COMPARISON OF THE PORK MEAT PRICES IN CHOSEN EUROPEAN COUNTRIES IN 2010 – 2018

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Abstract

Food supply chains represent a significant part of the European economy. Most of the farmers involved in pork meet supply chains are SMEs. The scale of production is increasing, which threatens the existence of SMEs, which are thought to have innovative power, among others because they are able to exploit cultural capital. The paper presents a time analysis of prices in the food supply chain of pork meat for 5 European countries in 2010 - 2018 with respect to small farms position in the European market. The analysis reveals dynamic aspects of price progression in the long time horizon. The results support the short-term decision making of SMEs producers involved in the European pork meat trade. The data analysis has shown that there is a significant difference between live weight pig prices of German producers and other producers in the five selected European producers.

Key words

Food supply chain, live weight pig prices, pig prices evolution, time series smoothing and modelling
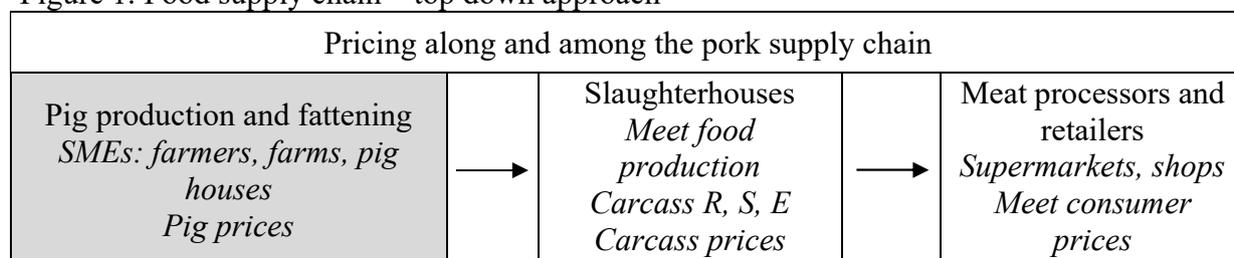
JEL Classification: Q13, C22

1 INTRODUCTION

The paper presents an analysis of live pig prices in the first step of the food supply chain of the swine market for five selected European countries in 2010 - 2018. The analysis reveals dynamic aspects of live pig prices progression in the long run and the position and competitiveness of the Czech pigs' producers on the common European market.

Many studies on the functioning of markets and pricing mechanisms took a "top-down" approach in which relation among farm prices, industry prices, wholesale prices and retail prices are analysed within the corresponding food market chain. Thus, the transmission of the pork commodity prices changes into consumer prices occurs in trespassing the different stages of the food supply chain (Figure 1):

Figure 1. Food supply chain – top down approach

Pricing along and among the pork supply chain				
Pig production and fattening *SMEs: farmers, farms, pig houses* *Pig prices*	→	Slaughterhouses *Meet food production* *Carcass R, S, E* *Carcass prices*	→	Meat processors and retailers *Supermarkets, shops* *Meet consumer prices*

Source: Own schema

The research follows up the evolution of pig prices in the first phase of the chain through the commodity "live weight". In this study, we analyse the latest prices and the historical evolution of the live pig prices on the European swine markets over period 2010 – 2018. The prices are

presented in Euro; the conversion of the Czech currency is made according to the exchange rates of each date.

Small farmers, being on the top of the chain, are threatened in their existence having to fulfil administrative and food safety requirements, which are difficult and costly to implement: HACCP and FSMS directives, tracking and tracing obligations, information gathering requirements from national and EU food law etc. (Madec et al., 2001; Veissier et al., 2008). In addition, farmers might be confronted with the existence of supermarket brands who could fortify the negative effects on pig production as well as products innovation. On the one hand, final consumers benefit from upscaling, standardization and formalization of the pig production because of increased attention to food safety and quality issues, which are high on the EU food policy agenda. Different supply chain configuration leads to dependencies and asymmetries in the pig commodity prices among the European countries. Maria, Garrone & Swinnen (2018) provided analysis of agricultural prices fluctuations for the EU during the period 2007-2016 and observed large differences in prices over time among different stages in the food chain and proved that agricultural prices were much more volatile than the processor and consumer prices. In both Italy and France, the agricultural sector demonstrates more fluctuations compared to others' mark-ups.

Davis (2017) have published the latest relative costs of pig meat production in 2017 up to the farmgate level in 17 countries associated in the "InterPIG" community. The comparison proved that there are discrepancies between involved countries: (1) Average feed prices were higher in 2017 than in 2016, increasing by an average of nearly 7% across the EU countries. (2) The cost of pig meat production in Great Britain increased by 8% in 2017. (3) In 2017 as a whole, EU feed costs per kg increased by 6% compared with a year earlier. (4) The overall average number of pigs weaned per sow per year in the EU countries showed nearly 2% increase in 2017, while Denmark achieved 33%. (5) In 2017, the average costs of production of deadweight in the EU are 1.55 Euro while in US 0.98 Euro. This significant difference between US and EU states is analyzed by Batavia et al. (2013) who state that Germany has a stronger position among other EURO and peripheral states because German exports are more subdued with a strong Deutsche mark than as has been the case from within the EURO area.

Bonneau et al. (2011) state that the farm-level pork production the EU is influenced by intensive production systems involving environmental and animal welfare, some countries are not economically competitive on the world market and the diversity of production systems is threatened due to economic pressures of demands from society and consumers. The author identifies two main clusters of conventional systems: one that can be identified as intensive, supplying the standard meat market (Germany, France, south and middle European states), and another which are also intensive but clearly welfare oriented (mainly encountered in the Netherlands and Nordic countries). Gomez-Herrera et al. (2014) discuss the importance of geographical distance which strongly reduces the online trade, compared to offline trade and show that there is a strong increase in the trade costs associated with crossing linguistic borders.

Howarth (2019) argues with data that, according to the European Commission, points to a slump in pigs' deadweight prices in the UK compared to other EU states in 2018. Commission actually publishes three sets of reference prices, for pigs, graded S, E and R. Given that over three-quarters of UK pigs are S-grade, there is little difference in the gap between UK and EU prices.

The problem of data interoperability and standardization of data highlight Bahlo et al. (2019) analyse how to combine private sensor-obtained data from the precision farming with public data and combine the sources of data to be disposable for various users at varying spatial scales. Antle et al. (2017) propose how to design next generation data models via an "user-driven

approach" to agricultural systems. The study is based on Cases and questioning with SMEs and farmers.

Capalbo, Antle and Seavert (2017) discusses the role of governments in the process of building data systems and relevant decision models to support farm decision making. Authors stress that the users do not want data and information per se, rather they want the information they can produce. This means that models must have value for farm managers. The improvement of inter-operability has to automate data collection using sensors, mobile devices, web-based sources and economic data such as prices.

Based on the desk research and analysis of data the study presents the following research objectives and questions:

- Describe the position of the Czech pig producers on the European pig production market among five selected European countries in 2010 - 2018.
- Assess the extent to which the economic crisis in 2010 - 2015 has been reflected in the prices of live weight pigs for selected pig producers.
- Provide the analysis of data for potential time series forecasting models.

2 PROBLEM FORMULATION

2.1 METHODOLOGY

The position of Czech pig producers on the European market is illustrated by the comparison of live pig prices of Czech pig producers and selected EU pig producers with similar production conditions. The univariate time series of live pig prices are used to analyse the dynamics of prices during the long period of 2010 - 2018. This has been realized through historical data to identify the pattern dynamics of live pig prices.

Data from the EUROSTAT database was transformed to cover a 30-day standard period of interval time series. Moving averages were used to transform weakly data into monthly data, all processed prices were unified into 1€ per kg. Data changes over time are described by basic descriptive characteristics, Durbin-Watson statistics is implemented to detect possible correlation among data. For the elaboration of data and data processing, the STATISTICA software was employed.

2.2 SELECTION OF COUNTRIES FOR THE COMPARISON

Based on the studies Davis, 2017, Bonneau et al. 2011 and Gomez-Herrera et al. 2014, for the comparison of prices were selected the following countries: *Germany, Netherlands, Hungary, Poland* and the *Czech Republic*. These countries represent groups of manufacturers that use similar technologies and/or have similar historical experience.

2.3 VISUAL ANALYSIS OF DATA, BASIC DESCRIPTIVE CHARACTERISTICS OF TIME SERIES

Basic information about the progression of prices gives a visual representation. Figure 2 shows the development of prices for five European countries over time 2010 - 2018. The graph format of data on the same chart allows to be shown correlatively for the monitored period in order to see trends or to compare differences between years. The evolution of the average prices and descriptive characteristics per years are shown in Table 1.

Plot representation of series in Figure 2 shows that components are changing slowly over time. The trend seems to be linear or slightly exponential.

Germany producers have an excellent position on the market being more profitable than others monitored manufactures. This confirms and extends the findings of Davis (2017) for the period 2016 – 2017.

Figure 2: Live weight pigs' prices in selected EU countries over 2010 - 2018.
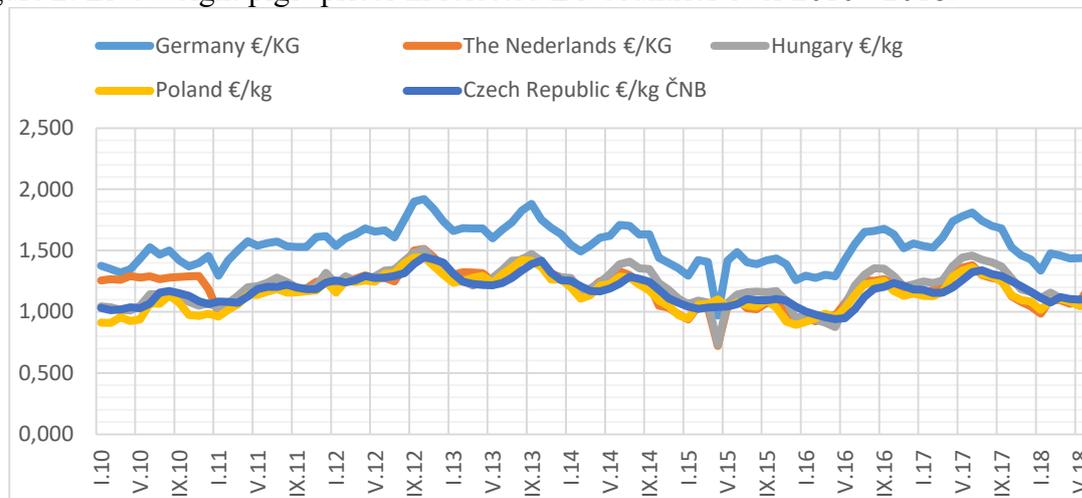
Table 1: Descriptive characteristics of live weight pig prices in selected EU countries through 2010 - 2018.

	Average	Median	Minimum	Maximum	Dispersion	Standard deviation
Germany	1.541	1.537	0.970	1.923	0.027	0.163
The Netherlands	1.216	1.248	0.723	1.559	0.024	0.156
Hungary	1.212	1.215	0.731	1.513	0.021	0.146
Poland	1.150	1.138	0.893	1.446	0.019	0.138
Czech Republic	1.175	1.184	0.942	1.448	0.013	0.113

|	Variance	Q1 lower	Q3 upper	Skew	Skew	Modus
Germany	10.567	1.423	1.660	-0.163	0.512	1.68
The Netherlands	12.850	1.095	1.315	-0.265	0.059	multi
Hungary	12.086	1.112	1.310	-0.344	0.226	multi
Poland	11.988	1.053	1.250	0.099	-0.720	multi
Czech Republic	9.653	1.085	1.253	0.150	-0.449	multi

The evolution of data over the time is rather conservative: coefficients of variance vary between 10% – 12% for all involved countries, e.g. the prices have changed in a range only around 10% during the entire eight years. Similar information gives the values of Q_1 and Q_3 quartiles, which are closer to the average values.

The population is not highly skewed. Although the distribution of prices is skewed to the right for Germany, The Nederland and Hungary, the degree of skewness is not high among the all-time period. In Poland and the Czech Republic, the prices remain relatively stable.

The box-plot on Figure 3 clearly depicts the central tendencies, small variability and overall range of data, which are symmetrically distributed for five monitored countries. The position of the "German box" illustrates the market dominance of Germany.

Figure 3: Box plot illustrates the descriptive characteristics of the time series over the period 2010 - 2018. The market position of Germany is extremely higher comparing with the positions of other countries.
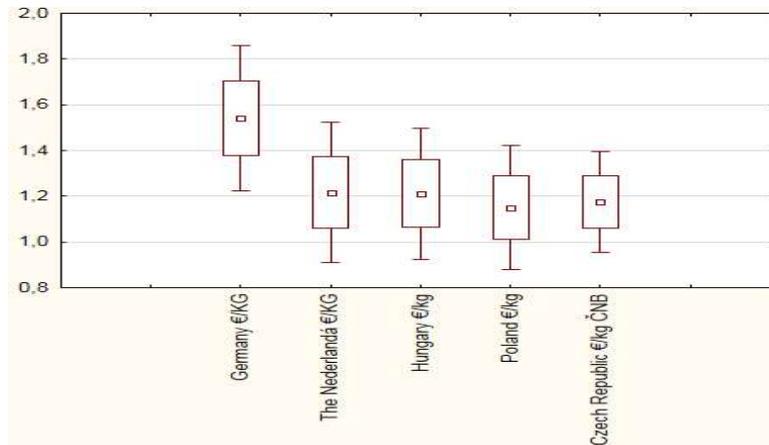
Source: Own data processing

2.4 EVALUATION OF AUTOCORRELATIONS AND IRREGULAR FLUCTUATIONS

For the application of the Durbin-Watson test is assumed, that the population of residuals at any time has a normal distribution. The analysis of residuals in Smutka at all. (2018) proved the assumption of the normality. For each monitored time series the null hypothesis H_0: "The error terms are not autocorrelated" was set an alternative hypothesis H_1: "The error terms are positively autocorrelated". Durbin-Watson statistics are presented in Table 2.

Table 2: Durbin-Watson statistics "d" for assessment of autocorrelation.

Durbin-Watson statistics for 102 observations 1 independent variable, $D_{L, 0,05} = 1{,}65$, $D_{U, 0,05} = 1{,}69$	$d = \dfrac{\sum(r_t - r_{t-1})^2}{\sum r_t^2}$
Germany	0,34
The Netherlands	0,50
Hungary	0,28
Poland	0,66
Czech Republic	0,28

Source: Own data processing

Durbin-Watson critical values for 102 observations and 1 independent variable are tabled $D_{L,0,05} = 1.65$; $D_{u,0,005} = 1.69$. All critical values satisfy the condition $d < d_{L,0,05}$, we reject H_0. There is evidence of positive (first-order) autocorrelation of all five monitored time series.

3 RESULTS

3.1 THE POSITION OF THE CZECH REPUBLIC AMONG FIVE EUROPEAN PIG PRODUCERS

The results of the data derived from the previous analysis may be summed up as follows:

In all five reviewed countries, the prices follow the same trend. Germany's dominant position on the pig market is clear throughout the time data under review. German producers sell their product at a significantly higher price over a seven-year period; the other four European producers are selling at lower prices.

The variation coefficient between 10% - 12% indicates that selling prices in all five monitored countries oscillate around the averages slightly.

The slight skew to the right manifests a slight increase in prices over the seven-year period.

The average price per kg of live weight in EU is 1.56 Euro for 2010 – 2018, 1.54 Euro for Germany. The Netherlands and Hungary pig producers sell pigs at prices by 21% lower, Czech producers by 24% lower, in Poland even by 25% lower. But, as stated in Batavia et al. (2013), some EU producers realize higher prices than the German average. Producers focused on animal welfare in pig housing are higher subsidized and get higher prices than the EU average: Ireland 106%, Sweden 106%, Finland 106%, Italy 121%.

3.2 THE IMPACT OF THE GLOBAL CRISIS

Although the world crisis has hit more than half of the surveyed period (2010 – 2015), there is no significant effect visible on the data. As mentioned above, differences in prices move in the range not exceeding 10%. Also, the average tempo of growth has been fluctuated slowly about 0.3%, see Table 3.

Table 3: Average coefficients of growth of live pig prices throughout 2010 - 2018.

Average growth of prices 2010 - 2018	Germany	The Nederland	Hungary	Poland	Czech Republic
Average coefficient of growth	1.000	0.991	1.001	1.002	1.001
Average absolute increment	0.001	-0.001	0.001	0.002	0.001
Average tempo of growth (%)	1.002	1.003	1.002	0.99	1

Source: Own data processing

4 RECOMMENDATIONS FOR THE POTENTIAL TIME SERIES FORECASTING MODELS

The plot view on Figures 2 and 3 and the statistics in Table 1 offer to suggest the linear trend op data evolution. However, visual observation also manifests a cyclical residual plot versus time, which suggests the possibility of positive autocorrelation. The property of slowly changing components of data over time (Table 1) ask for exponential smoothing. The confirmation of autocorrelation property for all studied time data will require implementing auto-regressive approach in forecasting procedures because standard prediction smoothing

methods will not function well in the forecasting model. The smoothing procedure is presented in Smutka at all. (2018).

5 CONCLUSION

Various studies have addressed the evolution of pig meat prices on the European market. In the global scientific literature, there is less attention put to the evolution of live pig prices. The studies present mostly measures concerning dead weight; slaughter processing and final pig meet processors. Czech pigs' producers need for accurate, timely and interoperable farm livestock data and information, associated models and knowledge products. There are data acquisition difficulties in agricultural environments due to the size and layout of farming systems and landscapes factors. When searching and processing the data we noticed that there is the lack of data interoperability among available data sources (ČSÚ, EUROSTAT, national ministries, professional chambers) due to multiple formats, not inter-connected communication protocols and interfaces, closed and proprietary data formats, along with the lack of standardised communication protocols. We have tried to process the data and employ visualisations (especially in a geographic context), to enhance the understanding of information of users and help toward economic acceptance.

REFERENCES

Bahlo, C., Dahlhaus, P., Thompson, H. & Trotter, M. (2019). The role of interoperable data standards in precision livestock farming in extensive livestock systems: A review. *In Computers and Electronics in Agriculture*, 156, p. 459-466.

Batavia, B., Nandakumar, P. & Wague, C. (2013). Export stagnation and budget deficits in the peripheral EU nations with EMU membership. *In The Journal of Economic Asymmetries,* 10(2), p. 94-100.

Bonneau, M., Antoine-Ilari, E., Phatsara, C., Brinkmann, D., Hviid, M., Christiansen, M. G., Fàbrega, E., Rodríguez, P., Rydhmer, L., Enting, I., de Greef, K., Edge, H., Dourmad, J.-Y. & Edwards, S. (2011). Diversity of pig production systems at farm level in Europe. *In Journal on Chain and Network Science*, 11(2), p. 115-135.

Davis, C. (2017). *Pig cost of production in selected countries Contents*. Available 2019-03-19 from: <https://ahdb.org.uk/knowledge-library/2017-pig-cost-of-production-in-selected-countries?>.

Gomez-Herrera, E., Martens, B. & Turlea, G. (2014). The drivers and impediments for cross-border e-commerce in the EU. *In Information Economics and Policy*, 28, p. 83-96.

Howarth, S. (2019). *How big is your premium? – comparing UK and EU pig prices, AHDB Pork*. Available 2019-03-19 from: <https://pork.ahdb.org.uk/prices-stats/news/2016/october/how-big-is-your-premium-comparing-uk-and-eu-pig-prices/>.

Madec, F., Geers, R., Vesseur, P. C., Kjeldsen, N. & Blaha, T. (2001). Traceability in the pig production chain. *In Revue Scientifique et Technique de l'OIE*, 20(2), p. 523-537.

Maria, G. & Swinnen, J. (2018). *The role of market power in the EU food supply chain, SUSFANS Deliverable document information, Horizon 2020*. Available 2019-03-19 from: <http://susfans.eu/system/files/public_files/Publications/Reports/SUSFANS-Deliverable-3.6-CEPS.pdf>.

Smutka, L., Havlicek, J., Dömeova, L., Sredl, K., Severova, L. & Rezbova, H. (2018). *Komparace časových řad výrobkové vertikály vepřové maso v prostředí vybraných zemí EU, TAČR, projekt ÉTA: Model transparence cen v potravinové vertikále - vepřové maso*. Available 2019-03-19 from: <https://cevema.pef.czu.cz/>.

Veissier, I., Butterworth, A., Bock, B. & Roe, E. (2008). European approaches to ensure good animal welfare. *Applied Animal Behaviour Science,* 113(4), p. 279-297.

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