Solomon et al., 2010)

3.8 Consumer and price

Money is according to theoretical definition considered as generally accepted medium of exchange. It can also be defined as such an asset which has three principal functions:

1. Medium of exchange - money is used for goods and services payment;
2. Unit of account - money is an unit used for value formulation of goods and services, accordingly for value measurement;
3. Store of value - meaning that money preserves its purchasing power and its holder can estrange the time period between the acceptance of this money and the moment of its single consumption. (Mankiw, 2001)

For a part of population money or trading with this commodity can serve as an adrenaline sport. For many people, even very well-educated, the investing in securities and trading in them has become very popular. The price of bad investment is rather high but this does not discourage many people. The adrenaline sports but also trading, with high level of risk cause strong and intense experience. But money can also become a stressing factor if

one approaches it too much as a certainty which does not need to be (not only) during crisis very reliable. Remembering collapsing financial institutions where many people lost their lifelong savings. Money-related are also the attitudes and behaviour in the area of savings and indebtedness which has become a problem for many people. The circle of loans and their repayment brings mental pressure and stress. (Vysekalová, 2011)

The price is without doubt one of the most important factors in decision making. But it is not the only factor and it is also very important to handle it properly. From the market point of view, the price is defined as quality over value.

$$Price = \frac{quality}{value}$$

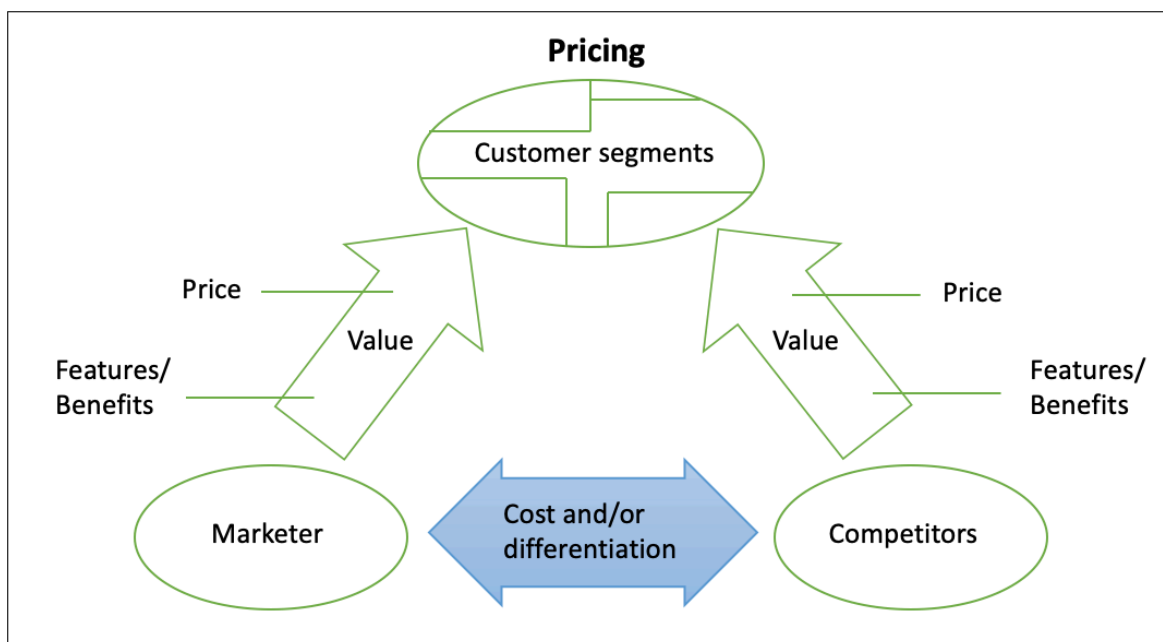
Prices in market mechanism belong to the most important economic categories. They represent the cynosure of merchandisers and also customers, and constitute the essential part of supply and demand. When formulating particular pricing strategy, it is convenient to define a body of rules where consumer and his possible reactions shall not be missing. A review below illustrates this dilemma more concretely:

- Scale of prices - Is it practical from size of purchase aspect to determine the price separately for each consumer?
- Consumer knowledge - Are consumers able to assess the value of product financially and recognize the differences between price levels?
- Information - Can the seller evaluate correctly the relationship between price, value and level of demand?
- Competitive substitutes - Do the products which can be considered as close substitutes and between which it would be possible to compare the prices exist in a given category?
- Favour - Will the customer prefer the competition for non-price reasons?

(Hanna, Dodge; 1995)

It is necessary to consider the total value as the customer perceives it himself, that means including symbolic features of the particular product. A conceptualization of providing total value to customers is shown in the figure below.

Figure 2: Conceptualization of providing total value to customers



Source: Hanna, 1995

3.9 Behavioural economics

The discipline which connects economics with psychology is named behavioural economics. This discipline presents the opportunity to explain why people's decisions are not always rational. It is important to emphasize the fundamental assumption of classical economic theory – the assumption of perfectly rational decision making. The human is according to this theory capable of making perfectly rational decisions. The principle of rationality represents the basis for all economic theories, prognoses and recommendations. But it is a pure fact that people make mistakes and human brain does not always work rationally. This shows the difference between classical and behavioural economics. (Ariely, 2009)

In 2017, the American economist Richard Thaler won the Nobel Prize in Economics. His field is behavioural economics. He received the prestigious award for incorporating psychological assumptions into the analysis of economic decision-making. Unlike classical economics, behavioural economics allows for irrational behaviour and attempts to understand why this may be the case. The concept can be applied in miniature to individual

situations, or more generally to include broader company events and actions or trends in financial markets. One example of how behavioural economics can help explain a particular situation or issue is Brexit. Thaler suggested that this theory could help clarify how a narrow vote to leave the EU was affected by intuitive choices as opposed to a rational decision. This theory can be especially useful for companies and traders who want to increase sales by promoting changes in consumer behaviour. Thaler is well known for his work on "nudge theory", a term he created to help explain how small interventions can encourage individuals to make several decisions. However, nudges can be manipulative at the expense of individuals. (Partington, 2017)

3.10 Supply and demand

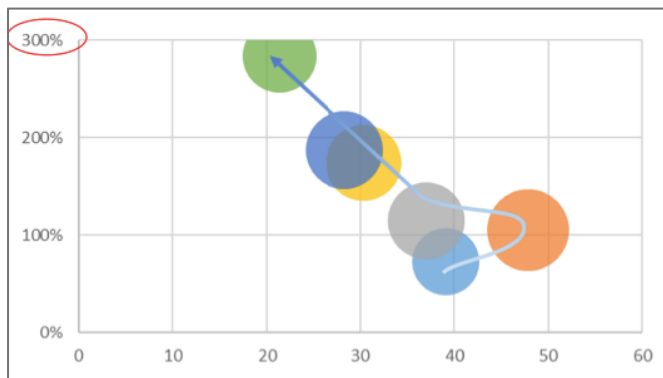
Classical economic theory says that market prices are given by two forces – supply and demand. The price where these two forces meet together is called equilibrium market price. There is one disputable point. It is assumed that supply and demand are independent forces. But the existence of many cases when customers' willingness to buy can be quite easily manipulated proves that customers do not always have their preferences under control and are not even rationally capable of defining how much money would they spend on certain products.

Many decisions (mostly first) that people make in the past, have a significant influence on their future decisions. But afterwards, it can lead to a frequent repetition of any decision without proper consideration. Hence, if buyers admit that their old choices were not always rational, logical and best, they can open their mind to the new ideas and opportunities. This can be merely advantageous.

In addition, supply and demand cannot be entirely independent, they interact. It can be seen in many everyday life examples – producers constantly show the customers recommended retail prices, discount offers and so forth. These variables are set by supply side though. Consequently, right these prices influence the potential buyers and how much they will be willing to pay. Meaning that demand cannot be fully free from supply and does not shape an individual force. (Ariely, 2009)

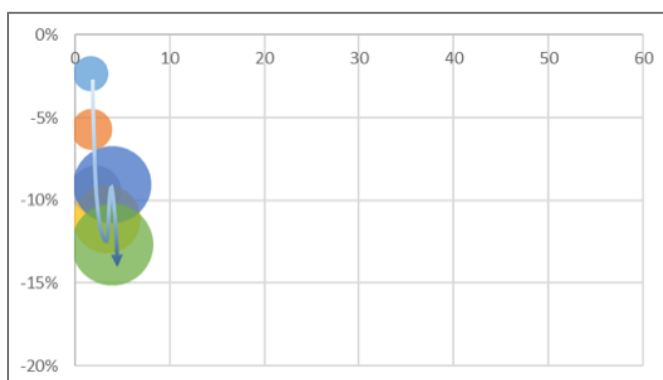
A specific example of supply and demand related to the topic of this thesis can be the global supply and demand of food with a focus on the beef trade in different regions. The following graphs show the consumption of beef per capita on a horizontal axis and on the vertical axis there is a surplus or shortage of this foodstuff. The individual bubbles represent a decade from 1961-1970 (light blue) to 2011-2020 (green) and the development is indicated by an arrow. The size of the bubble indicates the overall consumption in the particular region whereas the green bubble (2011-2020) is 100%.

Graph 1: Beef trade - Oceania



Source: FAOSTAT, OECD-FAO

Graph 2: Beef trade - Asia



Source: FAOSTAT, OECD-FAO

The highest consumption of beef can be seen in North America and reaches over 35 kilograms per person, followed by South America (around 35 kg), Oceania (slightly over 20 kg) and the EU with lower consumption (around 15 kg). In Asia (Graph 2), there is a current increasing trend in beef eating, but consumption per capita is still low (5 kg). In Africa, beef

consumption is more traditional, but limited by availability and income and is round 5 kg per capita.

Globally, very different patterns can be observed - a significant reduction in beef intake in North America and Oceania. In Asia, the change in per capita consumption is small, but with regard to population growth, this represents a significant increase in total volume.

Approximately 15% of global production is traded. The largest surpluses can be observed in South America and Oceania (Australia). While in South America 85% of beef is destined for domestic consumption, in Oceania (Graph 1) it is exported almost three times as much as is consumed locally. The deficit in the case of Asia is increasing and reaches 13%. (European Commission, 2019)

3.11 The word free

To some extent, the word free can have a wonder effect. From classical economics' point of view, equally lowering of prices should not cause any changeover in customers' behaviour. The customers should decide for the product which brings the highest utility. The results from a certain experiment show the opposite. There were two kinds of chocolate, one very fine and quality and the other rather low quality but quite popular. The first offer for buyers was 15 cents for quality one and 1 cent for the other one. Customers decided very rationally, they compared quality with taste. Almost three quarters chose the quality chocolate. Afterwards the price of both was reduced by 1 cent. The first chocolate cost 14 cents, while the second was for free. Suddenly, buyers started to prefer the second lower quality chocolate. As a result, with this pricing almost seventy percent decided for the second one. So according to classical economic theory the net utility would be counted as taste minus price and therefore even lowering the prices by 1 cent would not result in deeper price gap between those two products, customers should decide for the quality chocolate. But practically it is by contraries. (Ariely, 2009)

As mentioned above, the word free evokes strong emotions in customers. There is a difference, however, in what sense it is strong. For someone, the impression is immediately activated that there is no risk, and if the goods or services are not of good quality, at least the customer will not blame himself for not paying, so it is a rather positive reaction. For

another group of people, however, it may not be a strong positive reaction, because they may see a catch in the situation, a hidden risk. Or they may get the impression that the goods offered have little or no value. The word free can be very helpful if used in the right context. Marketers should also consider that it is not just about how the free word will be perceived, but what types of customers it will appeal to. If it is an advertising campaign aimed at selling as many goods as possible in the shortest possible interval, the word free here can be a meaningful initial stimulus. On the contrary, it is not appropriate to use it if professional services are offered, such as legal services. These companies do not aim to attract discount shoppers. (McKelvey, 2015)

3.12 Overrating the possession

According to Adam Smith, the possession is firmly imprinted into people's lives. A person who wants to sell his belongings usually expects to obtain a certain price and a buyer expects to pay a certain amount of money. This sum of money generally differs. A seller wants to receive as much as possible and a buyer wants to pay as least as possible. Plus the seller has a bond with his items – memories.

What was already mentioned is the fact that when people are offered better quality products which make their lives more comfortable and easier, they constantly want more. But when consumers lose this comfort regardless the reason, they consider it as a big loss and a failure. Therefore they try to avoid this situation as much as possible even if it means to pay so high mortgage that with their remaining earnings they barely make a living. (Ariely, 2009)

3.13 Theory of consumption

In economics, the term consumption refers to the use of goods and services by households. The common theoretical framework proposed by economists is based on the assumption that the expenditures of customers originate in their rational assessment of current and also future conditions. But this rational optimization is more or less impossible to test without any other assumptions about customers and their relation to the level of consumption that are defined more concretely. Accordingly, these preferences are captured

by an utility function. Three most common hypotheses assumed by economists are displayed below:

1. A declining marginal utility of consumption - the urgency of consumption needs shall decline as the consumption level increases;
2. People are risk-averse - people are not willing to risk in their consumption;
3. Particular precautionary saving scale - originated in an inevitable uncertainty regarding future income.

(Carroll, 2020)

It is also efficient to mention the permanent income hypothesis, which was formulated by Milton Friedman and is a theory of consumer spending based on the assumption that individuals spend money at a level corresponding to their expected long-term average income. This level is then considered to be the level of the so-called permanent income, which the agent can spend safely. The worker will try to save only if his current income is higher than the expected level of permanent income, in order to protect himself from a future decrease in income. Friedman believed that people would consume based on an estimate of their future income contrary to what the Keynesian economics suggested - people will consume based on their in the moment after-tax income. Individual liquidity may play a role in future income expectations. Individuals without assets may already have a habit of spending regardless of their income - current or future. (Kagan, 2020)

3.14 Beef meat as a commodity

To illustrate the situation on the global beef market, an overview of the most important producers, exporters and importers is presented below.

In 2019, a total of 61.642 million tonnes of beef meat were produced worldwide. The most significant producer was the United States, followed by Brazil and the European Union in third place. (Cook, 2021) The amount of beef produced in these countries is displayed in the Table 1 below.

Table 1: World beef production in 2019

	tonnes
World	61,642,000
USA	12,384,000
Brazil	10,200,000
EU	7,878,000

Source: FAS-USDA

Regarding beef exports in 2019, the largest exporter by volume was Brazil, followed by Australia, India, the USA and Argentina (Table 2). However, in terms of export value, Australia came first.

Table 2: Main beef exporting countries in 2019

Country	tonnes
Brazil	1,570,000
Australia	1,230,000
India	1,100,000
USA	966,000
Argentina	566,000

Source: IHS Markit, DAWR

Brazil finished first in beef exports with the value of 1.57 million tonnes, which represents a year-on-year increase of 16%. The largest export destinations for Brazil were China and Hong Kong. Australian beef exports to China increased to a value of 1.85 billion USD in 2019, up significantly from 883 million USD in 2018. India predominantly exports to the South-East Asian markets (Vietnam, Malaysia, Indonesia). The United States is in a role of a key competitor for Australia - exporting beef to over 130 diverse destinations, with a significant presence in Australia's high value markets (Japan and South Korea). South Korea is in a position of a major growth market for the United States, with beef exports increase by 8% year on year. Due to the significant devaluation of Peso, Argentina's competitive position in exports has improved dramatically. Total beef exports increased by 54% in 2019, Argentina is making great use of the strong demand in China. In 2019, 76% of all Argentine beef exports went to China. (Meat & Livestock Australia, 2020)

In terms of imports, China has become the country that imports most beef meat in the world. Followed by the USA, Japan, South Korea and Hong Kong. China's growing demand for beef, together with slow growth in domestic production, has led to a sharp increase in beef prices and also a sharp increase in beef imports into the country. Over the last 2-3 years, China has provided market access to approximately 20 beef export countries (including Ireland, France, the USA, the UK). The Chinese government is said to open up to more countries while simplifying market access procedures to enable better trade.

Table 3: Main beef importing countries in 2019

Country	tonnes
China	1,659,000
USA	1,387,000
Japan	624,000
South Korea	444,000
Hong Kong	356,000

Source: USDA, Japan Ministry of Finance

In 2019, China imported 1.6 million tonnes of beef and became the world's largest importer of beef (Table 3). The biggest suppliers of beef meat for China were Brazil, Uruguay, Argentina and Australia. (Chen, 2020) The second country to import large quantities of beef is the United States, most supplied by Canada, Mexico and Australia. The imported quantity of beef meat in 2019 reached almost 1.4 million tonnes. The amount of beef imported to Japan in 2019 reached 624,000 tonnes. The most important suppliers of beef to Japan are Australia and the USA, followed by New Zealand and Canada. South Korea imported 444,000 tons of beef and 53 percent comprised of US imports. This represents an increase, as beef imported from the USA accounted for 50.7% of all beef imported into South Korea in the previous year 2018. (Yonhap, 2020) Fifth in this ranking is Hong Kong with 356,000 tons of beef meat imported in 2019.

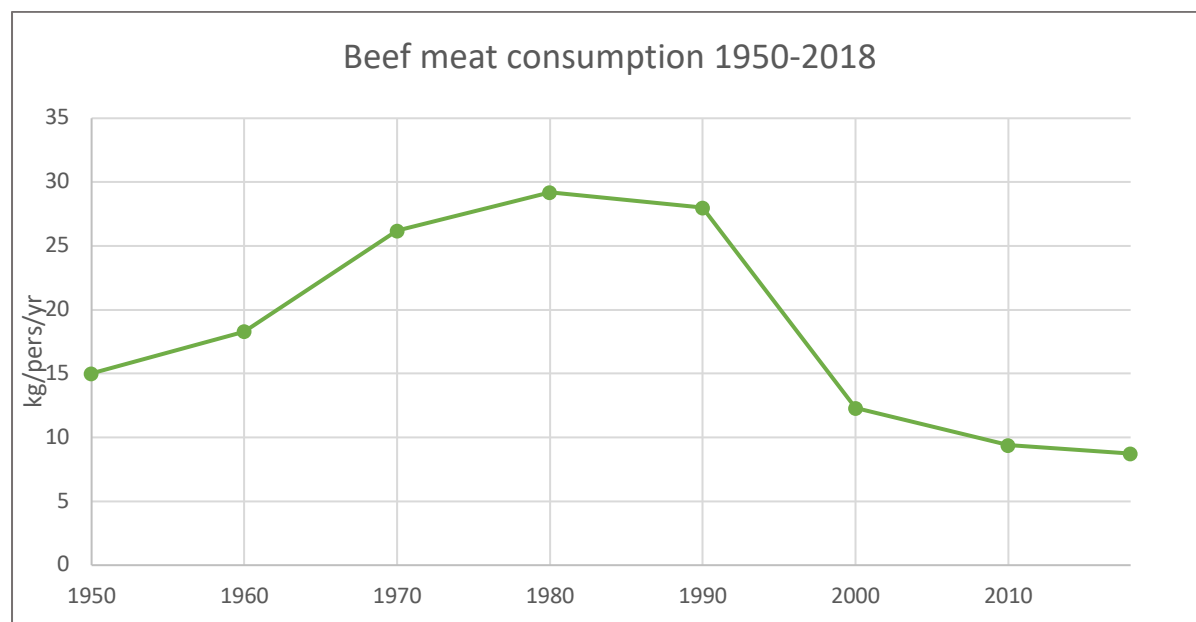
4 Practical Part

4.1 Beef meat in the Czech Republic

The beef meat represents a traditionally consumed type of meat in the Czech Republic. In the past, the Czech Republic was one of the countries with a high per capita meat consumption. Concerning the structure of meat consumption, pork had a dominant position in 1989, followed by beef meat and then poultry. However, the latter began to develop very dynamically and about 10 years later its consumption was higher than that of beef. Specifically, in 1989, meat consumption in the Czech Republic was 97.4 kilograms of meat per person per year and the beef represented 30 kg of consumption, in 2018 the total meat consumption was 82.4 kilograms of meat per person per year, of which only 8.7 kg accounted for beef.

Graph 3 below captures the long-term development of beef consumption in the time period 1950-2018.

Graph 3: Beef meat consumption in the Czech Republic 1950-2018



Source: CZSO, own processing

It is apparent that the steepest decline in consumption during this period occurred between 1990 and 2000 and the declining trend continued, but not so markedly. A more detailed assessment of the development of beef meat consumption is given in Chapter 4.2.3. After 1989 a sharp decline in production base occurred and this regarded most of the livestock. Simultaneously after price liberalisation in 1991 the sector of bovine meat recorded one of the steepest growth of the consumer prices. This meant an inconvenient position towards the other meat types and led to consumption decline which ended up with one third in 2001. It is the sector with the longest production cycle in animal production. (Peterová, 2010)

Beef meat consumption in the year 2017 reached the value of 8.43 kilograms per inhabitant per year. Beef meat accounted for 10.6% of the total meat consumption of 80.3 kilograms. Since 1995, when the share of beef in total consumption was 23%, it has been declining year-over-year, until in 2013 it reached the smallest share (10.2%) in the observed period 1995–2017. There are several reasons for this decrease, mainly due to the high price of beef compared to other types of meat. Another reason is the transition of consumers to more dietary meat and also the requirement for quick preparation of food from the meat. Due to the above reasons, pork and poultry dominate in meat consumption. The share of pork in total meat consumption in 2017 was 52.7%, poultry meat accounted for 34%. The remaining types of meat in 2017 accounted for 13.3%.

In 2018, beef production reached 174 thousand tonnes of live weight, which is 4.8% more than in 2017. (Josrová, 2018)

4.2 Econometric model

In this chapter it is determined which explanatory variables were chosen for the econometric model in order to explain the endogenous variable based on the economic theory and theoretical assumptions. Furthermore, the formulation of both the economic and econometric model is performed, followed by a detailed description of the explained variable and explanatory variables, including numerical characteristics. Next, an estimate of the model is performed with possible modifications and resulting values are verified. At

the end of this chapter, the elasticity coefficients for statistically significant exogenous variables are calculated and ex-post and ex-ante analysis is performed.

4.2.1 Economic theory

Selected variables that can affect the endogenous variable were determined on the basis of literature review as well as on the first chapter of the practical part of this thesis, with respect to the availability of data. The data used comprise time period from the year 1989 to 2018.

Declaration of variables

Table 4: List of selected variables

Variable	Name in model	Units	Variable designation
Consumption of beef meat	Cons_beef	kg/pers/yr	Y_t
Unit vector	const		X_{1t}
Consumer price of beef meat	Cons_price_b	CZK/kg	X_{2t}
Income	Income	thousand CZK	X_{3t}
Meat production	Meat_prod	thousand t live weight	X_{4t}
Export beef	Export_b	thousand t	X_{5t}
Import beef	Import_b	thousand t	X_{6t}
Consumption of poultry meat	Cons_poul	kg/pers/yr	X_{7t}
Consumer price of poultry meat	Cons_price_pl	CZK/kg	X_{8t}
Consumption of pork meat	Cons_pork	kg/pers/yr	X_{9t}
Consumer price of pork meat	Cons_price_pk	CZK/kg	X_{10t}

Source: own processing

Theoretical assumptions of model

- an increase in consumer price of beef will cause a decrease in beef meat consumption, because according to the basic economic theory, the higher the price, the lower the demand,
- an increasing income will cause an increasing consumption of beef meat, as consumers will have a higher disposable income and will be able to afford to spend more money,
- an increase in meat production will result in an increase of beef meat consumption, because the more animals intended for slaughter, the more meat is produced and subsequently consumed,
- an increased export of beef meat will cause a decline in beef meat consumption, as increased exports will leave less of concerned goods for domestic consumption,
- a growing import of beef meat will result in increased beef meat consumption, because it would be uneconomical not to consume imported goods and to let the goods spoil, because meat is not one of the long-lasting survival products,
- an increase in consumption of poultry meat will result in decreased consumption of beef meat, provided that these two types of meat are substitutes,
- an increasing consumer price of poultry meat will result in increasing consumption of beef meat, because consumers will tend to prefer to buy another cheaper type of meat,
- an increasing consumption of pork meat will result in a decreasing consumption of beef meat, provided that these two types of meat are substitutes,
- an increasing consumer price of pork meat will result in increased beef meat consumption, because consumers will tend to prefer to buy another cheaper type of meat.

4.2.2 Formulation of model

Formulation of economic model

Consumption of beef meat = function (consumer price of beef meat, income, meat production, export of beef, import of beef, consumption of poultry meat, consumer price of poultry meat, consumption of pork meat, consumer price of pork meat)

$$y = f(x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10})$$

Formulation of econometric model

The econometric model will be estimated using a basic linear function.

$$y_t = \gamma_1 x_{1t} + \gamma_2 x_{2t} + \gamma_3 x_{3t} + \gamma_4 x_{4t} + \gamma_5 x_{5t} + \gamma_6 x_{6t} + \gamma_7 x_{7t} + \gamma_8 x_{8t} + \gamma_9 x_{9t} + \gamma_{10} x_{10t} + u_t$$

$\gamma_1 - \gamma_{10}$ structural parameters of exogenous variables,

u_tstochastic variable.

4.2.3 Data collection, analysis and processing

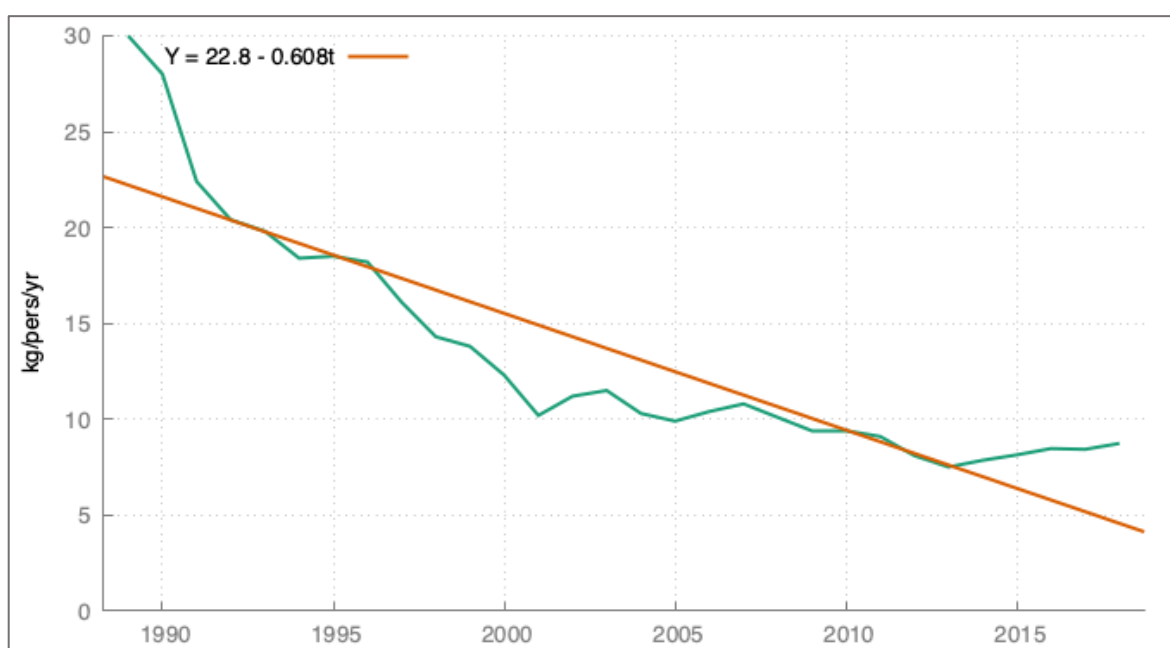
All data used in this model were obtained from databases of Czech statistical office. the data were analysed using trend analysis and further processed.

When working with time series, there may be a problem that some time series are stationary at original values and some are not, which can cause an apparent regression. If second differences had to be made further, it would be rather complicated to make a subsequent interpretation. Based on this fact, it will be determined that all time series are stationary in the first differences.

Consumption of beef meat - endogenous variable

The consumption of beef meat acts in the economic model as the endogenous variable. This means that this variable is influenced by selected group of other - independent (exogenous) variables. The development of beef meat consumption is displayed below in the Graph 4.

Graph 4: Consumption of beef meat (kg/pers/yr)

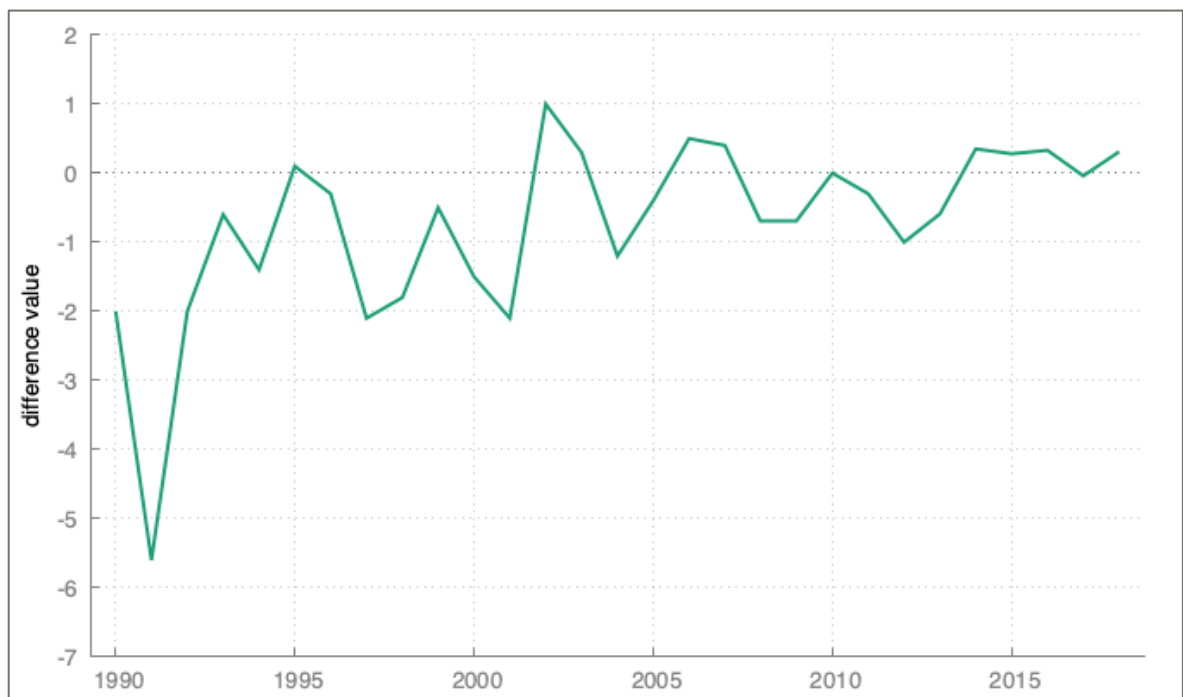


Source: CZSO, own processing

As it has been previously mentioned the beef meat consumption was quite steadily declining in the selected time period 1989-2018. The sharpest declines were captured in the period 1989-2001. This can be explained by a change in eating habits, where the decline in beef consumption in the Czech Republic is adequately offset by an increase in poultry meat consumption and also by the fact that the production base steeply declined after the year 1989. From linear trend function which was applied in the graph can be seen that with every year the consumption is declining by 0,6 kilograms per person. It is obvious that the linear trend is not completely ideal in this case, but it was used for an easier interpretation and description of the development of the consumption.

Within the selected time period, the average value of beef meat consumption amounted 13.392 kg per person per year, the median was 10.6 kilograms. The maximum recorded consumption value was 30 kg per person per year, while the lowest was 7.51 kg per person per year.

Graph 5: Changes in beef consumption (kg/pers/yr)



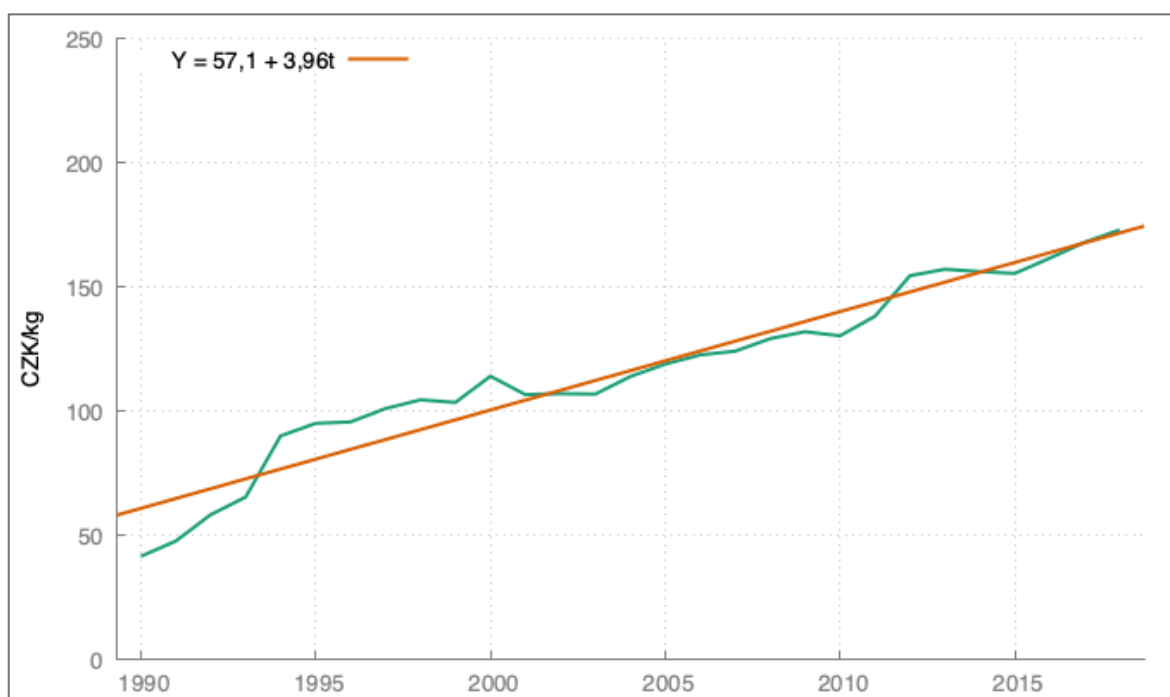
Source: CZSO, own processing

Based on the above explanation, a graph with first differences of beef consumption was added. From the Graph 5 can be seen a weakening trend of decreases - the values are decreasing over time and are noticeably minor at the end than it was in the beginning of the examined period. In brief, there is a noticeable situation where the captured fluctuations gradually decrease. This situation suggests that a time vector could be theoretically included in the model as well as the endogenous variable lagged by two periods since the values in the graph point to a certain recurring trend after approximately two years. This cyclicity in changes in beef consumption alternating after about two years, may indicate some change in consumer preferences.

Consumer price of beef meat

The consumer price of beef meat represents an exogenous variable in the model. This variable is supposed to influence the beef meat consumption (endogenous variable). According to many economic theories, the development of consumption is very much dependent on the consumer price of given good. The data are composed of two different types of goods - beef front with bone and boneless beef back.

Graph 6: Consumer price of beef meat (CZK/kg)

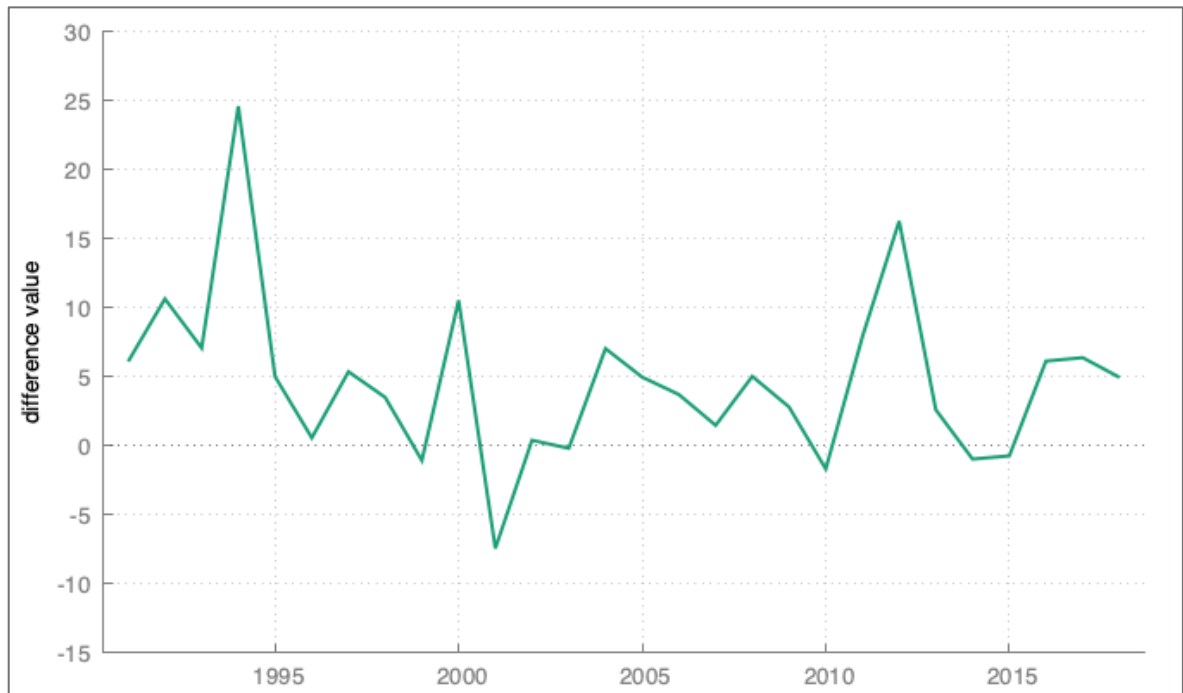


Source: CZSO, own processing

From the Graph 6 is apparent that the consumer price was quite steadily increasing within the selected time period. It is important to mention the increase in beef prices was steeper and more significant than in the case of poultry and pork. The increase in the price of beef is probably related to the declining consumption of beef until 2013. According to the linear trend, the consumer price rose by an average of 3.96 CZK on an year-over-year basis.

The average consumer price of beef meat in the observed period was 116.45 CZK per kilogram. The maximum reached value was 173.12 CZK while the lowest value was 41.72 CZK which represents a significant increase over the entire period under review.

Graph 7: Changes in consumer price of beef meat (CZK/kg)



Source: CZSO, own processing

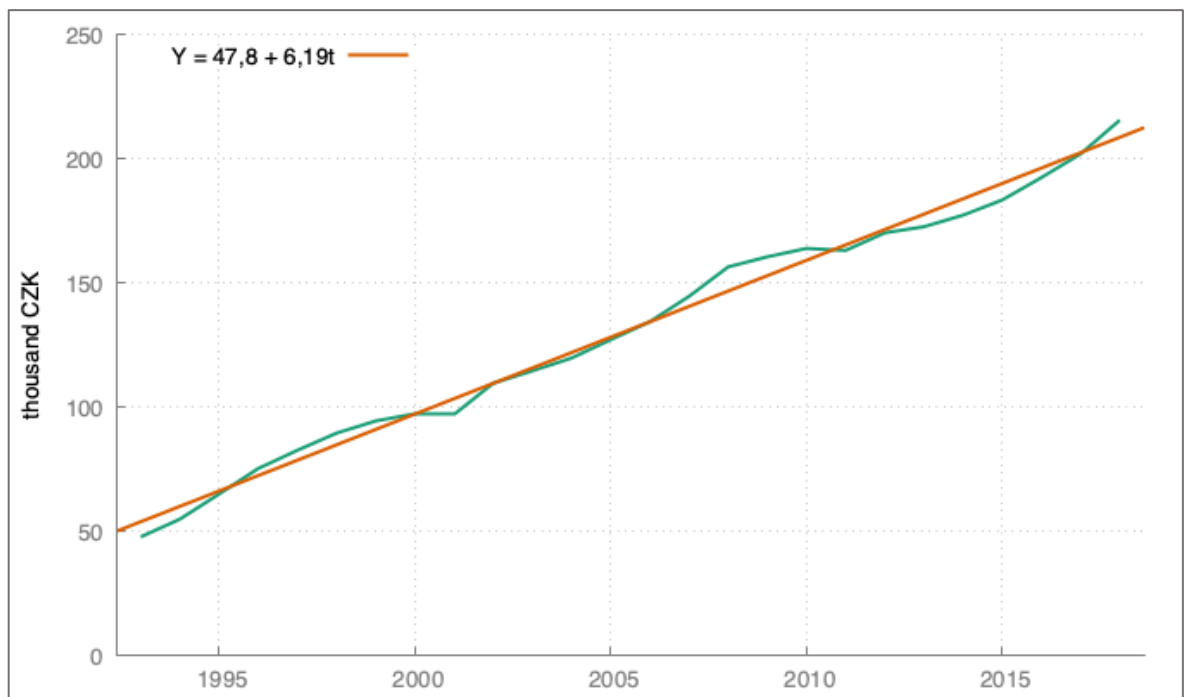
Graph 7 shows numerous fluctuations within the selected time period 1990-2018. The most significant changes in consumer price of beef meat (increases) were captured in the year 1994 and then in 2012. Otherwise, the values of the differences between particular years were not remarkable and remained rather stable within the time period as already mentioned in the previous graph.

Income

It is assumed that the income (in this case gross household income in Czech crowns per person per year) plays an important role regarding subsequent spending. That is the reason why this variable cannot be omitted in the assembled model. From the Graph 8

can be seen the very stable increasing trend with no greater fluctuations which can be captured very accurately using a linear trend.

Graph 8: Income (thousand CZK)



Source: CZSO, own processing

The year-over-year increase was in this case 6,190 Czech crowns. The initial lowest value was 47,940 CZK while the highest value was 215,670 CZK at the end of the observed period in 2018. The average value of the income level was 131,400 Czech crowns.

Graph 9: Changes in income (thousand CZK)



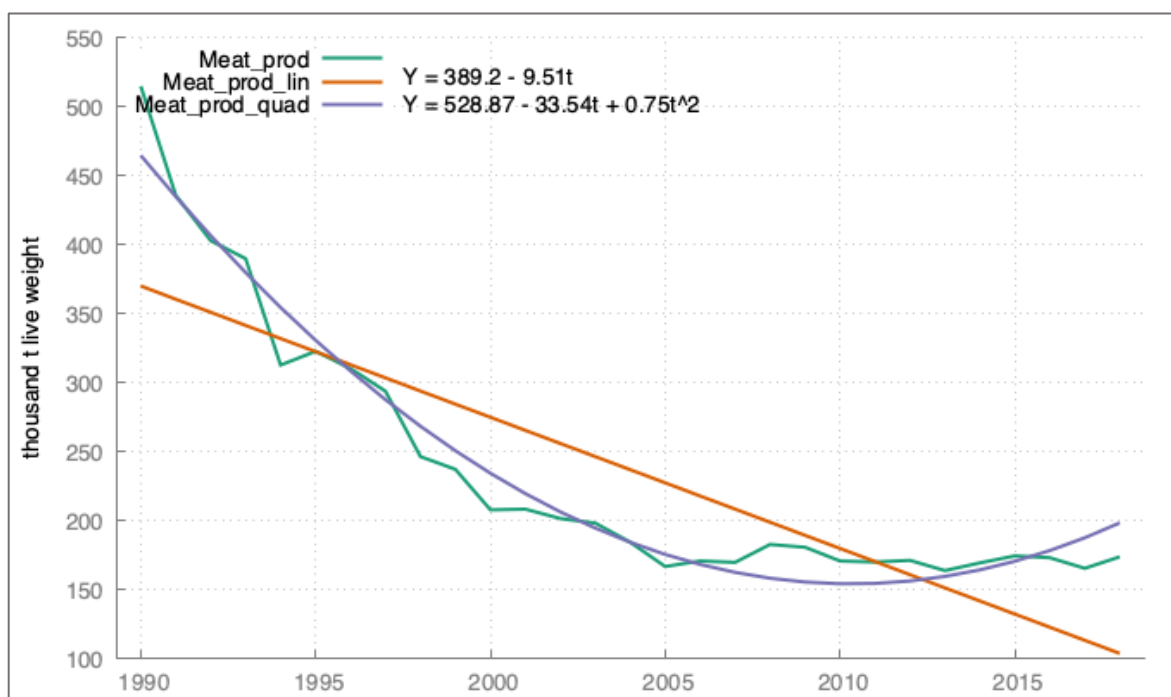
Source: CZSO, own processing

It is worth mentioning the change between the years 2001 and 2002 and then the largest positive increase between 2017 and 2018, which reached the value of 13,567 Czech crowns. The pace of growth slowed from 2008 to 2011, when the change even reached a negative value (Graph 9). Since 2013, positive stable increments are visible until the end of the period under review with the largest year-over-year change (increase) between the years 2017-2018.

Meat production

The production of cattle for slaughter showed initially a sharp decline, then a more gradual declining trend. The decrease was also striking, about 51 percent. So even here a hypothetical connection with a decrease in beef consumption is offered. According to the linear trend the average year-over-year decrease amounted 9.51 thousand tonnes of live weight. From Graph 10 is obvious that the linear trend is not the most suitable for the situation in this case, so a quadratic function has been added for possible forecasts and predictions. The linear trend was used for the interpretation.

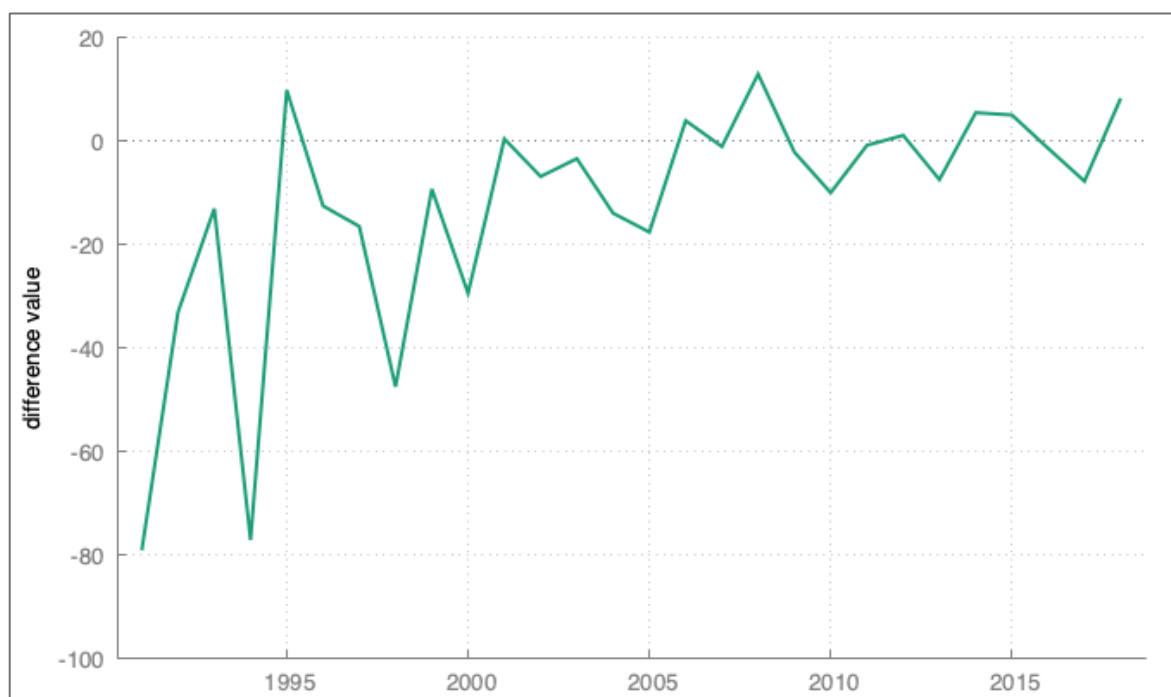
Graph 10: Meat production (thousand t live weight)



Source: CZSO, own processing

The minimum value was reached in the year 2013 with the value of 164,040 tonnes of live weight. The maximum value is apparent from the Graph 10 and it amounted 515,000 tonnes. The average meat production within the reviewed period accounted for 237,080 tonnes of live weight.

Graph 11: Changes in meat production (thousand t live weight)



Source: CZSO, own processing

The sharpest declines can be seen at the beginning of the time period. The biggest difference was captured between the year 1990 and 1991 with the value -79 thousand tonnes of live weight, the second biggest between 1993 and 1994. After these significant fluctuations a weakening trend in decreases can be seen similarly to Graph 5 which describes the changes in beef consumption. When comparing these two graphs (5 and 11), the initial declines in meat production appear to be steeper than those in beef consumption.

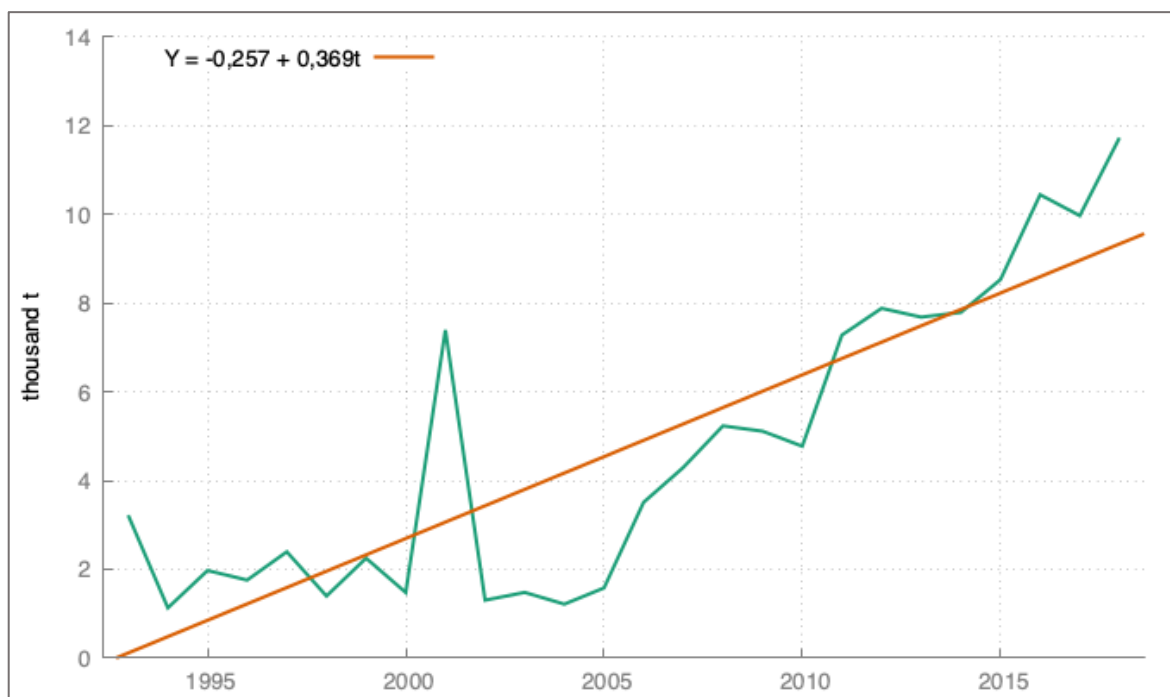
Export

The following two types of goods were used in the analysis of beef export - fresh cooled beef and frozen beef meat. Throughout the period under review, it is clear that beef export has grown quite significantly.

A possible reason why more and more beef is being exported is the fact that processing capacities in the Czech Republic are not running at full capacity and also that there is a long-term shortage of skilled butchers in the country. The unbalanced situation on

the beef market can also be attributed to a more favourable price, which breeders are able to obtain on a foreign market.

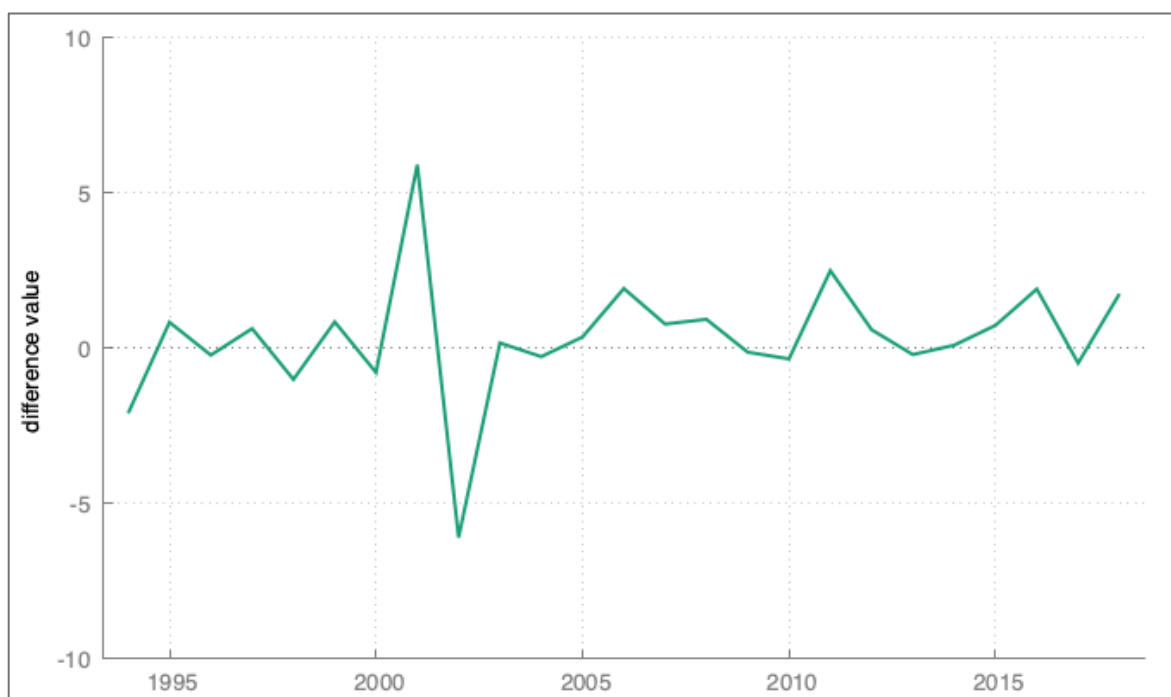
Graph 12: Export of beef meat (thousand t)



Source: CZSO, own processing

Graph 12 captures the largest fluctuation within the examined time period - year 2001. In 2001 this increase was probably influenced by the ban on exports from some European countries at the time of FMD (Foot-and-mouth disease) epidemic. The minimum recorded value could be observed in the year 1994 (1,129.8 tonnes of meat). The highest value of export was captured at the end of the period and counted 11,725 tonnes. The average export value was 4,722 tonnes of beef meat and the export increased by 369 tonnes per year on average.

Graph 13: Changes in beef export (thousand t)



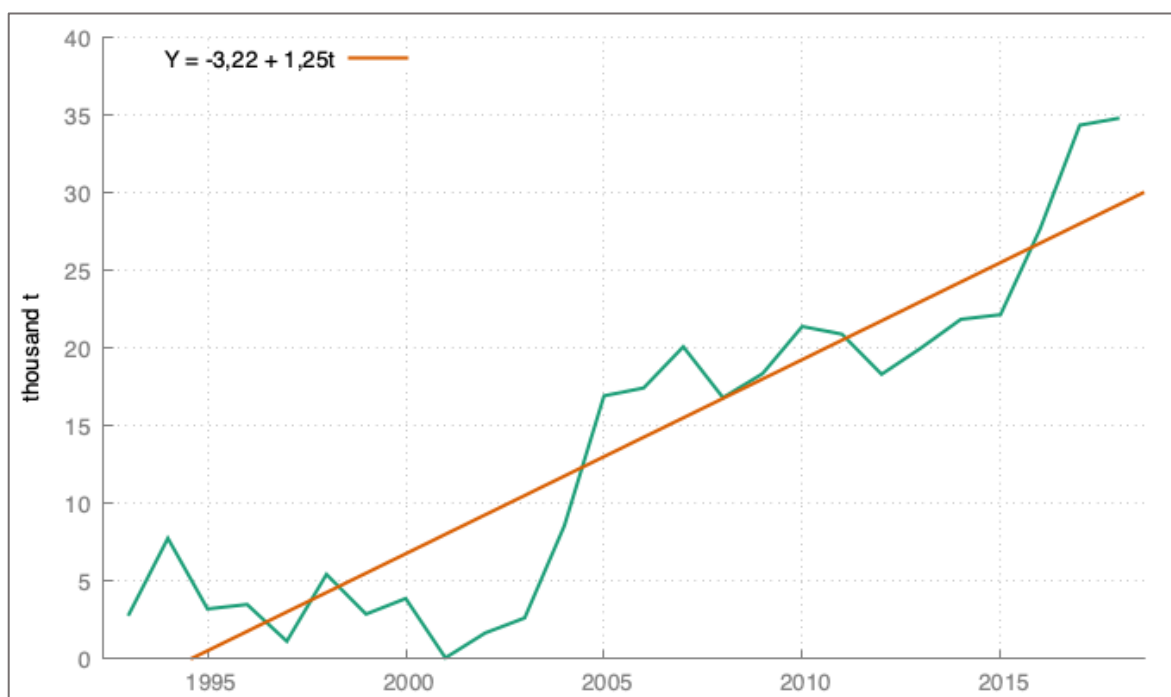
Source: CZSO, own processing

Apart from the substantive fluctuation in the period 2001-2002, no other such significant changes were recorded as shown in Graph 13. The increment between 2000 and 2001 counted 5.92 thousand tonnes, in the following period 2001-2002 the increment reached negative value (-6.1 thousand tonnes). Then for the next two years the differences remained around zero.

Import

As in the case of beef export, fresh cooled beef and frozen beef meat were used for the analysis of import. Compared to beef export, it appears that the increase in import during the considered period is even more pronounced. Fluctuations are evident during the period, in two cases there is a large increase in beef import. Due to the occurrence of BSE and FMD in Europe, the import was realized only minimally in 2001, which can be observed from Graph 14. On the contrary, there was a large increase in 2004 where the Czech Republic's accession to the EU is offered as a possible explanation.

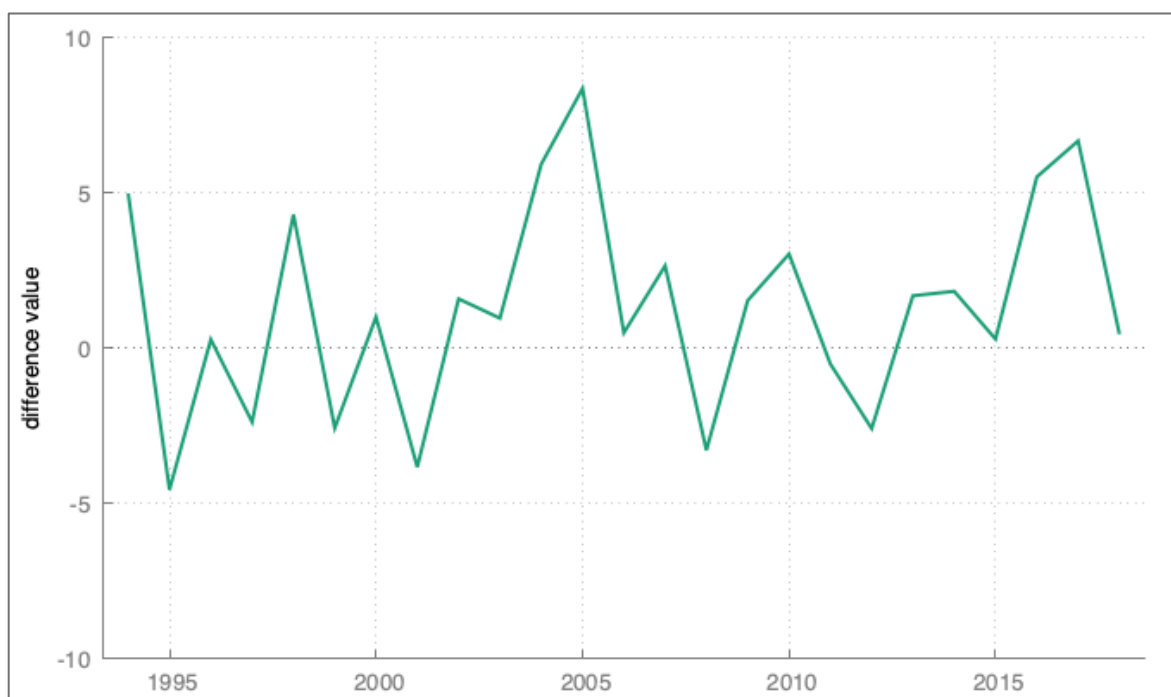
Graph 14: Import of beef meat (thousand t)



Source: CZSO, own processing

The average year-over-year increase within the whole period was 1.25 thousand tonnes, while the average value of the import reached 13.65 thousand tonnes of beef meat. The previously mentioned year 2001 represented the minimum value of import, namely 0.07 thousand tonnes, the highest recorded value of beef import was 34.84 thousand tonnes in 2018, at the end of the examined time period.

Graph 15: Changes in beef import (thousand t)



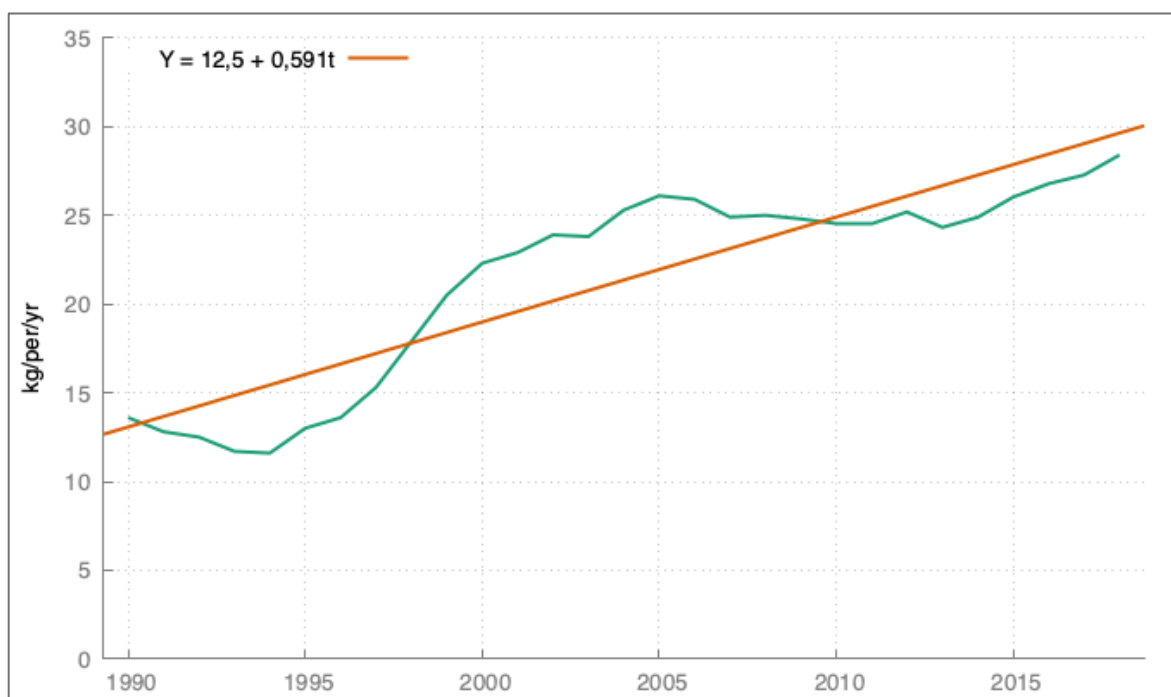
Source: CZSO, own processing

The biggest captured difference is obvious from Graph 15, between 2004-2005 and was equal to 8.37 thousand tonnes of beef meat. On the contrary, the largest change in the opposite direction occurred between 1994 and 1995 and amounted -4.55 thousand tonnes of meat.

Consumption of poultry meat

The development of poultry meat consumption differs significantly from that of both pork and beef. Graph 16 captures an increase in consumption and namely relatively significant. It can be also estimated that poultry meat has become the most sought-after and popular type of meat in the selected time period.

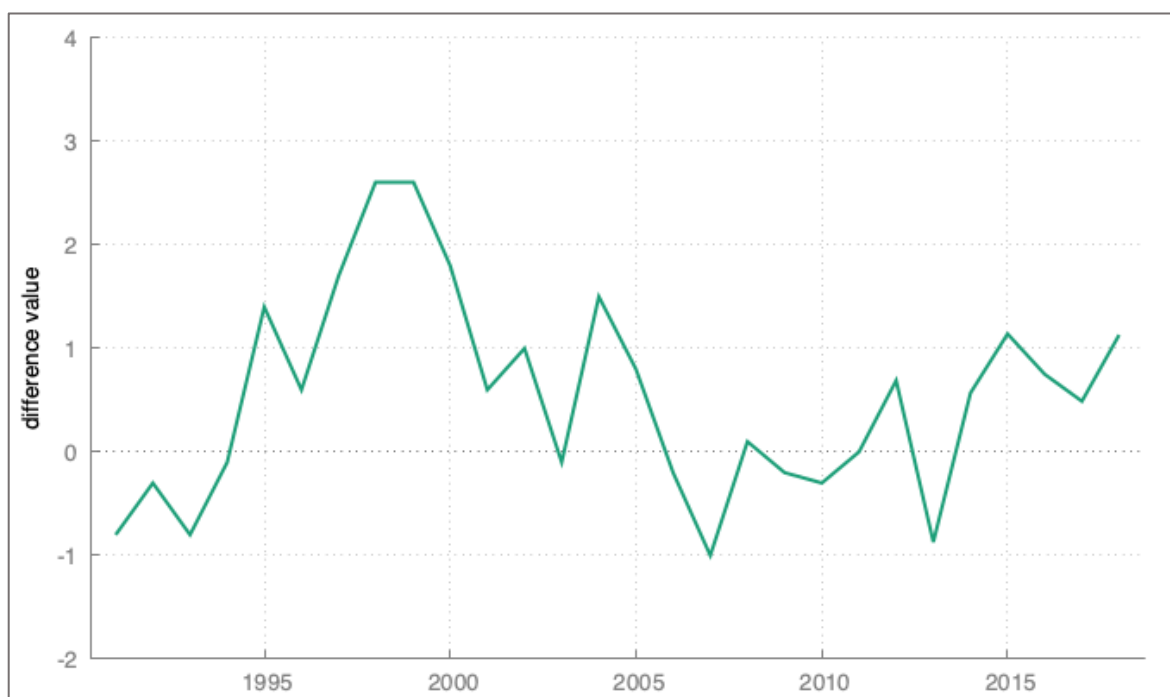
Graph 16: Consumption of poultry meat (kg/pers/yr)



Source: CZSO, own processing

The consumption of poultry meat doubled over the whole time period starting with the value of 13.6 kilograms per person per year and ending with 28.4 kilograms. Within the examined period the consumption of the poultry recorded a year-over-year increase of 0.59 kilograms per person per year. The average value of consumption was 21.35 kilograms.

Graph 17: Changes in poultry consumption (kg/pers/yr)



Source: CZSO, own processing

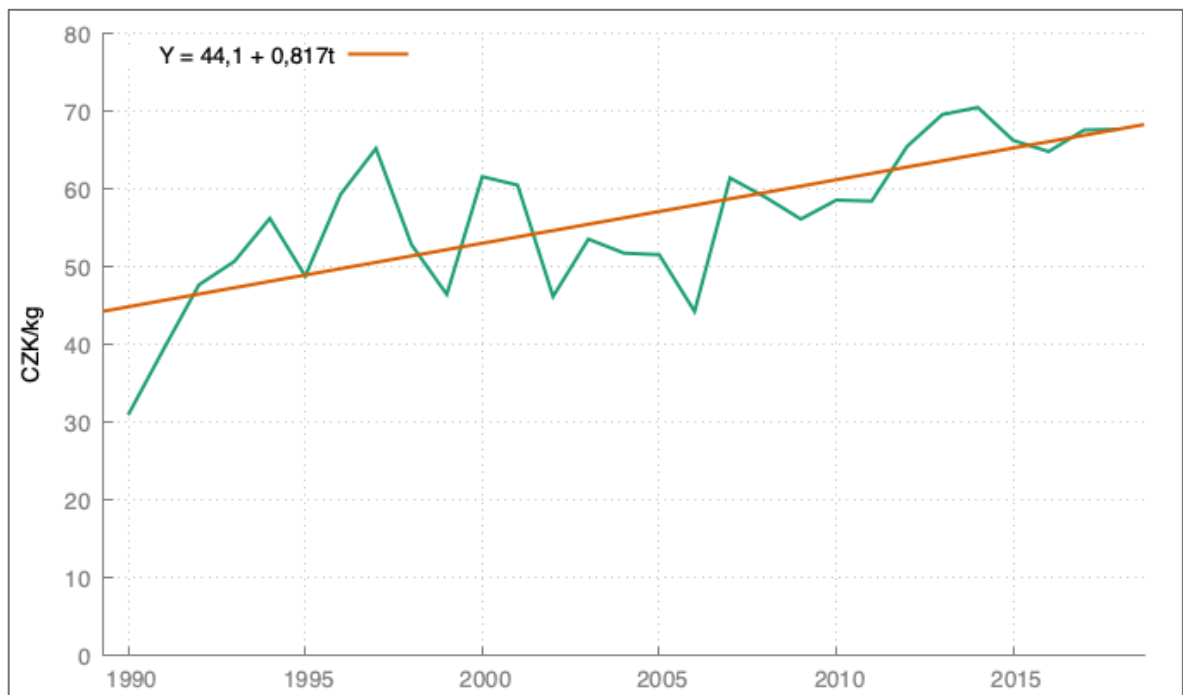
From the beginning of the period, the consumption even decreased, but began to increase from 1994, which can be evidently seen from Graph 17. The most significant change in the consumption of poultry was captured between 1997 and 1998 and also 1998 and 1999, since in this period the increments of the consumption were 2.6 kilograms per person per year. In 2006, a case of avian influenza appeared and this probably caused a decrease in consumption by 1 kilogram between 2006 and 2007. Even after this drop in consumption, the value remained at approximately the same level until 2011.

Consumer price of poultry meat

From the Graph 18 is obvious that the consumer price of poultry meat, particularly the prices of chickens, considerably fluctuated. The initial rise in prices corresponds to a fall in consumption until 1994, in the period 1994-2006 poultry meat consumption grew steadily, although prices were relatively high in 1997, 2000 and 2001.

In 2006, a case of avian influenza (H5N1) in wild birds first appeared in the Czech Republic, and the following year it was first reported in farmed poultry. This fact is evident from the Graph 18, where the price of poultry meat is very low (the third lowest in the whole time period). The fall in the price of meat did not cause an increase in consumption - people probably feared the disease.

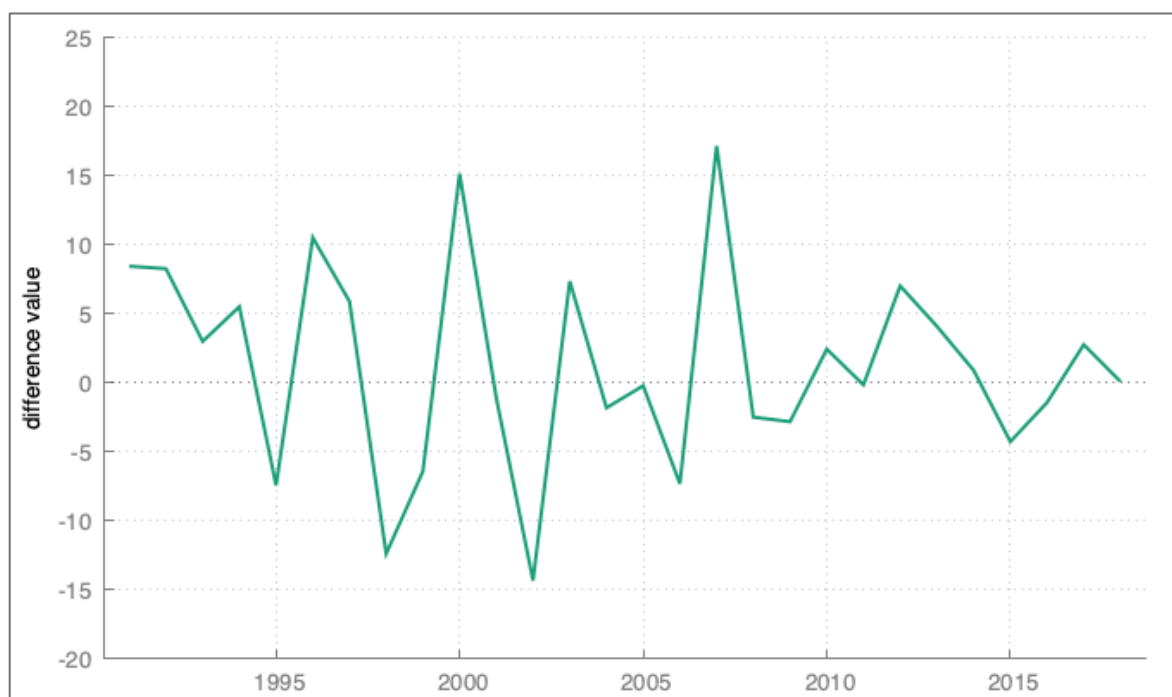
Graph 18: Consumer price of poultry meat (CZK/kg)



Source: CZSO, own processing

The year-over-year increase in consumer price of poultry meat for the examined period reached an average value of 0.82 CZK per kilogram. The lowest price was captured in 1990 with the value of 31 Czech crowns per kilogram and the highest consumer price of poultry was in 2014 and it amounted 70.55 CZK per kg. The average consumer price in the whole time period was 56.34 Czech crowns per kilogram of poultry meat.

Graph 19: Changes in consumer price of poultry meat (CZK/kg)



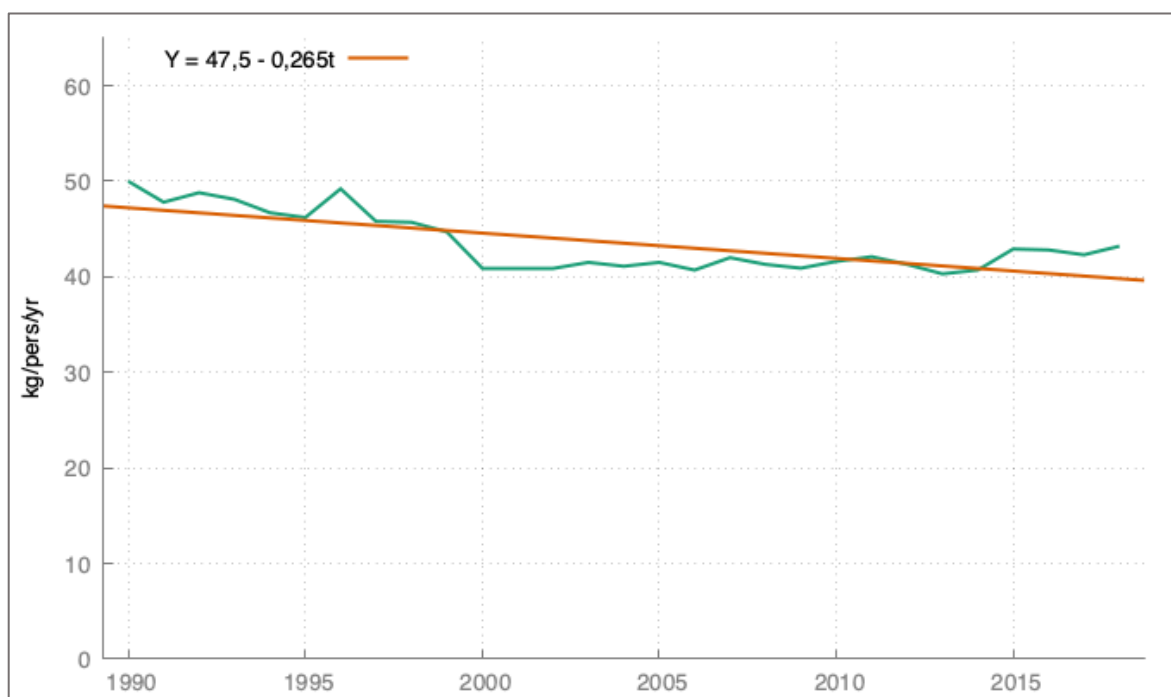
Source: CZSO, own processing

The second largest change (price increase) was recorded between 1999 and 2000 (Graph 19), the highest growth between 2006 and 2007, when the already mentioned avian influenza appeared. This situation is also associated with the consumption of poultry, which decreased during 2006 and then more or less stagnated. The sharpest decline was captured between the years 2001 and 2002 when the drop in consumer price amounted 14.32 CZK per kilogram.

Consumption of pork meat

The total consumption of pork meat in the Czech Republic decreased relatively evenly. Since 2000, consumption has been constant. The development tendency can be explained by the change of eating habits starting in 1990 due to the promotion of a healthy lifestyle in the then Czechoslovakia.

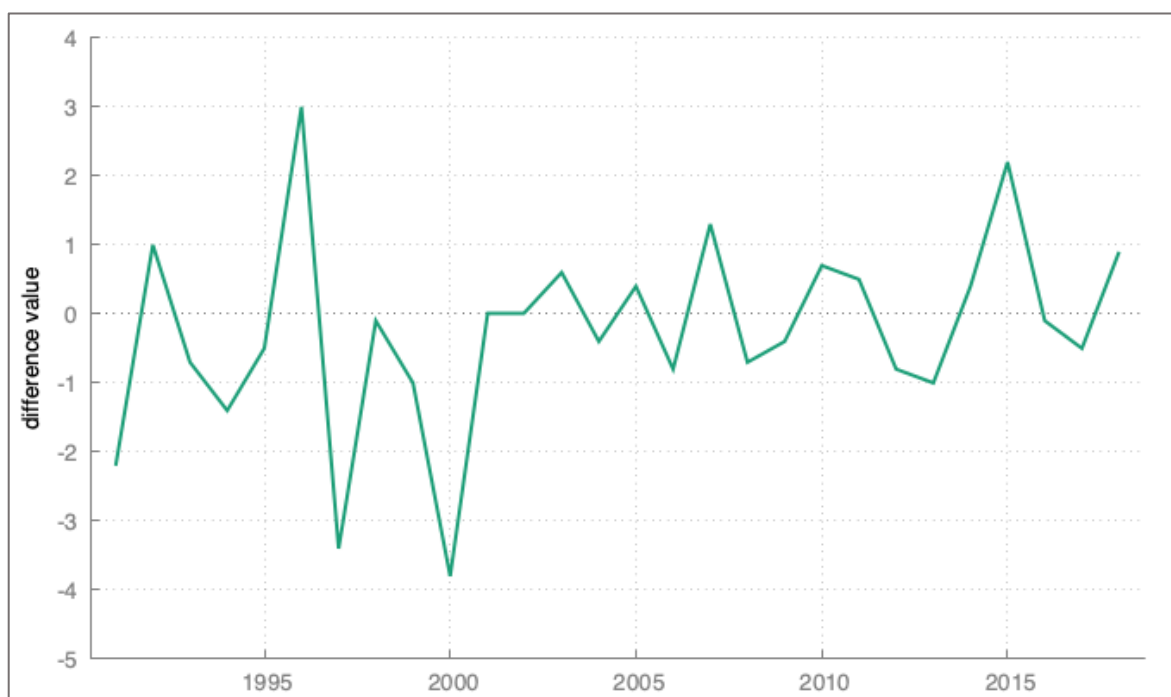
Graph 20: Consumption of pork meat (kg/pers/yr)



Source: CZSO, own processing

From the Graph 20 above it can be appropriately deduced that the highest value of consumption was reached at the beginning of the reviewed time period, in particular 50 kilograms per person per year, while the lowest consumption of pork was captured in 2013 with the value of 40.3 kilograms. On average, people in the Czech Republic consumed 43.51 kilograms of pork meat. The average year-over-year decrease represented 0.27 kilograms per person per year.

Graph 21: Changes in pork consumption (kg/pers/yr)



Source: CZSO, own processing

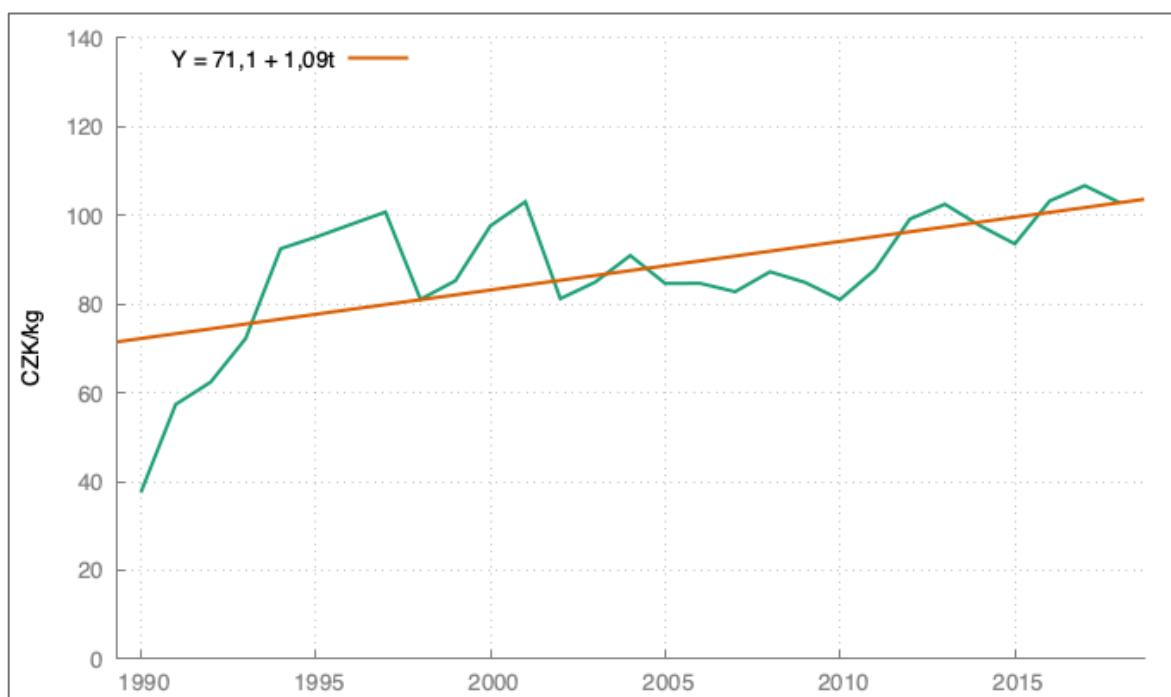
From the Graph 21 can be determined that the largest changes in pork consumption occurred until the year 2001. Since then, no distinctive changes were recorded. The highest captured change in the downward direction was between 1999 and 2000, its value represented a decline by 3.8 kilograms per person per year. The next biggest change in consumption of pork but in the opposite direction arose between years 1995 and 1996, when the difference value between those years reached 3 kg/person/year.

Consumer price of pork meat

The depicted consumer price consists of the average value of two types of goods - pork roast with bone and pork belly.

Graph 22 shows that prices have increased over the whole period. The most significant increase in prices was recorded until 1995, which corresponds to a decline in consumption of pork meat. The average year-over-year increase in consumer price amounted 1.1 CZK per kilogram.

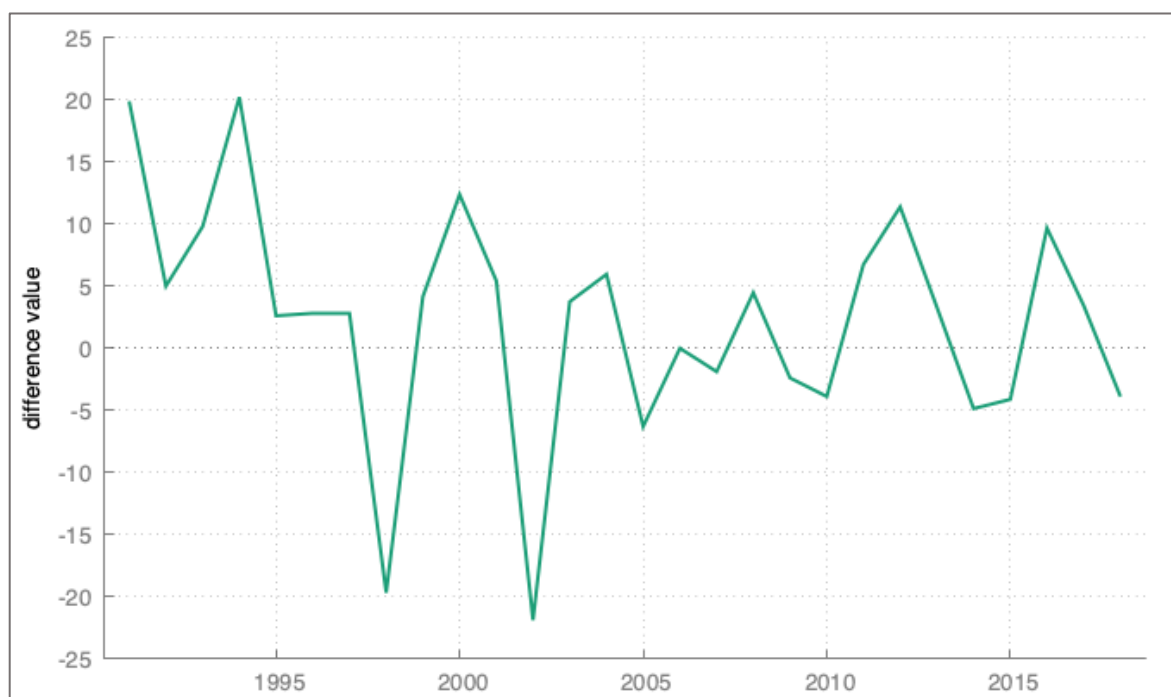
Graph 22: Consumer price of pork meat (CZK/kg)



Source: CZSO, own processing

The consumer price started on the level of 37.5 Czech crowns per kilogram of pork meat and at the same time it represents the lowest value in the introduced time period. From 1990 up to 2018, the average consumer price of pork had the value of 87.54 CZK per kilogram. The highest price can be observed at the end of the reference period, specifically in 2017. By then, the price reached 106.7 Czech crowns per kilogram of pork meat.

Graph 23: Changes in consumer price of pork meat (CZK/kg)



Source: CZSO, own processing

Graph 23 illustrates the changes in consumer price of pork. The most significant difference value was captured between 1993 and 1994 with 20.22 CZK per kilogram and represented a high increment. The second highest increment occurred at the beginning of the period - between the years 1990 and 1991 with the value of 19.9 Czech crowns per kilogram of pork. On the contrary, the highest decrease could be observed between 2001 and 2002 (21.87 CZK per kg), followed by that from period 1997-1998 when the change in consumer price between those two years amounted -19.66 CZK per kilogram.

4.2.4 Value adjustments

All variables were converted to the first differences, assuming that all variables are stationary in the first differences.

After making the first differences adjustment, a trend was found for the endogenous variable, in this particular case a weakening trend in declines as the consumption decreases in the selected time period. Based on this finding, a time variable was added (x_{1t}). Additionally, an endogenous variable delayed by two periods was added ($y_{(t-2)}$) as the graph

showed a certain cyclicality in changes in beef consumption alternating after about two years. Furthermore, insignificant variables were gradually eliminated by sequential elimination.

4.2.5 Estimated form of the model using the OLSM

$$\begin{aligned}
 y_t = & -1.30228 + 0.0416914x_{2t} + 0.0667176x_{3t} - 0.0431481x_{4t} \\
 & + 0.00952864x_{5t} + 0.146137x_{6t} - 0.156208x_{7t} - 0.0198387x_{8t} \\
 & + 0.0715477x_{9t} - 0.0151397x_{10t} + 0.00988648x_{11t} \\
 & - 0.695527y_{(t-2)} + u_t
 \end{aligned}$$

Figure 3: OLSM outputs for beef consumption in the Czech Republic in the years 1994-2018

Model 1: OLS, za použití pozorování 1994–2018 (T = 25)				
Závisle proměnná: d_Cons_beef				
	koeficient	směr. chyba	t-podíl	p-hodnota
const	-1,30228	0,314710	-4,138	0,0012 ***
time	0,00988648	0,0127148	0,7776	0,4507
d_Income	0,0667176	0,0200698	3,324	0,0055 ***
d_Meat_prod	0,0431481	0,00689575	6,257	2,94e-05 ***
d_Import_b	0,146137	0,0270669	5,399	0,0001 ***
d_Export_b	0,00952864	0,0231982	0,4107	0,6879
d_Cons_price_b	0,0416914	0,0180770	2,306	0,0382 **
d_Cons_pouhl	-0,156208	0,0730964	-2,137	0,0522 *
d_Cons_price_pl	-0,0198387	0,00963291	-2,059	0,0601 *
d_Cons_pork	0,0715477	0,0495942	1,443	0,1728
d_Cons_price_pk	-0,0151397	0,0122509	-1,236	0,2384
d_Cons_beef_2	-0,695527	0,0843204	-8,249	1,60e-06 ***
Střední hodnota závisle proměnné		-0,442400		
Sm. odchylka závisle proměnné		0,857629		
Součet čtverců reziduí		0,909425		
Sm. chyba regrese		0,264492		
Koeficient determinace		0,948482		
Adjustovaný koeficient determinace		0,904890		
F(11, 13)		21,75821		
P-hodnota(F)		1,41e-06		
Logaritmus věrohodnosti		5,949272		
Akaikovo kritérium		12,10146		
Schwarzovo kritérium		26,72797		
Hannan-Quinnovo kritérium		16,15823		
rho (koeficient autokorelace)		-0,190927		
Durbin-Watsonova statistika		2,374695		

Source: SW Gretl

Econometric verification

Figure 4: Model 1 - Autocorrelation test

```
LM test pro autokorelaci až do řádu 1 -  
Nulová hypotéza: žádná autokorelace  
Testovací statistika: LMF = 0,685678  
s p-hodnotou = P(F(1, 12) > 0,685678) = 0,423801
```

Source: SW Gretl

The resulting p-value of the Breusch-Godfrey autocorrelation test was 0.423801 and is higher than the significance level $\alpha = 0.01$, therefore the null hypothesis cannot be rejected. The stochastic variable is free from autocorrelation.

Figure 5: Model 1 - Heteroscedasticity test

```
Whiteův test heteroskedasticity -  
Nulová hypotéza: není zde heteroskedasticita  
Testovací statistika: LM = 20,4685  
s p-hodnotou = P(Chí-kvadrát(22) > 20,4685) = 0,55376
```

Source: SW Gretl

The resulting p-value of White's heteroscedasticity test was 0.55376 and is higher than the significance level $\alpha = 0.01$, again the null hypothesis cannot be rejected. The presence of homoscedasticity, which is desirable, is confirmed.

Figure 6: Model 1 - Residual normality test

```
Test normality reziduí -  
Nulová hypotéza: chyby jsou normálně rozdělené  
Testovací statistika: Chí-kvadrát(2) = 0,37782  
s p-hodnotou = 0,827877
```

Source: SW Gretl

The p-value of the residual normality test was 0.827877 and is higher than the significance level $\alpha = 0.01$, the null hypothesis cannot be rejected. The residuals are normally distributed.

Statistical verification

A problem arose in the model - there were parameters which were not statistically significant, it means that the influence of the exogenous variable on the explained variable is zero. Therefore, the sequential elimination (a gradual removing least significant variables until only those with a p-value lower than 0.01 remain) was performed with the selected significance level of $\alpha = 0.01$.

Figure 7: Sequential elimination of variables

```
Sekvenční eliminace s použitím oboustranného alfa = 0,01

Odstranit d_Export_b      (p-hodnota 0,688)
Odstranit time            (p-hodnota 0,425)
Odstranit d_Cons_price_pk (p-hodnota 0,188)
Odstranit d_Cons_pork     (p-hodnota 0,104)
Odstranit d_Cons_price_b  (p-hodnota 0,070)
Odstranit d_Cons_price_pl (p-hodnota 0,014)
Odstranit d_Cons_poul     (p-hodnota 0,116)

Test Modelu 1

Nulová hypotéza: regresní koeficienty jsou nulové u proměnných
time, d_Export_b, d_Cons_price_b, d_Cons_poul, d_Cons_price_pl,
d_Cons_pork, d_Cons_price_pk
Testovací statistika: F(7, 13) = 3,3301, p-hodnota 0,0292512
Omitting variables improved 0 of 3 information criteria.
```

Source: SW Gretl

After the sequential elimination a new estimation of model was performed. Changed values of coefficients were captured in the following equation and again verifications were executed.

$$y_t = -1.21541 + 0.0849065x_{3t} + 0.0448903x_{4t} + 0.178065x_{6t} - 0.651331y_{(t-2)} + u_t$$

Figure 8: New OLSM outputs for beef consumption

Model 2: OLS, za použití pozorování 1994–2018 (T = 25)					
Závisle proměnná: d_Cons_beef					
	koeficient	směr. chyba	t-podíl	p-hodnota	
const	-1,21541	0,172001	-7,066	7,50e-07	***
d_Income	0,0849065	0,0205336	4,135	0,0005	***
d_Meat_prod	0,0448903	0,00482278	9,308	1,04e-08	***
d_Import_b	0,178065	0,0263856	6,749	1,45e-06	***
d_Cons_beef_2	-0,651331	0,0951873	-6,843	1,19e-06	***
Střední hodnota závisle proměnné		-0,442400			
Sm. odchylka závisle proměnné		0,857629			
Součet čtverců reziduí		2,540145			
Sm. chyba regrese		0,356381			
Koeficient determinace		0,856104			
Adjustovaný koeficient determinace		0,827325			
F(4, 20)		29,74734			
P-hodnota(F)		3,64e-08			
Logaritmus věrohodnosti		-6,890278			
Akaikovo kritérium		23,78056			
Schwarzovo kritérium		29,87494			
Hannan-Quinnovo kritérium		25,47088			
rho (koeficient autokorelace)		0,293633			
Durbin-Watsonova statistika		1,322206			

Source: SW Gretl

Econometric verification

Figure 9: Model 2 - Autocorrelation test

```
LM test pro autokorelaci až do řádu 1 -
Nulová hypotéza: žádná autokorelace
Testovací statistika: LMF = 1,90931
s p-hodnotou = P(F(1, 19) > 1,90931) = 0,183072
```

Source: SW Gretl

The resulting p-value of the Breusch-Godfrey autocorrelation test was 0.183072 and is higher than the significance level $\alpha = 0.01$, therefore the null hypothesis cannot be rejected. The stochastic variable is free from autocorrelation.

Figure 10: Model 2 - Heteroscedasticity test

```
Whiteův test heteroskedasticity -
Nulová hypotéza: není zde heteroskedasticita
Testovací statistika: LM = 20,047
s p-hodnotou = P(Chí-kvadrát(14) > 20,047) = 0,128667
```

Source: SW Gretl

The resulting p-value of White's heteroscedasticity test was 0.128667 and is higher than the significance level $\alpha = 0.01$, again the null hypothesis cannot be rejected. The presence of homoscedasticity, which is desirable, is confirmed.

Figure 11: Model 2 - Residual normality test

```
Test normality reziduí -  
Nulová hypotéza: chyby jsou normálně rozdělené  
Testovací statistika: Chí-kvadrát(2) = 0,156712  
s p-hodnotou = 0,924635
```

Source: SW Gretl

The p-value of the residual normality test was 0.924635 and is higher than the significance level $\alpha = 0.01$, the null hypothesis cannot be rejected. The residuals are normally distributed.

Figure 12: Model 2 - Ramsey RESET test

```
Test RESET pro specifikaci (druhé a třetí mocniny)  
Testovací statistika: F = 0,036706,  
s p-hodnotou = P(F(2,18) > 0,0367063) = 0,964  
  
Test RESET pro specifikaci (pouze druhé mocniny)  
Testovací statistika: F = 0,075930,  
s p-hodnotou = P(F(1,19) > 0,0759296) = 0,786  
  
Test RESET pro specifikaci (pouze třetí mocniny)  
Testovací statistika: F = 0,071948,  
s p-hodnotou = P(F(1,19) > 0,0719478) = 0,791
```

Source: SW Gretl

The p-values of Ramsey RESET test were 0.964 (squares and cubes), 0.786 (only squares), 0.791 (only cubes) and all together are higher than the significance level $\alpha = 0.01$, the null hypothesis cannot be rejected. The original form of the model is correctly specified.

Statistical verification

The coefficient of determination for the model is 0.856104, therefore it can be stated that from 85.61% the changes in beef consumption are explained by changes in exogenous variables in the model.

The model as a whole can be described as statistically significant, as its p-value is $3.64 \cdot 10^{-8}$ and is therefore lower than the significance level $\alpha = 0.01$.

For the selected explanatory variables, statistical significance was found for income, meat production, import and lagged endogenous variable by two periods. All the listed variables are statistically significant at the significance level $\alpha = 0.01$.

Economic verification

Based on the result of the test on the statistical significance of individual explanatory variables, it can be stated:

- if an increment of income is increased by 1 unit (thousand CZK), then the increment of beef meat consumption increases by 0,0849065 kilograms per person per year ceteris paribus,
- if the increment of meat production decreases by 1 unit (thousand tonnes of live weight), then the increment of beef consumption decreases by 0,0448903 kilograms per person per year ceteris paribus,
- if the increment of import is increased by 1 unit (thousand tonnes), then the increment of beef meat consumption increases by 0,178065 kilograms per person per year ceteris paribus,
- if the increment of beef consumption lagged by two periods increases by one unit (1 kilogram per person per year), then the increment of beef consumption decreases by 0.651331 kg per person per year ceteris paribus.

Subsequently, on the basis of the above presented and interpreted results it can be concluded that:

- the relationship between income and beef meat consumption is in accordance with the theoretical assumption,
- the relationship between meat production and consumption of beef is in accordance with the theoretical assumption,
- the relationship between import and beef meat consumption is in accordance with the theoretical assumption,
- based on the graphical analysis, a possible change in consumer preferences after two years was detected, the assumption was a negative sign of the parameter and this was confirmed, the hypothesis of a change in consumer preferences after two years was confirmed.

4.2.6 Model application

The coefficients of elasticity were calculated for purpose of the model application and results are displayed in the following table. The elasticity values are calculated for differentiated exogenous variables.

Table 5: Elasticity coefficients of beef meat consumption

d_Income	d_Meat_prod	d_Import_b	d_Cons_beef_2
-0,0415274	-0,058785	-0,2014056	0,048439954
0,04152738	0,058785004	0,20140559	0,048439954

Source: own processing

The first row of Table 5 shows the values of elasticity, the second row contains the coefficients of elasticity in absolute value. The larger the number in absolute value, the greater the effect on the explained variable. It can be deduced from the table that the explanatory variable which has the greatest influence on the explained variable is

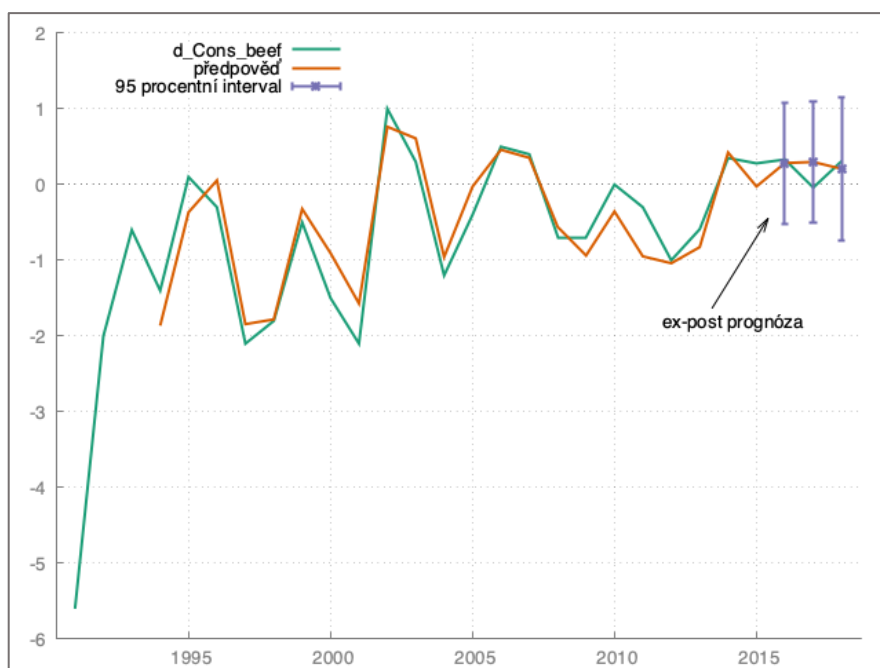
the import. This is followed by meat production, endogenous variable delayed by two periods and, finally, income.

Ex-post analysis

The ex-post analysis pronounces how accurately the model mimicked the real development of beef consumption.

In Graph 24 the ex-post prognosis is performed with difference values of beef meat consumption for the last three years of the examined period. It is obvious the values used in the calculation of the forecast start from the year 1994. The forecasted changes in consumption quite accurately copies the original values of the differences.

Graph 24: Ex-post prognosis of beef consumption in differences



Source: SW Gretl

Figure 13 describes the analysis of differences in values. The prediction is shown below as well as 95% confidence intervals. For 2016 and 2018, forecasted changes in beef consumption are lower, for 2017 slightly higher than the original difference.

Figure 13: Ex-post value characteristics of differences

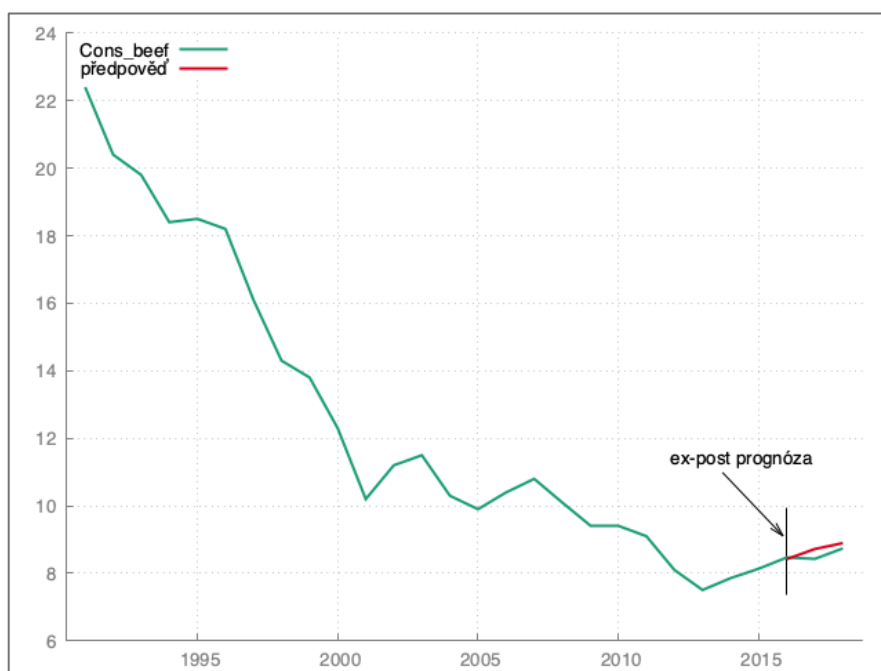
Pro 95% konfidenční intervaly, $t(17, 0,025) = 2,110$					
	d_Cons_beef	předpověď	směr. chyba	95% konfidenční interval	
2016	0,33	0,28	0,377	-0,51 -	1,08
2017	-0,04	0,30	0,377	-0,50 -	1,09
2018	0,31	0,21	0,450	-0,74 -	1,16
Statistiky vyhodnocující předpověď using 3 observations					
	Střední chyba		-0,062923		
	Odmocnina střední kvadratické chyby		0,20621		
	Střední absolutní chyba		0,16284		
	Střední procentuální chyba		298,01		
	Střední absolutní procentuální chyba		298,01		
	Theilovo U		0,31607		
	Zastoupení vychýlení, UM		0,093113		
	Zastoupení regrese, UR		0,46067		
	Zastoupení disturbancí, UD		0,44622		

Source: SW Gretl

The value of mean absolute percentage error is very high because the original and predicted differences are very small (approaching zero) and when calculating this error, the resulting numbers based, among other things, on the proportion of these values are very high. However, the value of this error for differences is not as authoritative as in the case of levels, so it is necessary to look primarily at the value of the mean absolute percentage error in Figure 14.

Graph 25 represents the ex-post prognosis of beef meat consumption for the years 2016, 2017 and 2018. As previously mentioned, it can be seen that the predicted values fairly accurately imitate the real values of the beef consumption.

Graph 25: Ex-post prognosis of beef consumption



Source: SW Gretl

In following Figure 14 the values of predictions are displayed. It can be seen from the figure (and also graph) that the forecasted numbers are very close to the original ones in a real time. The mean absolute percentage error also shows a fairly good result (under 2%).

Figure 14: Ex-post value characteristics

	Cons_beef	předpověď
2016	8,47	8,42
2017	8,43	8,72
2018	8,74	8,90

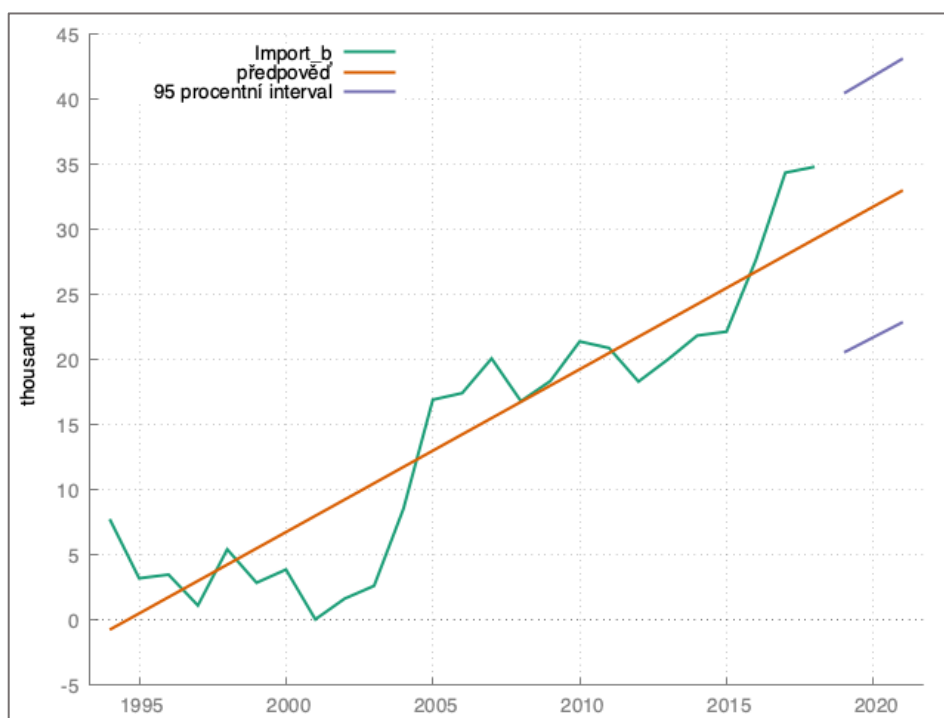
Statistiky vyhodnocující předpověď using 3 observations	
Střední chyba	-0,13498
Odmocnina střední kvadratické chyby	0,19394
Střední absolutní chyba	0,16576
Střední procentuální chyba	-1,5798
Střední absolutní procentuální chyba	1,9432
Theilovo U	1,0607
Zastoupení vychýlení, UM	0,48441
Zastoupení regrese, UR	0,26113
Zastoupení disturbancí, UD	0,25446

Source: SW Gretl

Ex-ante analysis

At first, values for statistically significant explanatory variables were predicted using trend functions. In the first case, the prediction was calculated for the beef import variable. From the trend functions, the linear function was chosen. A model for estimating the trend function parameter for the import is introduced in Appendix 2. Graph 26 shows that in 2019, according to the forecast, beef import should decrease compared to 2018 and then gradually increase again in 2020 and 2021.

Graph 26: Prognosis of beef import



Source: SW Gretl

In Figure 15 the forecasted beef import values are displayed as well as the 95% confidence intervals. The value of beef imports in 2021 is estimated at 33 thousand tonnes of meat.

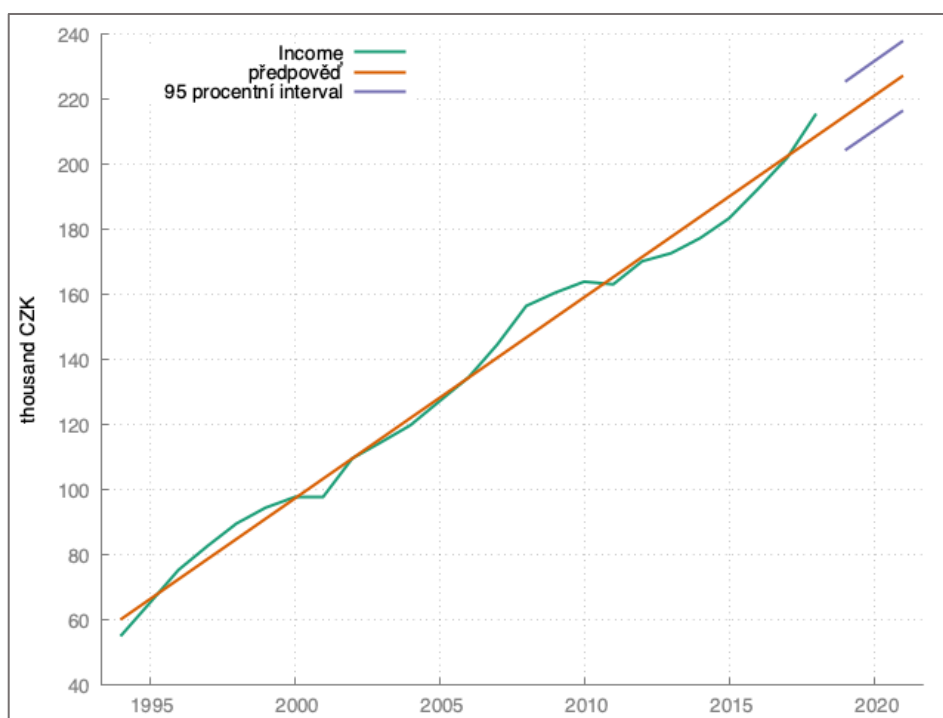
Figure 15: Predicted values of beef import

Pro 95% konfidenční intervaly, $t(24, 0,025) = 2,064$			
Import_b	předpověď	směr. chyba	95% konfidenční interval
2019	30,5291	4,82280	20,5753 - 40,4829
2020	31,7791	4,86233	21,7437 - 41,8145
2021	33,0291	4,90433	22,9070 - 43,1511

Source: SW Gretl

Another statistically significant variable was the income. Here again, a linear function was used, which captures the development of income relatively accurately as can be seen from Graph 27. A model of parameter estimation for the income trend function is provided in Appendix 3.

Graph 27: Prognosis of income



Source: SW Gretl

The expected value of income for 2019 is 214.964 thousand Czech crowns (Figure 16) and is slightly lower than in 2018 (215.669 thousand CZK). In the coming years, the income is forecasted to grow steeper.

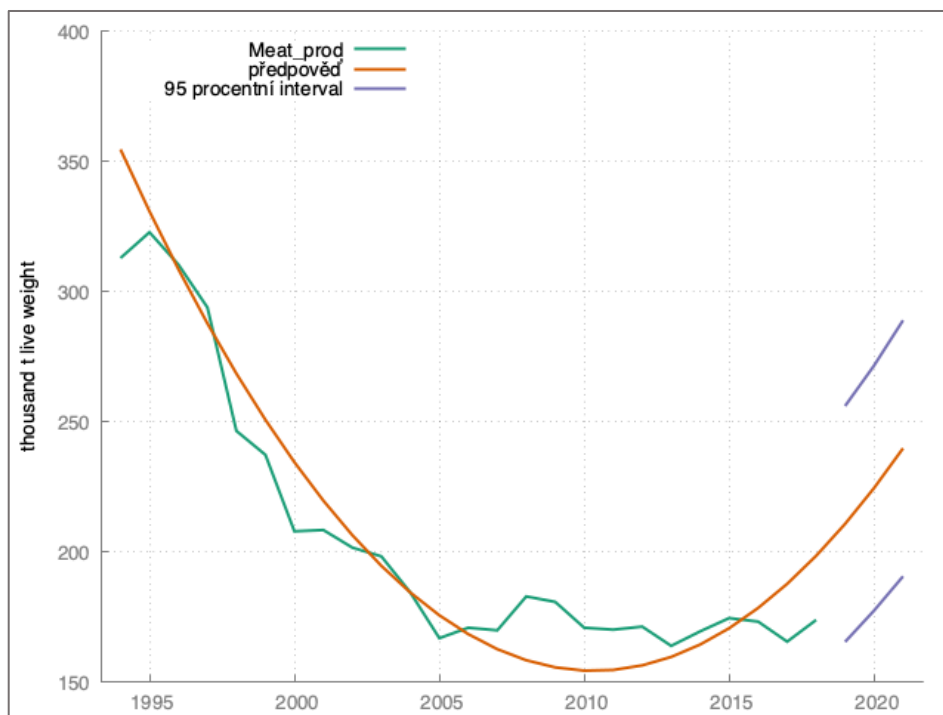
Figure 16: Predicted values of income

Pro 95% konfidenční intervaly, $t(24, 0,025) = 2,064$				
Income	předpověď	směr. chyba	95% konfidenční interval	
2019	214,964	5,10313	204,432	– 225,497
2020	221,154	5,14495	210,535	– 231,773
2021	227,344	5,18940	216,633	– 238,054

Source: SW Gretl

In the case of the variable meat production, the quadratic function was chosen as the trend function. An estimation of trend function parameters for meat production is available in Appendix 4. It is obvious from Graph 28 that in the years 2019-2021 a rather steep increase in production is estimated.

Graph 28: Prognosis of meat production



Source: SW Gretl

While in 2018 the production of meat reached 173.982 thousand tonnes of live weight, in 2019 the value of production is according to Figure 17 predicted to be 210.867 thousand tonnes of live weight. In the following years it should also increase significantly.

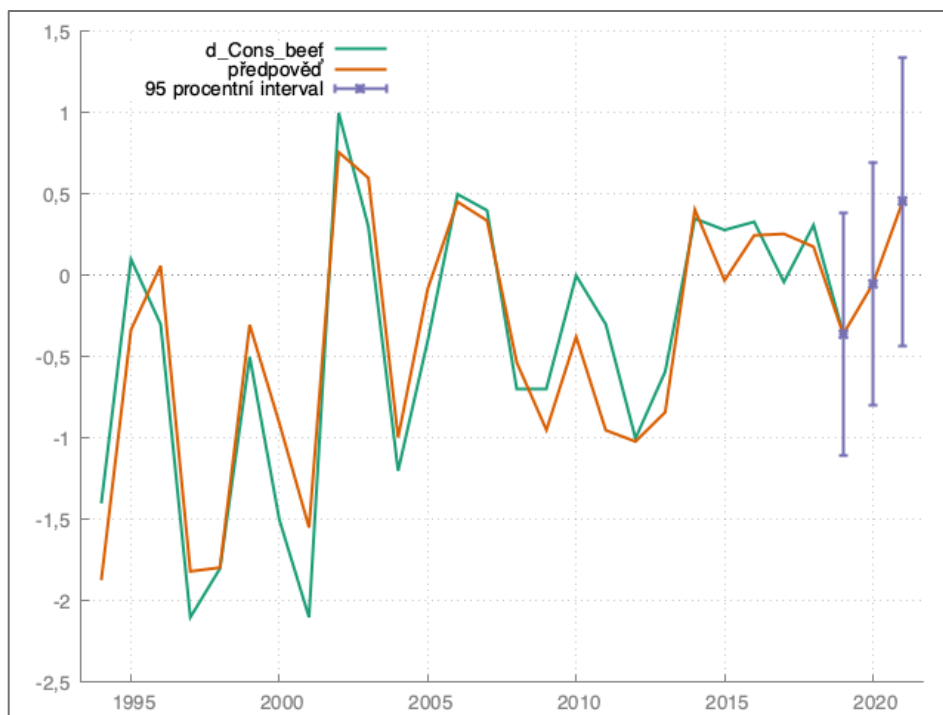
Figure 17: Predicted values of meat production

Pro 95% konfidenční intervaly, $t(26, 0,025) = 2,056$				
Meat_prod	předpověď	směr. chyba	95% konfidenční interval	
2019	210,867	22,0315	165,581	256,153
2020	224,638	22,8958	177,575	271,701
2021	239,911	23,9212	190,740	289,081

Source: SW Gretl

The following Graph 29 shows the predicted changes in beef consumption. In the forecast period 2019-2021, the changes should first reach negative values and finally, between 2020 and 2021, the increment of the consumption should be positive.

Graph 29: Ex-ante prognosis of beef consumption in differences



Source: SW Gretl

Figure 18 records the values of changes in beef consumption in the Czech Republic. If the value of consumption in 2018 is compared with the predicted value from 2019, then

a negative increment is evident, specifically -0.36 kg of meat per person per year. However, between 2020 and 2021, the predicted change is positive, namely 0.45 kilograms.

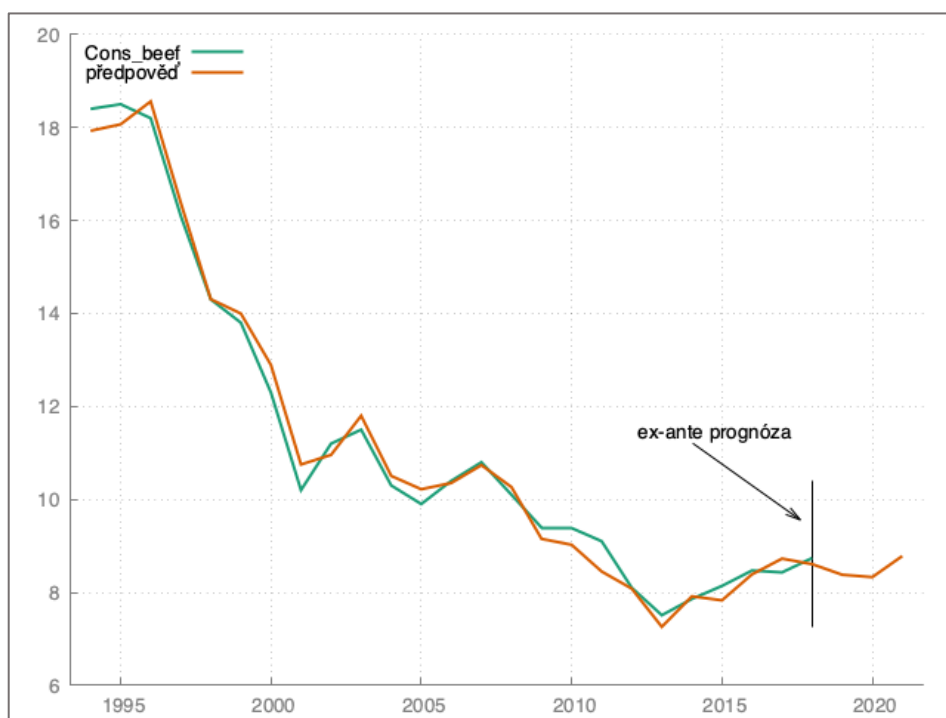
Figure 18: Ex-ante value characteristics of differences

Pro 95% konfidenční intervaly, $t(20, 0,025) = 2,086$				
d_Cons_beef	předpověď	směr. chyba	95% konfidenční interval	
2019	-0,36	0,356	-1,10	0,38
2020	-0,05	0,356	-0,79	0,69
2021	0,45	0,425	-0,43	1,34

Source: SW Gretl

The shape of the ex-ante prognosis for beef meat consumption can be read from Graph 30. As denoted with differences above, the beef consumption in the Czech Republic should first decrease slightly and then increase from 2020 onwards.

Graph 30: Ex-ante prognosis of beef consumption



Source: SW Gretl

In Figure 19 and Table 6 the final predicted values and 95% confidence intervals for beef meat consumption can be found. As previously mentioned, the value at the beginning of the predicted period, i.e. the year 2019 is slightly lower than it was in 2018, then slightly decreases in 2020 and then in 2021 the predicted value gets above the value from 2018, which was 8.74 kilograms of meat per person per year.

Figure 19: Ex-ante value characteristics

	Cons_beef	předpověď
2019		8,37961
2020		8,32863
2021		8,78146

Source: SW Gretl

Table 6: Ex-ante confidence intervals for beef consumption

year	95% confidence intervals	
	lower limit	upper limit
2019	7.27961	8.75961
2020	7.53863	9.01863
2021	8.35146	10.12146

Source: own processing

5 Results and Discussion

Based on the resulting model, statistically significant variables were determined. Furthermore, using the calculation of elasticities, it was found that the variable with the greatest impact on beef consumption is the import. Conversely, the variable that has the least effect on the dependent variable from this selection is income.

It is necessary to mention that in 2018 the Czech Republic was at a very high level in terms of self-sufficiency in beef - over 120%, here the question arises why the import of beef is such an important factor. As already mentioned in the analysis of individual variables, the tendency of consumers to buy meat at the lowest possible price still prevails in the Czech Republic. If a Czech breeder is offered a better price, the animals usually travel abroad. According to Pánková (2019), the demand from Czech processors is still low and consumers in the Czech Republic still prefer lower meat prices. This situation is a possible explanation for another variable for which statistical significance has not been proved in the model at all and is in most cases expected to play a significant role - the price of beef meat.

However, the truth is that in recent years the popularity of farmers' markets and farm shops has been growing among consumers, with quality playing the most important role. So there are more and more people who are willing to pay for a quality piece of beef as well as for other foodstuffs a higher price and quality is not indifferent to them. This trend is evidenced by the growing number of registered farm markets, of which there were over 200 in the Czech Republic in 2015. (Spilková, 2016)

In this econometric model, the value of the coefficient of determination is 0.856104, which means that 85.61% of the changes in beef consumption are explained by changes in the explanatory variables. The model can be declared statistically significant because its p-value is $3.64 \cdot 10^{-8}$ and is therefore lower than the significance level $\alpha = 0.01$. All of the explanatory variables referenced in the first paragraph are statistically significant at the significance level $\alpha = 0.01$.

According to the ex-ante analysis for the period 2019-2021, a slight decrease in beef consumption is expected at first, and in the last mentioned year, consumption should start to increase. Although consumption appears realistic in the forecast, it should be noted that trend functions of significant variables have been used for this prognosis which may lead to a certain distortion, as particular fluctuations may not always be accurately captured. This situation suggests that other more complex methods could be possibly applied in order to record fluctuations in time series of these variables more accurately.

6 Conclusion

The aim of this thesis was to determine the variables that affect the selected dependent variable - beef meat consumption in the Czech Republic. Based on the resulting model and the subsequent calculation of elasticities, it was found that the variable that has the greatest influence on the endogenous variable is the import of beef meat. This is followed by variables meat production, beef meat consumption lagged by two periods and finally income.

All of the enumerated explanatory variables were proved to be statistically significant. Based on this finding, predetermined hypotheses for these exogenous variables were confirmed. This means that it has been confirmed that an increase in meat production, income and import will lead to an increase in beef meat consumption. For the other explanatory variables, the defined hypotheses must have been rejected, as their parameters were not proven to be statistically significant, including for example the consumer price of beef, which was expected to play a significant role in beef consumption.

From a statistical point of view, the changes in beef consumption are from 85.61% explained by the changes in explanatory variables.

According to the ex-post analysis, the estimated values for the years 2016, 2017 and 2018 were very close to the real ones and the mean absolute percentage error was 1.94%, so it can be stated that the estimated model quite accurately imitates the real development of beef consumption.

To perform the ex-ante forecast, trend functions of statistically significant explanatory variables were used and a forecast was presented for the following three years. Based on this forecast, the beef consumption in the Czech Republic should first decrease slightly and then start to increase from 2020 onwards.

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8 Appendices

Appendix 1: Background data for defined variables

Date	Cons beef	Price beef	Meat prod	Cons pork	Cons poultry	Price poultry	Price pork	Income	Import	Export
1989	30,00									
1990	28,00	41,72	515,000	50,00	13,60	31,00	37,50			
1991	22,40	47,83	436,000	47,80	12,80	39,46	57,40			
1992	20,40	58,49	403,000	48,80	12,50	47,74	62,42			
1993	19,80	65,59	390,000	48,10	11,70	50,75	72,24	47,937	2,781977	3,216665
1994	18,40	90,20	313,000	46,70	11,60	56,27	92,46	55,108	7,772193	1,129783
1995	18,50	95,23	322,880	46,20	13,00	48,85	95,09	65,215	3,223616	1,971438
1996	18,20	95,81	310,426	49,20	13,60	59,37	97,92	75,475	3,511474	1,755430
1997	16,10	101,19	294,000	45,80	15,30	65,27	100,74	82,804	1,139658	2,393693
1998	14,30	104,71	246,585	45,70	17,90	52,90	81,08	89,712	5,449166	1,395034
1999	13,80	103,66	237,378	44,70	20,50	46,49	85,25	94,588	2,887566	2,248984
2000	12,30	114,21	208,040	40,90	22,30	61,65	97,64	97,807	3,896328	1,476292
2001	10,20	106,79	208,524	40,90	22,90	60,55	103,07	97,807	0,074677	7,392062
2002	11,20	107,20	201,744	40,90	23,90	46,23	81,20	109,776	1,670490	1,302325
2003	11,50	107,03	198,417	41,50	23,80	53,60	84,97	114,760	2,644923	1,477633
2004	10,30	114,08	184,531	41,10	25,30	51,80	90,94	119,923	8,578366	1,212337
2005	9,90	119,07	167,000	41,50	26,10	51,60	84,65	127,294	16,947378	1,579469
2006	10,40	122,79	171,000	40,70	25,90	44,30	84,66	134,569	17,452364	3,508630
2007	10,80	124,28	170,000	42,00	24,90	61,47	82,79	144,743	20,110864	4,294395
2008	10,10	129,32	183,000	41,30	25,00	58,99	87,27	156,598	16,832247	5,230922
2009	9,40	132,14	180,912	40,90	24,80	56,18	84,89	160,675	18,376080	5,110465
2010	9,40	130,47	171,000	41,60	24,50	58,63	81,02	164,047	21,416222	4,773810
2011	9,10	138,38	170,253	42,10	24,50	58,49	87,78	163,235	20,917086	7,278971
2012	8,10	154,67	171,426	41,30	25,19	65,52	99,18	170,332	18,337221	7,880998
2013	7,51	157,29	164,043	40,30	24,32	69,63	102,51	172,802	20,033941	7,682454
2014	7,86	156,34	169,588	40,70	24,89	70,55	97,67	177,430	21,873311	7,787612
2015	8,14	155,62	174,694	42,90	26,03	66,30	93,57	183,536	22,173290	8,530637
2016	8,47	161,77	173,342	42,80	26,78	64,87	103,25	192,575	27,696421	10,442811
2017	8,43	168,16	165,650	42,30	27,27	67,64	106,70	202,102	34,379632	9,969367
2018	8,74	173,13	173,982	43,20	28,40	67,74	102,82	215,669	34,836257	11,725363

Source: CZSO

Appendix 2: Parameters estimation of beef import trend function

import: OLS, za použití pozorování 1993–2018 (T = 26)					
Závisle proměnná: Import_b					
	koeficient	směr. chyba	t-podíl	p-hodnota	
const	-8,22037	2,22639	-3,692	0,0011	***
time	1,24998	0,116936	10,69	1,32e-10	***
Střední hodnota závisle proměnné			13,65434		
Sm. odchylka závisle proměnné			10,51675		
Součet čtverců reziduí			479,9555		
Sm. chyba regrese			4,471929		
Koeficient determinace			0,826421		
Adjustovaný koeficient determinace			0,819188		
F(1, 24)			114,2654		
P-hodnota(F)			1,32e-10		
Logaritmus věrohodnosti			-74,79516		
Akaikovo kritérium			153,5903		
Schwarzovo kritérium			156,1065		
Hannan-Quinnovo kritérium			154,3149		
rho (koeficient autokorelace)			0,699645		
Durbin-Watsonova statistika			0,579344		

Source: SW Gretl

Appendix 3: Parameters estimation of income trend function

income: OLS, za použití pozorování 1993–2018 (T = 26)					
Závisle proměnná: Income					
	koeficient	směr. chyba	t-podíl	p-hodnota	
const	23,0863	2,35580	9,800	7,29e-10	***
time	6,18961	0,123733	50,02	8,74e-26	***
Střední hodnota závisle proměnné			131,4046		
Sm. odchylka závisle proměnné			47,56793		
Součet čtverců reziduí			537,3723		
Sm. chyba regrese			4,731861		
Koeficient determinace			0,990500		
Adjustovaný koeficient determinace			0,990105		
F(1, 24)			2502,414		
P-hodnota(F)			8,74e-26		
Logaritmus věrohodnosti			-76,26413		
Akaikovo kritérium			156,5283		
Schwarzovo kritérium			159,0445		
Hannan-Quinnovo kritérium			157,2528		
rho (koeficient autokorelace)			0,681664		
Durbin-Watsonova statistika			0,599623		

Source: SW Gretl

Appendix 4: Parameters estimation of meat production trend function

meat_prod:					
OLS, za použití pozorování 1990–2018 (T = 29)					
Závisle proměnná: Meat_prod					
	koeficient	směr. chyba	t-podíl	p-hodnota	
const	528,865	12,9088	40,97	3,78e-25	***
time	-33,5361	1,84627	-18,16	2,71e-16	***
sq_time	0,750905	0,0561853	13,36	3,71e-13	***
Střední hodnota závisle proměnné			237,0833		
Sm. odchylka závisle proměnné			95,73947		
Součet čtverců reziduí			9297,137		
Sm. chyba regrese			18,90984		
Koeficient determinace			0,963775		
Adjustovaný koeficient determinace			0,960988		
F(2, 26)			345,8676		
P-hodnota(F)			1,85e-19		
Logaritmus věrohodnosti			-124,8166		
Akaikovo kritérium			255,6332		
Schwarzovo kritérium			259,7351		
Hannan-Quinnovo kritérium			256,9179		
rho (koeficient autokorelace)			0,369485		
Durbin-Watsonova statistika			0,972927		

Source: SW Gretl