How to be sustainable in beef consumption – Exploring the factors. Case study

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Abstract: The aim of the paper is to explain beef consumption through the economic indicators and the prediction tendencies of beef consumption. There are countries like Slovakia that confirm the opposite trend despite the global trend of consumption growth. In terms of the ecosystems' sustainability, beef production should be adjusted accordingly, as in the case of Slovakia. We focus on the economic aspect of beef consumption from the perspective of sustainability. Commodity prices are considered to be a significant factor influencing consumption and the behaviour of beef consumers. Despite increasing income in Slovakia, consumption of beef covers only 30% of recommended doses in the year 2018. To achieve the objective of the research, we decided to use the calculation of price and income elasticity of food demand using the Almost Ideal Demand System (AIDS) model to analyse meat consumption trends. The findings confirm that beef consumption will decline in Slovakia in the following years, and it will be progressively replaced by pork and poultry meat.

Keywords: beef meat; behaviour; elasticities; predictions; sustainability

Consumption of food, particularly meat and meat products, is one of the main drivers of environmental impacts, as argued by Notarnicola et al. (2017). Although meat is vital to meet the basic human needs for nutrition, it poses a critical threat to the environment.

For a better understanding of the sustainable consumption of meat, it is appropriate to define what actually unsustainable consumption is. This is due to excessive meat consumption, as it has, on average, the greatest combined negative impact on the environment and human health (Rust et al. 2020) if a person eats more than the recommended daily intake. Cechura and Hocman (2010) noted that the agricultural sector in Europe had experienced several economic and institutional challenges over the last two decades. Current agricultural production faces various challenges. Successful solutions require increased production capacity, taking into account sustainability factors, explains Svetlanská et al. (2017). The food market, especially meat, is characterised by constant changes, which has been mainly caused by consumer behaviour. Increasing interest in purchasing sustainable products could take into account the current trend in the food market, predict Predanocyová et al. (2018).

In our research, the question arises whether economic factors are still the only factors determining world

consumption, especially in Slovakia. In this context, it is essential to note the study of Bansback (1995), which showed that non-economic factors have recently become more important in determining consumers' purchasing decisions. The findings of Bansback (1995) mean that the emphasis on price and income is no longer significant in determining demand.

The livestock sector is generally considered to be one of the most important players in the environmental burden. For these reasons, in the current analysis, we have decided to focus on the beef contribution. We are focusing on the economic aspects of beef consumption in the context of sustainability. Meat production and consumption have some impact on the environment and human health. If we want to look at meat consumption from a sustainability point of view, the amount of meat should be produced in a quantity needed to cover the basic nutritional needs of the human population. The situation with the meat is not as straightforward as describe Sykes et al. (2019). We disagree with the statement that the only solution to relieve the planet of emissions is to reduce the number of cattle. In Slovakia, we illustrate how Slovaks do not solve any sustainability and CO_2 emissions. They are far from these noble goals (Skultety 2019). The country's present situation is an example of how one can be sustainable without knowing about it. For better understanding the situation in consumption, we use the Almost Ideal Demand System (AIDS) model that detects Marshallian and Hicks elasticities computed by Deaton and Muellbauer (1980).

We consider the price of the studied commodity to be a significant factor influencing consumption, which significantly influences consumer behaviour in Slovakia. Over 30 years, there has been a 13% decrease in beef consumption, and it has been increasingly replaced by pork and poultry, concludes Skultety (2019). This decline in consumption will continue in the next five years.

MATERIAL AND METHODS

The paper focuses on two areas, the first of which is food consumption, specifically selected type of meat – beef. Consequently, we investigate consumer behaviour using Marshallian and Hicks elasticities using the AIDS model calculated in software R 3.6.3 (Henningsen and Hamann 2007). The analysis is performed for the period 2001–2018. For this analysis, we use data from the Statistical Office of the Slovak Republic (SOSR 2020), namely:

– consumption of selected types of food per capita (kind of meat);
– average consumer prices of selected products (prices are adjusted for inflation);
– average income in Slovakia.

Data as a meat consumption structure and bovine meat food supply quantity (kg/capita/year) for the European Union (EU) were obtained from the FAOSTAT database (FAO 2020).

In the second area, we focus on predicting the development of beef consumption and the prices of beef products examined in the consumer basket in software SAS 9.4 according to SAS Institute Inc. (2014). Beef consumption and consumer prices are predicted based on annual data for the period 1996–2018. These data are freely available at the Statistical Office of the Slovak Republic (SOSR 2020).

Modelling consumer behaviour in the beef consumption. The first part of the presented paper examines consumer behaviour in food consumption in terms of the prices of individual food groups. From a sustainability point of view, we consider it very important to understand how consumers are replacing beef consumption as this substitution can burden other aspects of the ecosystem. For this reason, we decided to model food demand based on calculated price and income elasticities of demand using the AIDS model. At the same time, the model provides information about possible substitutes and complements within individual food groups. The authors of the AIDS were Deaton and Muellbauer (1980).

In general, the parameter estimate is calculated due to the substitution of formulas and has the following form:

$$w_k = (\alpha_k - \beta_k \alpha_0) + \sum_{j=1}^{n} \gamma_{kj} \log p_j +$$
$$+ \beta_k \left(\log M - \sum_{l=1}^{n} \alpha_l \log p_l + \frac{1}{2} \sum_{l=1}^{n} \sum_{j=1}^{n} \gamma_{lj}^* \log p_l \log p_j \right) \tag{1}$$

where: α_k, β_k, γ_{kj} – regression parameters; γ_{lj}^* – regression parameter for i,j; α_l – regression coefficient for l[th] item; i, j indexes – meat items; w_k – expenditure share of food k among the meat items; p_j – price of food j[th]; p_l – price of food l[th]; M – total expenditure of all meat items included in the model.

Equation (1) is not very difficult to estimate, because the conditions of the 1st order for maximising plausibility are linear in the parameters α, γ for given β and *vice versa*, so the maximisation of 'concentrated' plausibility of the function is performed iteratively, each

iteration being always applied only to a subset of these parameters. If the symmetry of the parameters γ does not apply, then $\gamma_{kj} \neq \gamma_{jk}$, then the parameter γ^* is defined as the average of both values.

Price elasticities can be derived from either the Marshallian demand equation or the Hicksian demand equation. The Marshallian demand equation is obtained from maximising utility subject to the budget constraint (Keynes 1924), while the Hicksian demand equation is derived from solving the dual problem of expenditure minimisation at a certain utility level (Hicks 1970). Elasticities derived from the Marshallian equation are called Marshallian or uncompensated elasticities, whereas elasticities derived from the Hicksian equation are referred to as Hicksian or compensated elasticities. Marshallian elasticities can be transformed into Hicksian elasticities through the Slutsky equation:

$$e_{ij}^H = e_{ij}^M + w_j e_i \qquad (2)$$

where: e^H – Hicksian elasticity; e^M – Marshallian elasticity; w_j – budget share on good j; e_i – income elasticity for good i.

More detailed discussions on the Marshallian and the Hicksian demand can be found in other contributions (Bansback 1995; Yuzbashkandi and Mehrjo 2020). Other research work dealing with meat consumption is based on this methodology (Zhuang and Abbott 2007; Säll and Gren 2015).

Predictions in the beef consumption and prices of the beef stuffs. As we are interested in developing the situation in the consumption of beef, we decided to use the method of prediction from a methodological point of view.

It is an analysis of time series based on specific properties of the examined time series. Based on the type of time series, its unit root test, residual test and errors of models, we consider linear trend with autoregressive errors to be the most appropriate prediction model in terms of prediction accuracy rates. The aim of evaluating the accuracy of forecasts is to analyse and minimise errors. Forecast errors, the differences between the actual and the forecast value, are assessed individually for individual time horizons (underestimation or overestimation). These include mean absolute percentage error, mean absolute error or mean squared error, as Hyndman and Athanasopoulos (2018) noted.

Anderson and Mentz (1980) and Hyndman and Athanasopoulos (2018) augmented the regression model with an autoregressive model for the random error,

thereby accounting for the autocorrelation of the errors. Instead of the usual regression model, the following autoregressive error model is used:

$$y_t = x_t \beta + v_t$$

$$v_t = -\varphi_1 v_{t-1} - \varphi_2 v_{t-2} - \dots - \varphi_m v_{t-m} + \varepsilon_t \qquad (3)$$

$$\varepsilon_t \sim IN(0, \sigma^2)$$

where: y_t – dependent values; x_t – column vector of repressor variables; β – column vector of structural parameters; $\varphi = (\varphi_1 \dots \varphi_m)$ – vector of autoregressive parameters; v_t – variance matrix of the error vector v; $\varepsilon_t \sim IN(0, \sigma^2)$ – each ε_t is normally and independently distributed with mean 0 and variance σ^2.

By simultaneously estimating the regression coefficients β and the autoregressive error model parameters φ_i, the autoregressive procedure in SAS 9.4 (SAS Institute Inc. 2014) corrects the regression estimates for autocorrelation. Thus, this kind of regression analysis is autoregressive error correction or serial correlation correction.

RESULTS AND DISCUSSION

In recent years, the history of beef consumption in Slovakia has increasingly focused on structural changes in the demand for meat products, especially beef. Beef consumption decreased by almost 11% during the period considered. In the article, we will discuss the situation in Slovakia and the reasons why this is actually happening. We dare to say that probably no commodity expresses peace or fluctuations in living standards and changing views on proper human nutrition, such as meat. Over the last twenty years, there has been a clear decline in meat consumption, accompanied by a decline in beef consumption and an increase in poultry consumption. An important factor causing the situation is the fixed pricing policy of large retail chains, problems with domestic production and imports of lower quality products. Economic factors such as prices, income and inflation have the most significant impact on food expenditure developments.

Vennari (2008) has argued that many predictions of meat consumption are examined from the simple point of view that if income levels increase, meat consumption will also increase, as meat is generally considered a common commodity. As consumers' incomes increase, so does the demand for meat, claimed

Capps et al. (1988) and Schroeder et al. (2000). This approach is understandable, as meat has traditionally been considering a desirable and expensive food product in Western countries, as published by Twigg (1983). Increased incomes or lower prices have led to the increased consumption of animal-based foods and processed foods. While those well-educated can choose to adopt a healthy lifestyle, the poor have fewer food choices and more limited access to nutritional education, concluded Kearney (2010).

Figure 1 shows the development of prices and consumption of beef in comparison with the average income of Slovaks. Due to the limited availability of price data, time series were examined from 1996 to 2018. The graph shows how beef consumption is declining, although average income is growing exponentially and average prices were stabilised at around EUR 8 per kg. This is a very positive phenomenon in terms of sustainability and efforts to reduce emissions. Rising commodity prices have essentially affected domestic consumption in the sense that people are no longer willing to buy it. This trend has also been caused by food scandals in the EU, as well as by various animal diseases, causing deaths of many animals and subsequently the rise of price.

These facts are of great importance for the analysis. The decisive factors and the effects of changes in the structure of meat consumption are incomes and related effects outside domestic consumption, prices, information on nutritional values, and to a lesser extent, environmental awareness. The structure of meat consumption in Slovakia is not satisfactory due to balanced dietary principles. Consumer behaviour has been explained by the usual eating habits and the unsatisfactory income situation of most Slovak households, which defined Benda Prokeinova and Hanova (2016).

Consumption of beef in Slovakia in the period from 1996 to 2012 shows a declining trend. The average annual consumption decreased by 8 kg per person (Figure 2). In the following years 2013–2018 there was a slight increase with a stagnant tendency. During this period, the price of beef decreased, which was influenced by a slight increase in beef consumption. The price drop was EUR 50 cents per kg of meat, and the change in consumption represented an increase of 1 kg in the period 2013–2018.

The recommended dose calculated per year per person is compared with the consumption of beef meat in Slovakia for each year and presented in Figure 2. The recommended dose is setting by the Public Health Office of the Slovak Republic (2010). Not only in Slovakia but also in the EU, the average recommended consumption is 17.4 kg per person per year. We have to state that the consumption of beef in Slovakia is insufficient in the last reference year, representing only 30% of the recommended dose. It seems that the theory of several economists cannot be acceptable. Income in Slovakia is growing every year, while the average consumption of beef in the observed period is decreasing on average.

If we look at the average of the EU, we observe a slight decrease in consumption compared to the recommended standard of 17.4 kg. The average consumption for the surveyed period is around 15 kg per person per year. If we compare it with the EU average, Slovakia shows negligible beef consumption. Again, from the point of view of sustainability, Slovakia appears to be highly positive. If we look at Figure 2 in terms
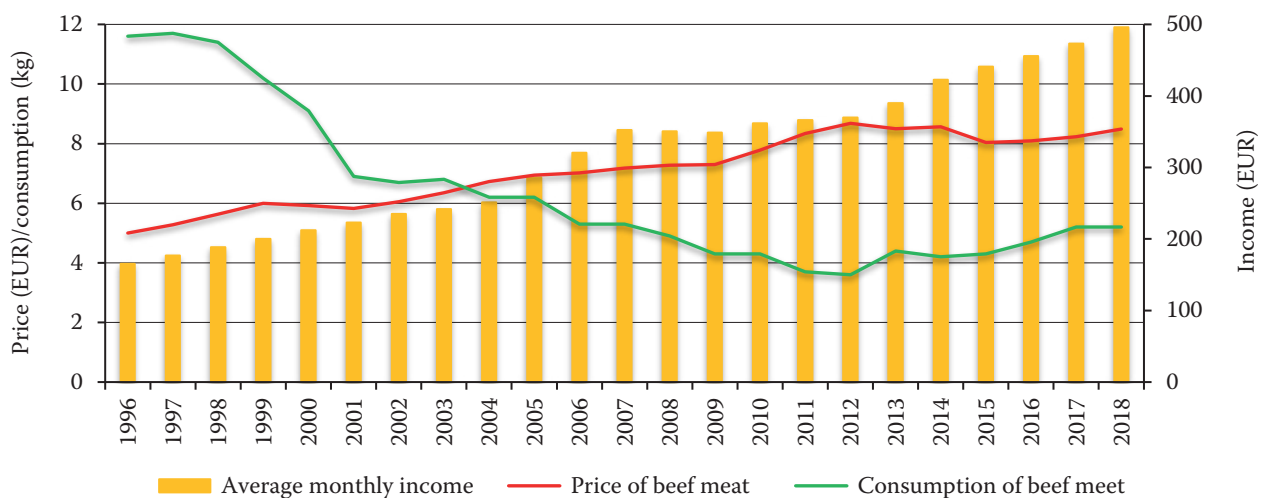

Figure 1. Comparison of average monthly income, consumption and price of beef meat in Slovakia during 1996–2018

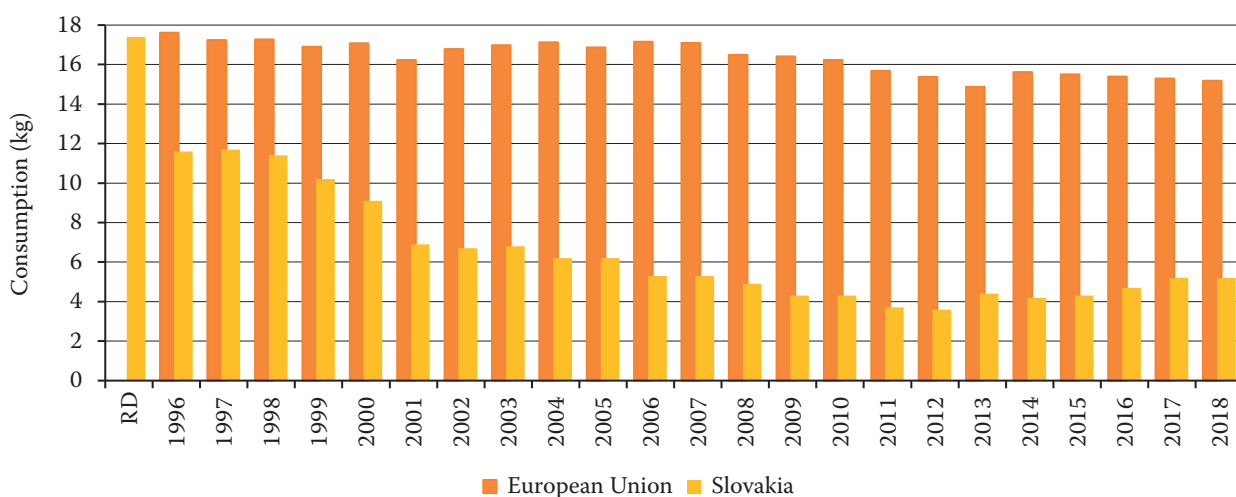Source: Statistical Office of the Slovak Republic database (SORS 2020)

Figure 2. Comparison of the beef meat recommended dose (RD) per year and per head in kg in Slovakia and EU during 1996–2018

Source: Statistical Office of the Slovak Republic database (SOSR 2020) and FAO (2020)

of the development of consumption based on the recommended dose, we can see a gradual decline in average consumption in the EU. It is obvious that this trend is gradually coming to EU member states.

We investigated this phenomenon's causes and decided to analyse the income and price elasticities calculated through the AIDS demand model.

Consumption of beef may fall due to prices that do not fall, and they remain at a similar level. At the same time, it may be a consumer habit. People have lost the habit of eating beef meat, and for this reason, it is consumed less. The uncompensated price elasticities of demand for all meat groups are negative and consistent as we expected.

For price and income elasticity, we calculated our own-price elasticities for all four groups of meat, which are harmful, statistically significant, and credible. The resulting elasticities are located on the diagonal of the matrix (Table 1); beef –0.69, pork –0.98, poultry –0.75. As we can see from Table 1, all intrinsic price elasticities take on negative values. A change in the price of goods by 1% will reduce the quantity

purchased for beef by 0.69%, for pork by 0.98%, for poultry by 0.98%. The price increase would affect the consumption of pork the most.

The elasticity of expenditure (income) is described in Table 2 as a percentage change in the amount required if expenditure changes by approximately 1%, while other factors remain *ceteris paribus*. Elasticity does not depend on the units of measurement in which demand is measured. That is the fact why we consider it the most significant measure of consumer sensitivity to changes in income or prices. If the elasticity of expenditure becomes positive, it means that all categories of meat are ordinary goods. Beef and pork gained a value of more than one value. This means that it is considered a luxury item.

Hicks price elasticities (Table 3) are also negative for all foods examined, as we expected. The values of cross-

Table 1. Uncompensated price elasticities (Marshall elasticities)

	Beef price	Pork price	Poultry price
Beef quantity	−0.686	−0.149	−0.245
Pork quantity	−0.008	−0.983	−0.023
Poultry quantity	−0.105	−0.029	−0.747

Source: Own calculations based on Statistical Office of the Slovak Republic database (SOSR 2020)

Table 2. Income elasticity

	Beef	Pork	Poultry
Income elasticity	1.080	1.013	0.881

Source: Own calculations based on Statistical Office of the Slovak Republic database (SOSR 2020)

Table 3. Compensated cross elasticities (Hicks elasticities)

	Beef price	Pork price	Poultry price
Beef quantity	−0.614	0.711	−0.096
Pork quantity	0.058	−0.174	0.115
Poultry quantity	−0.046	0.673	−0.626

Source: Own calculations based on Statistical Office of the Slovak Republic database (SOSR 2020)

-price elasticities are smaller in absolute values than their expenditure or own price elasticities. This fact applies to both compensated and uncompensated price elasticities, conclude Benda Prokeinova and Hanova (2016).

The compensated cross elasticities (Table 3) are located above and below the diagonal representing the compensated intrinsic elasticities and acquire positive and negative values. A positive sign expresses a substitute, and a negative sign a complement. Compensated own price elasticity for beef is (–0.61), pork (–0.17), and the most flexible is the value of elasticity for poultry (–0.62). The values of cross elasticity can acquire both positive and negative values. Substitutes represent positive values, and complements represent negative values. In terms of cross-price elasticity, pork consumption shows low compensation for the beef price (0.06), while beef consumption is susceptible to the price of pork (0.71).

Consequently, pork consumption shows a low refund for the beef price (0.06), while poultry consumption shows a high sensitivity to the price of pork (0.67). Poultry consumption shows a negative and low compensation for the price of beef (–0.05) and *vice versa*; poultry consumption shows low sensitivity to beef (–0.10). In the final evaluation of the AIDS method, we can state that the result confirmed the real consumption of meat and the real pattern of consumer behaviour in meat consumption. Slovaks are substituting beef with increased consumption of pork and poultry. In the event of a rising price for pork, they will substitute for poultry, but not beef.

Prediction of beef consumption and beef product's prices. Given the situation in beef consumption, it would be appropriate to predict the development of consumption and adequately assess the development of prices of selected types of beef. The above forecast represents a situation assuming *ceteris paribus* and predictive development will show us the consumption trend.

The time series contains complete monthly data for the period from 2001 to 2020 and is suitable and adequate for the Box-Jenkins methodology. We tried to model with exponential smoothing and with logarithmic models. We determined the linear trend with autoregressive errors as the most suitable model, as those models' errors were the smallest. The values of autocorrelation coefficients did not exceed the so-called significance limit.

After looking at the prediction model in Figure 3, we can say that there will be a declining trend in beef consumption. This trend certainly started earlier than in 1996, and since then consumption has been steadily declining. The main reason for the declining interest is also the rising price per kg. Therefore, we see no reason to grow imports of this commodity over the next five years.

The forecasts were based on annual data time series of consumption and prices. Based on the results of the forecasts (Figure 3–4), we would like to summarise our findings. In terms of the development of consumption, it is clear that beef consumption shows a declining trend. The declining trend in beef consumption is expected to continue over the next five years due to rising beef prices. We verified this statement by predicting the prices of beef products, which we obtained from the consumer basket of the Statistical Office of the Slo-
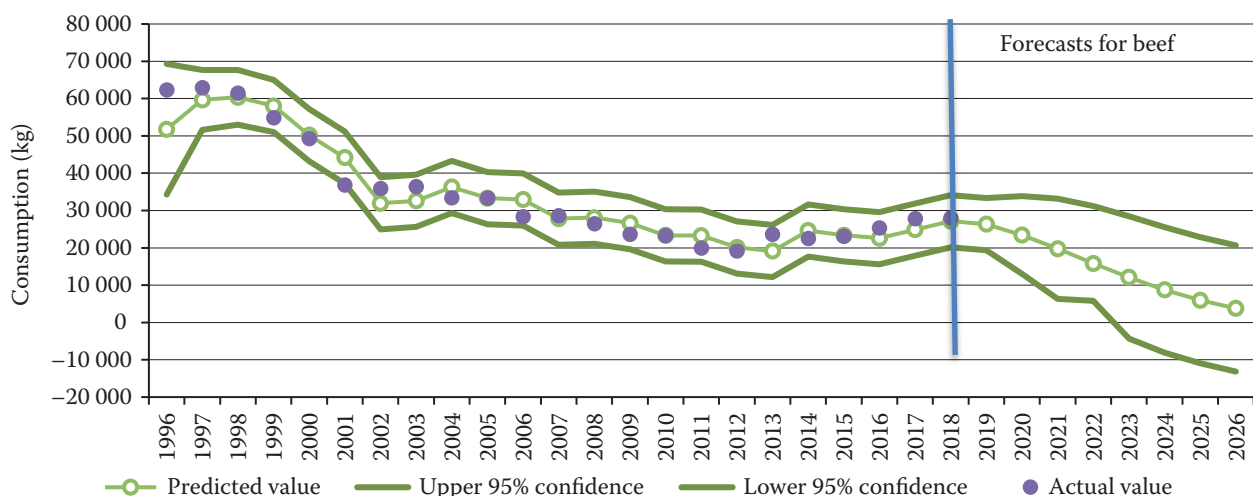

Figure 3. Prediction of the beef meat consumption in Slovakia

Source: Own calculations based on Statistical Office of the Slovak Republic database (SOSR 2020)
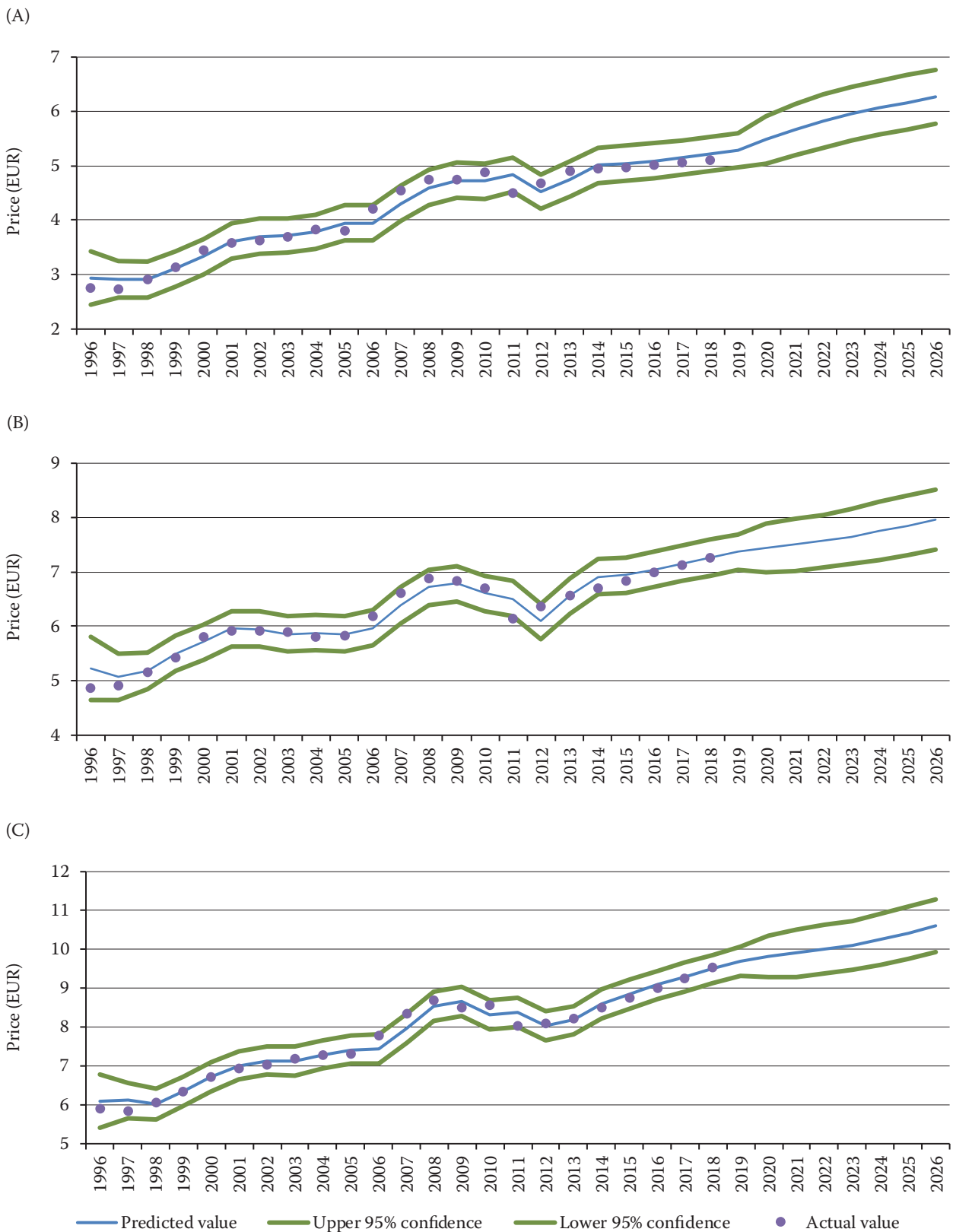
(A)

(B)

(C)

Figure 4. Prediction of the beef meat prices in Slovakia: (A) chuck roast with the bone, (B) boneless chuck roast, and (C) boneless round roast

Source: Own calculations based on Statistical Office of the Slovak Republic database (SOSR 2020)

vak Republic (SOSR 2020). All prices of the examined beef products show an increasing trend. The forecast indicates that the upward trend in prices in the coming periods will continue. Indeed, Slovaks do not have a significant chance to change consumer behaviour, as price forecasts confirm a growing trend. If we look at the situation in terms of real consumption, household income and ex-post beef prices, we currently only have a scenario with declining beef consumption.

Dagevos and Voordouw (2013) called on researchers to show good examples and practices aimed at reducing meat by consumers. We firmly believe that the Slovak case study will also show the way how it is possible to reduce consumption without significant restrictions and without offering alternative meat substitutes.

CONCLUSION

At this point, we come into conflict. On the one hand, there is the agricultural economic view of the matter. We need to produce beef so that we can sell it and make money. The environmental perspective is to monitor the carbon footprint and emissions produced by beef production, which produces a certain amount of emissions. The social aspect in which the population plays an important role with their consumption habits and, in particular, with the income through which they express what they can and cannot afford.

In Slovakia, we found that there is a continuing downward trend in beef consumption, mainly due to price increases. Obviously, consumer prices will rise linearly according to prediction models. From a sustainability point of view, we can consider pricing policy to be an effective tool in reducing beef consumption in the future. This trend is in line with countries' efforts to reduce their carbon footprint, according to a survey by Sykes et al. (2019).

Vennari (2008) suggested reducing meat consumption by:
– providing financial assistance for the development of artificial meat and substitutes to all kinds of meat;
– increasing consumer knowledge on this issue. If consumers gain more knowledge about vegetarianism, they can try new products, resulting in companies getting more funding to finance and develop new products;
– evitable changes in the way of providing economic subsidies for agriculture and especially for all kinds of meat;
– consumer access to new sources of protein should also ensure.

We consider these measures to be fiction in the real world. Many points are controversial and very difficult to implement. Consumers have their habits and culture of eating, where we cannot imagine replacing real meat with artificial meat. Alternatively, the transition of consumers to a vegetarian diet is also unrealistic in many countries. In Argentina, for example, where beefsteak is like pizza in Italy, it would require extraordinary efforts of marketers and politicians to turn people into vegetarians.

One of the solutions in reducing beef consumption is the Green Deal, which aims to support public investment in clean technologies in food production. There is a remarkable number of intersections between the objectives of the Green New Agreement published by Simms (2008) and cell farming. The potential for reducing greenhouse gases is the most obvious, but others go far beyond the environmental impact. Investments in the so-called clean meat world increase economic opportunities for all. Acquiring cell farming under the auspices of the Green New Deal right now, as the industry is still evolving, could also alleviate the potential problems that the new industry could pose, described Rust et al. (2020).

From the studied materials and the examination of various databases, we conclude that the pricing policy mainly influences beef consumption. If the price of beef were at the level of pork in Slovakia, the structure of meat consumption would look different. If emissions production and the carbon footprint are mixed, then responsible consumers will stop shopping, and the others will not care; production will not change anyway. There are initiatives to introduce a type of carbon tax that would constitute a quasi-fine for the production of beef emissions, but we only see it as a chance for an increase in a given commodity's price. Beef will become a commodity for the rich, which has already happened in Slovakia. The question for farmers, politicians, and especially consumers remains: What do they want? If we focus on the economics of breeding and, therefore, on profit, can we also consider the environment? If we introduce environmental taxes, will consumers still be willing to buy?

REFERENCES

Anderson T.W., Mentz R.P. (1980): On the structure of the likelihood function of autoregressive and moving average models. Journal of Time Series, 1: 83–94.

Bansback B. (1995): Towards a broader understanding of meat demand. Journal of Agricultural Economics, 46: 287–308.

Benda Prokeinova R., Hanova M. (2016): Modelling consumer's behaviour of the meat consumption in Slovakia. Agricultural Economics – Czech, 62: 235–245.

Capps O., Moen S.D., Branson R.E. (1988): Consumer characteristics associated with the selection of lean meat products. Agribusiness, 4: 549–557.

Cechura L., Hockmann H. (2010): Sources of economical growth in the Czech food processing. Prague Economic Papers, 19: 169–182.

Dagevos H., Voordouw J. (2013): Sustainability and meat consumption: Is reduction realistic? Sustainability: Science, Practice and Policy, 9: 60–69.

Deaton A., Muellbauer J. (1980): An almost ideal demand system. American Economic Review, 70: 312–326.

FAO (2020): Bovine Meat Food Supply Quantity (kg/capita/year). [Dataset]. The Food and Agriculture Organization of the United Nations. Available at http://www.fao.org/faostat/en/#data/CL/visualize (accessed December 12, 2020).

Henningsen A., Hamann J.D. (2007): Systemfit: A package for estimating systems of simultaneous equations in R. Journal of Statistical Software, 23: 1–40.

Hicks J. (1970): Elasticity of substitution again: Substitutes and complements. Oxford Economic Papers, 22: 289–296.

Hyndman R.J., Athanasopoulos G. (2018): Forecasting: Principles and Practice. Melbourne, Australia, Monash University: 1–382.

Kearney J. (2010): Food consumption trends and drivers. Philosophical Transactions of the Royal Society B: Biological Sciences, 365: 2793–2807.

Keynes J.M. (1924): Alfred Marshall, 1842–1924. Economic Journal, 34: 311–372.

Notarnicola B., Tassielli G., Renzulli P.A., Castellani V., Sala S. (2017): Environmental impacts of food consumption in Europe. Journal of Cleaner Production, 140: 753–765.

Public Health Office of the Slovak Republic. (2010): Recommended Nutrition Doses for Population of the Slovak Republic. [Dataset]. Available at https://www.uvzsr.sk/en/index.php?option=com_content&view=article&id=31:recommended-nutrition-doses-for-population-of-the-slovak-republic&catid=3:documents&Itemid=4 (accessed January 21, 2021).

Predanocyová K., Šedík P., Kubicová Ľ., Horská E. (2018): Consumption and offer of organic food on the Slovak market. Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 66: 1315–1323.

Rust N.A., Ridding L., Ward C., Clark B., Kehoe L., Dora M., West N. (2020): How to transition to reduced-meat diets that benefit people and the planet. Science of the Total Environment, 718: 137–208.

SAS Institute Inc. (2014): SAS/ETS® 13.2 User's Guide. Cary, North Carolina, USA, SAS Institute Inc. Available at https://support.sas.com/documentation/onlinedoc/ets/examples/132/index.html (accessed Dec 15, 2020).

Säll S., Gren M. (2015): Effects of an environmental tax on meat and dairy consumption in Sweden. Food Policy, 55: 41–53.

Schroeder T.C., Marsh T.L., Mintert J. (2000): Beef Demand Determinants. Report Prepared to the Beef Board Joint Evaluation Advisory Committee (January 2000). Manhattan, Kansas, USA, Department of Agricultural Economics, Kansas State University: 1–54.

Simms A. (2008): A green new deal. Renewal, 16: 77–84.

SOSR (2020): Global Consumption of Foodstuffs in the Slovak Republic. [Dataset]. Statistical Office of the Slovak Republic. Available at http://datacube.statistics.sk/#!/view/en/VBD_SLOVSTAT/ps2040rs/v_ps2040rs_00_00_00_en (accessed December 12, 2020). (in Slovak)

Skultety J. (2019): Overall GHG Emissions Trends: Fourth Biennial Report of Slovak Republic. Bratislava, Slovakia, Ministry of Environment of the Slovak Republic, Slovak Hydrometeorological Institute.

Svetlanská T., Turčeková N., Adamičková I., Skalský R. (2017): Food security facets: Case of Slovakia regions. Journal of Security & Sustainability Issues, 7: 311–320.

Sykes A.J., Topp C.F., Rees R.M. (2019): Understanding uncertainty in the carbon footprint of beef production. Journal of Cleaner Production, 234: 423–435.

Twigg J. (1983): Vegetarianism and the meanings of meat. In: Murcott A. (ed.): The Sociology of Food and Eating: Essays on the Sociological Significance of Food. Aldershot, United Kingdom, Gover: 18–30.

Vennari M. (2008): The future of meat consumption – Expert views from Finland. Technological Forecasting and Social Change, 75: 893–904.

Zhuang R., Abbott P. (2007): Price elasticities of key agricultural commodities in China. China Economic Review, 18: 155–169.

Yuzbashkandi S.S., Mehrjo A. (2020): Towards agricultural demand for the main energy carriers in Iran: Application of linear approximate almost ideal demand system (LA-AIDS) analysis. Journal of the Saudi Society of Agricultural Sciences, 19: 313–318.