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Drivers for the agricultural price gap in the different agrarian structures of the EU[1]

Introduction

There is a great diversity of natural environments, climates, economic conditions and farming practices across Europe. They are reflected in the broad array of food and drink products that are made available for human consumption and animal feed, as well as a range of inputs for non-food processes. Indeed, agricultural products contribute to the cultural identity of Europe's people and regions. The analysis of price data usually implies comparison of price indices related to the previous year. Comparison over long-term is required to study the price movements in order to understand the history and to indicate future outlook. While price relatives of single commodities can be studied in isolation, general conclusion can only be derived from averages, covering a given set or class of commodities. The index of agricultural goods output comprises weighted changes of prices of agricultural commodities whereas the index of intermediate consumption describes fluctuations of outlays' prices such as seeds and planting stock, energy, fertilizers, soil improvers, plant protection products or feedingstuffs. The relation of these two indices is defined as "price gap" or "price scissors". There is a lot of price models for agricultural goods investigated in the subject literature. Inthe last few years there has been an increase in the volatility of many agricultural commodity prices. This has increased the risk faced by agricultural producers. The main purpose of agricultural commodity price forecasting is to allow producers to make better-informed decisions and to manage price risk. (Ticlavilca et.al. 2010; Mellor, Raisuddin 1989) However, the issue of modeling drivers for

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the price gap has been rarely enquired into. The main objective of the article is to estimate long-term regression models of the agricultural price gap for different European countries that represent varied agrarian structures. This article also gives an overview of the changes in agricultural outputs and inputs in the European countries. The analysis entails few stages. In the first stage long-term price indices (from 1970 until 2014) were computed for all available agricultural products and outlays in the EU-27 countries. In the second stage a cluster analysis was performed with regard to the utilization of a land factor by individual farms in the subsequent European countries. In the third stage three countries were chosen for case studies from the each of the distinguished clusters and the econometric models of price gap were estimated where the indices of outputs and inputs are independent variables.

Agricultural policy and commodity prices

Subsidizing the agricultural prices has been determined by the preoccupation to provide farmers with a minimum income, joint in relation to that of the workers, and in order to protect them against the fluctuations of the price of the agricultural products caused by the uncertain nature of these productions (Bucharest University of Economic Studies 2015).

Today, low-income countries (about three-quarters of them are in Sub-Saharan Africa) are still predominantly agriculture based, small, and fragile, and they tend to have weak institutions. Yet, in contrast to middle-income countries, economic activity in low-income countries strengthened in 2014 on the back of rising public investment, significant expansion of service sectors, solid harvests, and substantial capital inflows. Growth in low-income countries is expected to remain strong in 2015–17. On average, agriculture accounts for about 25 percent of GDP in low-income countries. In many cases, exports are dominated by agricultural commodities. For low-income economies in Sub-Saharan Africa, it is estimated that 1 percentage point of agricultural growth is three times as effective in reducing poverty as 1 percentage point of growth in the nonagricultural sector (World Bank Group 2015).

Increases in labor income are associated with a reduction in poverty through at least two channels. First, growth in the agricultural sector, the primary source of income for the poor, raises incomes more than growth in less labor-intensive sectors, in particular the natural resource sector. Second, the movement of labor from the low-productivity agriculture sector to the higher-productivity manufacturing and service sectors raises labor incomes, including of those of the poor.

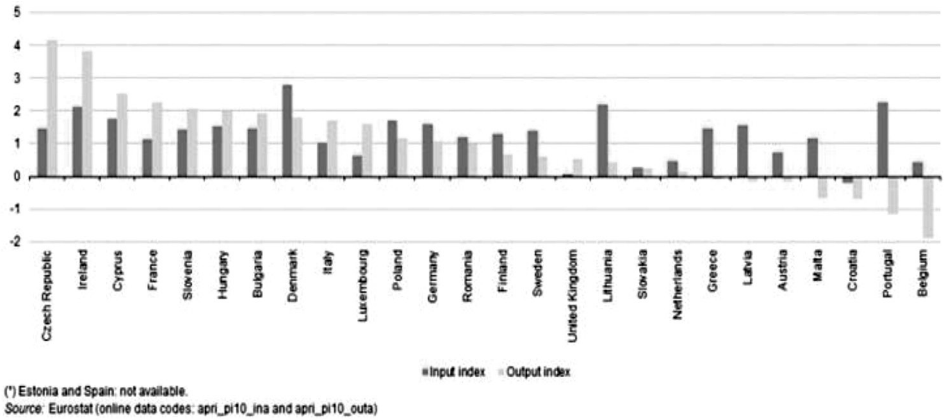
Higher shares of agriculture and service sectors in GDP are negatively correlated with revenue to GDP ratios in developing countries, as is poor governance (World Bank, 2015). This is particularly relevant for South Asia, where agriculture has historically been untaxed or undertaxed, while service sectors are also relatively large. For instance, extremely low taxation of the agriculture and service sectors in Pakistan, has raised the tax burden on industry: although industry accounts for only a quarter of GDP, tax revenues from industry are about 60 times more than for agriculture and 5 times more than for services (World Bank Group 2015). There are however researchers who argue the opposite thesis (Poczta 2015). They point out that in developing countries agriculture is usually taxed while in well-developed countries it is subsidized. Along with the economic growth and changes in the structures of the economy, the distribution of benefits and costs of agricultural policy changes. Firstly, the relation of population working in agricultural sector to the total population is getting relatively smaller. This means that the per capita cost (i.e. per person employed outside agriculture) of supporting agricultural income decreases and so does the incentive to act against such policy (Swinnen 2008; Poczta 2013). Secondly, due to the Engel's law and decrease in the share of food expenditure in total consumer spending, public opposition to agricultural subsidies will reduce, as the relative costs of such support for consumers decline (Fischer 2006; Poczta 2013).

In commodity markets, episodes of large price declines have mostly been observed in agriculture, typically associated with specific weather conditions. After reaching deep lows during the global financial crisis, most commodity prices peaked in the first quarter of 2011. Since then, prices of metals and agricultural and raw materials have declined steadily as a result of weak global demand and robust supplies.

During the period 2010 to 2014 there were considerable differences between the EU Member States in the development of deflated agricultural output prices; such deflated prices show the extent to which agricultural prices have changed compared with consumer prices. Deflated output prices rose in 19 of the EU Member States, the largest increases being recorded for the Czech Republic (average growth of 4,2% per annum), Ireland (3,8% per annum) and Cyprus (2,5% per annum), while reductions were posted in seven of the EU Member States, the largest being in Portugal (–1,2% per annum) and Belgium (–1,9% per annum). The average annual rate of change in input prices was greater than the change in output prices (Eurostat statistics explained). However the long-term analysis doesn't not confirm this conclusions.

The overall upward development of output prices between 2010 and 2014 was largely a result of rising prices for animal output, in particular, milk and to a somewhat lesser degree, cattle, poultry and pigs. While the price of crop output generally rose at a slower pace there were some exceptions, with relatively fast price increases for forage plants, wine and olive oil. Along with the physical quantities, the selling prices of agricultural products and purchase prices of the means of production have a decisive influence on farmers' incomes (Office for Official Publications of the European Communities 2002).

Figure 1. Change in deflated price indices of agricultural input and output, 2010–2014 (average annual rate of change, %):



Source: Eurostat statistics

Significant reforms of the common agricultural policy (CAP) have taken place in recent years, most notably in 2003, 2008 and 2013, with the aim of making the agricultural sector more market-oriented. The 2003 reform introduced a new system of direct payments, known as the single payment scheme, under which aid is no longer linked to the level of production (decoupling); this single payment scheme aims to guarantee farmers more stable incomes. Farmers can decide what to produce in the knowledge that they will receive the same amount of aid, allowing them to adjust production to suit demand. In 2008, further changes were made to the CAP, building on the reform package from 2003.

The Europe 2020 strategy offers a new perspective on economic, social, environmental, climate-related and technological challenges and future agricultural reform is likely to be made in relation to the goals of developing intelligent, sustainable and inclusive growth, while taking account of the wealth and diversity of the agricultural sector within the EU Member States. As part of this process, the European Commission launched a public debate on the future of the CAP during 2010. Its outcome, coupled with input from the European Council and Parliament led the Commission to present a Communication in November 2010, titled „The CAP towards 2020: meeting the food, natural resources and territorial challenges of the future" (COM 2010).

In December 2013, this latest reform of the CAP was formally adopted by the European Parliament and the Council. Among the main elements of the CAP post-2013 are a fairer distribution of direct payments (with targeted support and convergence goals), revisions to public intervention and private storage aid, and continued support for rural development. (Eurostat statistics explained 2016).

Models of agricultural prices

In countries where agricultural commodities have a relevant weight in the GDP commodities, prices represent important variables in the economy. Accrued estimations of these prices are very important, because they can influence government's plans, macroeconomics policies as well as financial planning for economic agents involved in the commodity production chain. Government can use agricultural forecast to design national and regional polices providing technical and market support to agricultural sector. Furthermore forecasts can improve the decision making process of production and marketing for farmers and purchasing and storing for agribusiness industries, improving their performance. Some developing countries have great part of its exports returns generated by primary agricultural commodities. Price volatility affects macroeconomic performance, influencing the country overall economy. Agricultural prices forecasts have a major role in such countries, because macroeconomic policies are formulated considering the forecasted prices as a major factor (Adalto et.al. 2014).

Labys (2006) divides the forecast models into two categories: structural approachand nonstructural approach. Structural approach includes models based on interaction among endogenous markets. These models are based on microeconomics, econometrics and modeling theories. Nonstructural approach encompasses models with a single economic sector and prices are independent of other market variables. Inside the structural approach, four classes of models can be defined: time dependent variable; trend-breaks; cyclical behavior and volatility. Time dependent process includes models that explain the dependent variable using its on lagged values. Trend-breaks are models that explain separately trends, seasonality, cyclical and irregular factors. Cyclical behavior includes models of price cycles and volatility models analyze price variances (Adalto et.al. 2014). One of such models is ARIMA model.

Producing reliable forecasts is often a key objective in agricultural economics research. A reliable forecast should be unbiased or at least consistent, should provide a narrow confidence interval for the expected value of the economic variable of interest, and should incorporate confidence bands that adequately portray the likelihood of the variable's occurrences. Time-series models have been widely used for these purposes. Among them, the generalized autoregressive conditional heteroskedastic process (GARCH) and its predecessor, the autoregressive conditional heteroskedastic process (ARCH), have proven useful for modeling a variety of time-series phenomena because many time-series variables exhibit autocorrelation as well as dynamic heteroskedasticity. Some of these variables, however, are also non-normally distributed. Agricultural economics applications of standard GARCH models include analyses by Moss (1992), and by Moss et al. (1990) proposed a non-normal-error GARCH model of speculative prices and rates of return based on the Student-t distribution (t-GARCH), which is leptokurtic but symmetric. Yang and Brorsen (1992), concerned with the non-normality of daily cash prices, explored the use of a mixed diffusion-jump process, a deterministic chaos model, and the t-GARCH model to explain the stochastic behavior of these prices. They concluded that, while the t-GARCH model gives the best explaination for daily cash price behavior, "it is not well calibrated" because it cannot explain all of the observed non-normality – referring to the t-GARCH model's inability to account for the skewness in the distribution of cash prices. Because most GARCH applications occur with small- or moderatesized samples, a flexible specification which can accommodate both error-term skewness and kurtosis is important to improve the reliability of quasi-maximum likelihood estimation of GARCH models. To address the problem of unreliable quasi-maximum likelihood estimation of GARCH models, Wang et al. (2002) have recently proposed an asymmetric-error GARCH model based on the Exponential Generalized Beta 2 (EGB2) family of distributions and applied it in the modeling of exchange rates [Ashutosh 2013].

Simple price forecast models such as naïve, or distributed-lag models have performed quite well in predicting agricultural commodity prices. Other models such as "deferred future plus historical basis" models, autoregressive integrated moving average (ARIMA) models and composite models lead to more accurate estimates. However, as the accuracy increases, so does the statistical complexity. Practical applications of more complex models are limited by the lack of required data and the expense of data acquisition. On the other hand, the increased volatility in agricultural commodity prices may increase the difficulty of forecasting accurately,making the simple methods less reliable and even the more complex forecast methods may not be robust in this new market environment. To overcome these limitations, machine learning (ML) models can be used as an alternative to complex forecast models. ML theory is related to pattern recognition and statistical inference wherein a model is capable of learning to improve its performance on the basis of its own prior experience. Examples of ML models include the artificial neural networks (ANNs), support vector machines (SVMs) and relevance vector machines (RVMs). ML models have been applied in financial economics modeling. Enke and Thawornwong (2005) used data mining and ANNs to forecast stock market returns. Co and Boosarawongse (2007) demonstrated that ANNs outperformed exponential smoothing and ARIMA models in forecasting rice exports. Also ML models have been applied in forecasting agricultural commodity prices. Shahwan and Odening (2007) used a hybrid between ANNs and ARIMA model to predict agricultural commodity prices (Ticlavilca et al. 2010). We believe that in modeling price gap naïve, linear models will performe quite well since the price gap series have normal distribution and they are stationary (don't have unit roots).

Methodology

One important strand of recent changes in agricultural policy has been to move away from price support mechanisms, so that prices reflect more accuratelymarket forces and changes in supply and demand [Office for Official Publications of the European Communities 2002]. The purpose of the price indices designed and compiled by EUROSTAT with the help of the Member States is to provide information on trends in producer prices of agricultural products and purchase prices of the means of agricultural production. They are intended to facilitate comparisons between trends in producer prices and trends in purchase prices of the means of agricultural production. They cannot, however, express differences between the Member States in terms of absolute agricultural price levels. (Office for Official Publications of the European Communities 2002). The index of producer prices of agricultural products (output index) is based on the sales of the agricultural products, and the input index is based on the purchases of the means of agricultural production. In the first stage long-term price indices (from 1980 to 2014) were computed basing on EUROSTAT (Economic Accounts for Agriculture) and FAOSTAT agricultural prices data for all available agricultural products and outlays in the EU-27 countries. Then aggregated indices were weighted with a volume of production or intermediate consumption on thebasis of the averageprice indicesfor the respectiveoutputs or inputs (c.f table 1).

Table. 1 Independent variables (prices indices related to the previous year) used in price gap regression

Outputs:	Respective EUFADN code	Inputs:	Respective EUFADN code
Cereals	SE140	Total intermediate consumption	SE305, 330, 331, 275
Protein crops	SE145	Seeds and planting stock	SE285
Potatoes	SE150	Energy; lubricants	SE345
Sugar beet	SE155	Fertilisers and soil improvers	SE295
Oil-seed crops	SE160	Plant protection products, herbicides, insecticides and pesticides	SE300
Industrial crops	SE165	Feedingstuffs	SE310, 320
Vegetables & horticulture	SE170	Maintenance of materials	SE340
Fruits	SE175	Maintenance of buildings	SE340
Citrus fruit	SE180	Agricultural services	SE350
Wine and grapes	SE185		
Olives & olive oil	SE190		

Outputs:	Respective EUFADN code	Inputs:	Respective EUFADN code
Forage crops	SE195		
Cows' milk	SE216		
Beef and veal	SE220		
Pigmeat	SE225		
Sheep and goats	SE230		
Poultrymeat	SE235		
Eggs	SE240		
Total output crops & crop production	SE135		
Total output livestock & livestock products	SE206		
Total output (agricultural goods output)	SE131		

Source: own elaboration using on the basis of Eurostat (Economic Accounts for Agrculture) and Faostat databases

In the second stage, we performed a cluster analysis of 27 EU countries, based on a representative sample of farms selected from the EU Farm Accountancy Data Network (EUFADN) withe regard to the use of land factor. After elimination of collinearity[2], the following independent variables remained in the analysis:

- the economic size, in ESU[3];
- the utilized agricultural area (UAA) in ha;
- set-aside land area in ha;
- fallow land area in ha;
- area of forests in ha;
- net added value (NAV) per ESU.

[2] Variables characterized by very high or almost complete correlation were removed.

[3] The ESU (European Size Unit) is a standard gross margin of €1200 that is used to express the economic size of an agricultural holding or farm. For each activity (or "enterprise") on a farm (for example wheat production, dairy cows or the output from a vineyard), the standard gross margin (SGM) is estimated based on the area used for the particular activity (or the number of heads of livestock) and a regional coefficient. The sum of all such margins derived from activities on a particular farm is its economic size, which is then expressed in European Size Units (by dividing the total SGM in euro by 1200, thus converting it to ESU). Eurostat, *http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Glossary:ESU* (accessed 16 July 2013)

On this basis, 136 average farms from representative sample for various regions of the EU-27 (representing together 4 919 580 farms in 2012) were divided into classes according to a cluster analysis[4]. Ward's tree clustering method has been applied.

Cluster analysis is a multivariate statistical technique that entails the division of a large group of observations into smaller and more homogeneous groups. Ward's method, an agglomerative hierarchical clustering procedure, bases on least-squares criteria and minimizes the within-cluster sum of squares, thus maximizing the within-cluster homogeneity (Everitt et al., 2011). In general, this method is regarded as very efficient.

The farms' structures were hierarchically arranged and divided into four classes (Fig. 1). The disjointness of the clusters was verified using the Silhouette index *S(i)*recommended by Gatnar and Walesiak (Gatnar, Walesiak 2004):

$$S(i) = \frac{b(i)-a(i)}{max\,[a(i);b(i)]} \qquad (2)$$

where:
a(i) is the average distance of the object *i* from other objects in the class *P* identified under the given division,
b(i) is the average distance of the object *i* from objects in the class *R* situated closest to that object, according to the adopted classification. The index *S(i)* takes values in the range <0,1>, and the critical level was taken to be 0.5.

In the third stage we estimated linear, naïve models for the chosen countries (Greece, Ireland, Portugal against France, Great Britain and Denmark) using the LS method of multiple regression (backward stepwise procedure). We have tested the distribution of the dependent variable (i.e. the price gap index[5] related to the previous year) and of the residuals, as well as a stationarity of the time series, serial correlation and coefficients of tolerance for depending variables which measure their co-linearity. We have also computed the correlation matrices for the significant independent variables considering that they are stationary. Since price models usually base on log-linear functions (Malpezzi 2003), there are premises to argue that simple linear function reflects in a better way a variation of the price gap. The scatter plots for the price gap and the agricultural prices confirmed that assumption.

[4] Sampling was performed by EUFADN National Liaison Agencies, according to the Classification rules defined and formally established by the Commission Regulation (EC) No 1242/2008 of 8 December 2008 (Official Journal of the European Union, L 335 p. 3, 13.12.2008)

[5] Price gap index = index of agricultural goods output / the index of total intermediate consumption.

Results

Cluster analysis

Land as a production factor is of much greater importance in agriculture than in other sectors. It performs the function of both the location of the farm and the means of production (Poczta, Mrówczyńska, 2002). Compared with other continents, Europe has a relatively high proportion of agricultural land (over 50% of the total land area). This land encompasses a strip of lowlands in the moderate climatic zone from the Atlantic coast to the Ural Mountains. While more meadows and pastures are located in the eastern part of Europe, long-term plantations cover the southern areas. The quality of soil varies significantly, from quite fertile brown soil in the west to weak podzolic soil in the central part, and to very fertile chernozem soil in eastern areas (Wiking, 2013).

In the division of European regions analysed by A. Matuszczak (2013) according to features relating to the land factor, the two most numerous classes – the first and the second – are considerably dominant.

The first class includes primarily farms from the French, German, Danish, British and Finnish regions. As such, it provides support for the first hypothesis stated in the introduction, in respect of the existence of a common management model for the old EU-15 countries and a homogenous agrarian structure. Based on the values of the descriptive statistics, the farms in this class (from regions in the countries that first adopted the mechanisms of the common agricultural policy) can be described as average farms within the EU (that is, they are the most similar to the averages obtained for the entire analysed population).

In the second class, the dominant farms are those from regions in countries that joined the EU relatively late (Poland, Lithuania, Hungary, Ireland, Bulgaria, Romania) and where, as such, agriculture is still an important sector of the national economy[6], as well as regions in the south of Europe (Italy, Greece and Spain). Relative to the total population of farms analysed, the agrarian structure here is fragmented – both the average economic size and the area of utilized agricultural land are three times smaller than the average and three times smaller than for farms in the first class. The area of leased agricultural land is relatively small, and the level of afforestation is the lowest in Europe. Against a background of low values characterizing land resources in this class, the profitability indices per ESU and per ha UAA are above the average values. In fact, on average, they are twice as high as on an average farm throughout the EU regions.

[6] In these countries, agriculture still makes a relatively high contribution to the GDP, there is still a high level of employment in agriculture, etc.

The third class consists of regions in Latvia, Estonia, Austria and Slovenia, as well as a few Italian regions, where the area of agricultural land is nearly two times smaller and farms' economic power three times smaller than the average. The farms in this group also have the highest afforestation index (six times higher than the average). These features, however, do not prevent the attainment of an income from a family farm at a level similar to the average in the EU, or an NAV that is twice as high as the average. Presumably, such results are connected with the fact that these regions are significant beneficiaries of agri-environmental funds.

The fourth class includes farms from regions in eastern Germany and Sweden, and a few regions in northern Italy and Slovakia, for which the key measures relating to the land factor (economic size, area of UAA and area of leased UAA) are over five times higher than for the average farm in the EU regions. Unfortunately, the efficiency ratios connected with the land factor on these farms are not consistent with the scale of land resource use. In fact, the values of these ratios are exceptionally unfavourable, especially in the case of family farm income per ha UAA and per ESU, which is nearly six times lower than the average. These poor results can be attributed to the types of production dominant in these regions.

Regression for the cluster 1

We are going to discuss the results in the following order:

1) A fit of the model and significant variables (a direction of the impact, partial correlations).
2) Descriptive statistics.
3) Normality tests, a serial correlation and tolerance coefficients.
4) Marginal effects for independent variables.
5) Correlation matrix.

All models are well fitted (c.f. tables 2–4). The coefficients of determination accounts for the R^2= ,96395164 in France to the R2= ,82588130 in Denmark. According to the partial correlations, the strongest positive impact (on the side of the outputs) is attributed to the prices of cereals (including seeds), potatoes, vegetables and horticultural products in France, vegetables, horticultural products and cattle in GB and again vegetables, horticultural products and pigs in Denmark. On the side of the inputs, the strongest negative impact concerns prices of maintenance of buildings in France, feedingstuffs in GB and fertilisers and soil improvers in Denmark (c.f. tables 2–4).

In terms of descriptive statistics, the price gap mean for the long-period is slightly below 1 (i.e. 0,99) in France and GB which means that agricultural prices were unfavorable for farmers. At the same time, the standard deviation is low (0,04 in France and 0,03 in GB) as well as the coefficient of variation

Table 2. Regression for the price gap in agriculture in France (1981–2014)

N=34	Regression Summary for Dependent Variable: Price Gap (Spreadsheet-France_ost) R= ,98181039 R2= ,96395164 Adjusted R2= ,94592746 F(11,22)=53,481 p					
	b	**Std.Err.of b**	**PartialCor**	**Tolerance**	**t(22)**	**p-value**
Intercept	1,521825	0,089873	-	-	16,93314	0,000000
Energy; lubricants*	0,001301	0,000299	-0,679850	0,350954	-4,34823	0,000258
Fertilisers and soil improvers	0,000914	0,000198	-0,701005	0,612480	-4,61049	0,000136
Maintenance of buildings	0,009246	0,001125	-0,868582	0,486330	-8,22128	0,000000
Cereals (including seeds)	0,001769	0,000149	0,929817	0,553099	11,85044	0,000000
Sugar beet	0,000809	0,000232	0,596141	0,625967	3,48265	0,002110
Vegetables and horticultural products	0,003264	0,000611	0,751541	0,488510	5,34351	0,000023
Potatoes	0,000423	0,000051	0,871830	0,713543	8,34866	0,000000
Citrus fruits	0,000370	0,000082	-0,692300	0,688467	-4,49990	0,000178
Pigs	0,000799	0,000211	0,628137	0,479270	3,78642	0,001014
Sheep and goats	0,002928	0,000546	-0,752926	0,468065	-5,36622	0,000022
Milk	0,002670	0,000467	0,772890	0,379515	5,71308	0,000010
Price gap mean	**0,990361**					
Std.Dev.	0,043240					

Coef.Var	4,366130							
Minimum; Maximum	0,896078; 1,123849							
Normality tests	K-S d=,09440, p> .20; Lilliefors p> .20 Shapiro-Wilk W=,96994, p=,45972							
Durbin-Watson d; Serial Corr.	1,957915; 0,010513							
Average marginal effects (for absolute value of b)	0,002227							
Correlation matrix for significant variables**								
Var.	**Cereals (including seeds)**	**Sugar beet**	**Vegetables and horti-cultural**	**Potatoes**	**Citrus fruits**	**Pigs**	**Sheep and goats**	**Milk**
Energy; lubricants	0,273447	0,227849	**0,414652**	0,064306	-0,062467	**0,567296**	0,121954	**0,514147**
Fertilisers and soil improvers	**-0,365476**	0,069371	0,125536	-0,104423	0,026791	**0,363023**	0,060058	-0,065954
Maintenance of buildings	0,213800	0,194677	**0,583191**	0,185993	0,025512	**0,392369**	0,274355	**0,372694**

* the inputs are marked in grey, ** significant correlations are bolded for α=0,05.

Source: own computations using STATISTICA 11 on the basis of Eurostat (Economic Accounts for Agrculture) and Faostat databases

Table 3. Regression for the price gap in agriculture in Great Britain (1981–2014)

N=33	Regression Summary for Dependent Variable: 'Price Gap' R= ,91756614 R2= ,84192761 Adjusted R2= ,78923682 F(8,24)=15,979 p					
	b	Std.Err. of b	PartialCor	Tolerance	t(24)	p-value
Intercept	0,942945	0,103816	-	-	9,08284	0,000000
Fertilisers and soil improvers*	-0,000619	0,000194	-0,546433	0,533016	-3,19636	0,003875
Plant protection products, herbicides, insecticides and pesticides	-0,002105	0,000598	-0,583237	0,692166	-3,51749	0,001764
Feedingstuffs	-0,003641	0,000821	-0,671295	0,161899	-4,43700	0,000174
Other goods and services	-0,002915	0,000764	-0,614332	0,716362	-3,81421	0,000841
Cereals (including seeds)	0,001679	0,000463	0,595211	0,200820	3,62872	0,001338
Vegetables and horticultural products	0,003481	0,000538	0,797273	0,625401	6,47067	0,000001
Cattle	0,002218	0,000379	0,766774	0,516611	5,85186	0,000005
Milk	0,002370	0,000567	0,649280	0,345911	4,18225	0,000332
Price gap mean	**0,9966**					
Std.Dev.	0,034264					
Coef.Var	3,422670					
Minimum; Maximum	0,914226; 1,082524					

Normality tests	K-S d=,12304, p> .20; Lilliefors p> .20 Shapiro-Wilk W=,96304, p=,31427			
Durbin-Watson d; Serial Corr.	2,290049; -0,163652			
Average marginal effects (for absolute value of b)	0,0023785			
Correlation matrix for significant variables**				
Var.	**Cereals**	**Vegetables and horticultural**	**Cattle**	**Milk**
Fertilisers and soil improvers	**0,458676**	0,031912	**0,512550**	**0,613442**
Plant protection products	0,052686	**0,443735**	0,050944	0,057184
Feedingstuffs	**0,848813**	0,136357	**0,603125**	**0,757196**
Other goods and services	**0,421424**	0,340054	0,093596	0,241537

* the inputs are marked in grey, ** significant correlations are bolded for α=0,05.

Source: own computations using STATISTICA 11 on the basis of Eurostat (Economic Accounts for Agrculture) and Faostat databases

Table 4. Regression for the price gap in agriculture in Denmark (1981–2014)

N=34	Regression Summary for Dependent Variable: Price Gap (Spreadsheet-Denmark_ost.sta) R= ,90878011 R2= ,82588130 Adjusted R2= ,77016331 F(8,25)=14,823 p					
	b	**Std.Err. of b**	**Partial-Cor.**	**Toleran-ce**	**t(25)**	**p-value**
Intercept	0,611414	0,189647	-	-	3,22396	0,003504
Fertilisers and soil improvers*	-0,002533	0,000463	-0,738299	0,639273	-5,47316	0,000011
Feedingstuffs	-0,004186	0,001429	-0,505618	0,299927	-2,93025	0,007135
Maintenance of materials	-0,017975	0,004319	-0,639763	0,157492	-4,16203	0,000326
Maintenance of buildings	0,017024	0,004401	0,611904	0,152189	3,86824	0,000694
Industrial crops	0,002262	0,000781	0,501424	0,487276	2,89773	0,007709
Vegetables and horticultural products	0,004253	0,000838	0,712192	0,742710	5,07270	0,000031
Pigs	0,002431	0,000496	0,700146	0,778627	4,90298	0,000048
Milk	0,002907	0,001091	0,470288	0,465745	2,66448	0,013306
Price gap mean	**1,017504**					
Std.Dev.	0,066241					
Coef.Var	6,510143					
Minimum; Maximum	0,872000; 1,176938					

Normality tests	K-S d=,08874, p> .20; Lilliefors p> .20 Shapiro-Wilk W=,98072, p=,79528			
Durbin-Watson d; Serial Corr.	1,871523; 0,050677			
Average marginal effects (for absolute value of b)	0,006696375			
Correlation matrix for significant variables**				
Var.	**Industrial crops**	**Vegetables and horticultural**	**Pigs**	**Milk**
Fertilisers and soil improvers	0,044407	0,251177	**0,351340**	0,191219
Feedingstuffs	**0,605930**	0,201552	0,322341	**0,674761**
Maintenance of materials	0,198847	0,332793	0,054562	0,297787
Maintenance of buildings	0,194507	0,181483	0,110219	0,293591

* the inputs are marked in grey, ** significant correlations are bolded for α=0,05.

Source: own computations using STATISTICA 11 on the basis of Eurostat (Economic Accounts for Agrculture) and Faostat databases

(4,3% in France and 3,4% in GB). On the other hand, the average price gap exceeds 1 (i.e. 1,02) in the long-term in Denmark. Meanwhile, the coefficient of variation is much higher (i.e. 6,6%) than in the previous countries which means that the agricultural prices were more volatile (c.f. tables 2–4). That result can be explained by the level of specialization in farming which is also higher in Denmark.

Considering the assumptions of LS method, they have been fulfilled in all countries. The normality tests confirmed the normal distribution of the dependent variable (c.f. tables 2–4) The tolerance coefficients prove that the contribution of the independent variables to the model is essential and that there is no problem of a co-linearity. The Durbin-Watson statistics indicate very weak serial correlation that has also been supported by the ADF tests (units roots were not found).

As regards the marginal effects, they are quite weak in absolute values. For example, the rise of the price index for cereals in France by 1% (*ceteris paribus*) causes the improvement of the price gap by 0,002 (0,2%, c.f. tables 2–4, "b" coeff.). However, we observe an interesting regularity, i.e. the marginal effects for inputs are mainly negative while they are usually positive for the outputs. A similar conclusion can be derived from the analysis of the correlation matrix for the significant variables: all correlations of the inputs and outputs prices are positive with one exception of the fertilizers and crops in France.

Regression for the cluster 2

We follow the same order of the analysis as above.

All models are well fitted too (c.f. tables 5–7). The coefficients of determination accounts for the R2= ,97147877 in Portugal to the R2= ,88271170 in Greece. The strongest positive impact (on the side of the outputs) is exerted by the prices of vegetables, horticultural products and olive oil in Greece, wine, cereals and pigs in Portugal and cattle and milk in Ireland. Such results have been expected taking into account a specialization of agriculture in these countries. On the side of the inputs, the strongest negative impact is related to the prices of energy in Greece, feedingstuffs in Portugal, and fertilisers in Ireland (c.f. tables 5–7).

The price gap mean for the long-period is slightly above 1 in all countries from the cluster 2 which means that agricultural prices were favorable for farmers in long-term. This proves a quite interesting conclusion considering the fact that farms in these countries are fragmented and rather weak from the economic point of view. At the same time, the standard deviations as well as the coefficients of variation are higher than in the cluster 1 which means that the agricultural prices were more volatile (c.f. tables 5–7).

Table 5. Regression for the price gap in agriculture in Greece (1981–2014)

N=34	Regression Summary for Dependent Variable 'Price Gap': R= ,93952738 R2= ,88271170 Adjusted R2= ,86176736 F(5,28)=42,146 p					
	b	**Std.Err.of b**	**PartialCor.**	**Tolerance**	**t(28)**	**p-value**
Intercept	0,733342	0,078444	-	-	9,34862	0,000000
Energy; lubricants*	-0,001646	0,000395	-0,618376	0,856536	-4,16364	0,000271
Other goods and services	-0,001598	0,000488	-0,526340	0,901800	-3,27557	0,002810
Industrial crops	0,001090	0,000321	0,539669	0,746044	3,39202	0,002085
Vegetables and horticultural products	0,003118	0,000444	0,798710	0,667181	7,02388	0,000000
Olive oil	0,001551	0,000295	0,704213	0,722083	5,24845	0,000014
Price gap mean	**1,014775**					
Std.Dev.	0,066909					
Coef.Var	6,593460					
Minimum; Maximum	0,874881; 1,145100					
Normality tests	K-S d=,11092, p> .20; Lilliefors p> .20 Shapiro-Wilk W=,96059, p=,25302					
Durbin-Watson d; Serial Corr.	2,275115; -0,159426					
Average marginal effects (for absolute value of b)	0,001801					

Correlation matrix for significant variables**

Var.	Industrial crops	Vegetables and horticultural	Olive oil
Energy; lubricants	0,088973	0,199801	**0,341040**
Other goods and services	-0,135361	-0,143181	0,147145

* the inputs are marked in grey, ** significant correlations are bolded for α=0,05.

Source: own computations using STATISTICA 11 on the basis of Eurostat (Economic Accounts for Agrculture) and Faostat databases

Table 6. Regression for the price gap in agriculture in Portugal (1981–2014)

N=34	Regression Summary for Dependent Variable 'Price Gap' R= ,98563623 R2= ,97147877 Adjusted R2= ,95907823 F(10,23)=78,342 p					
	b	Std.Err.of b	PartialCor.	Tolerance	t(23)	p-value
Intercept	0,966586	0,028472	-	-	33,9485	0,000000
Seeds and planting stock*	-0,000824	0,000143	-0,769353	0,588108	-5,7757	0,000007
Feedingstuffs	-0,005184	0,000289	-0,965983	0,284204	-17,9140	0,000000
Maintenance of buildings	0,003314	0,000413	0,858280	0,312757	8,0209	0,000000
Other goods and services	-0,002073	0,000269	-0,849013	0,320058	-7,7062	0,000000
Cereals (including seeds)	0,001234	0,000166	0,840899	0,395779	7,4517	0,000000
Protein crops (including seeds)	-0,000593	0,000167	-0,595563	0,667161	-3,5556	0,001683
Vegetables and horticultural products	0,001444	0,000264	0,751991	0,378117	5,4711	0,000015
Potatoes (including seeds)	0,000190	0,000054	0,592379	0,742797	3,5262	0,001809
Wine	0,001593	0,000163	0,897781	0,774546	9,7756	0,000000
Pigs	0,001182	0,000178	0,811302	0,459108	6,6553	0,000001
Price gap mean	**1,002353**					
Std.Dev.	0,054916					
Coef.Var	5,478753					

Minimum; Maximum	0,885041; 1,135576				
Normality tests	K-S d=,11648, p> .20; Lilliefors p> .20 Shapiro-Wilk W=,98153, p=,81950				
Durbin-Watson d; Serial Corr.	2,519127; -0,265177				
Average marginal effects (for absolute value of b)	0,0017631				
Correlation matrix for significant variables**					
	Protein crops	**Vegetables and horticultural**	**Potatoes**	**Wine**	**Pigs**
Seeds and planting stock	0,224992	**0,500465**	0,023504	0,165257	0,250611
Feedingstuffs	**0,420142**	**0,376264**	0,186090	0,068588	**0,402674**
Maintenance of buildings	**0,402245**	**0,492627**	0,228976	0,216408	**0,452959**
Other goods and services	**0,452108**	**0,501038**	0,317670	0,160763	**0,535120**

* the inputs are marked in grey, ** significant correlations are bolded for $\alpha=0,05$.

Source: own computations using STATISTICA 11 on the basis of Eurostat (Economic Accounts for Agrculture) and Faostat databases

Table 7. Regression for the price gap in agriculture in Ireland (1981–2014)

N=34	Regression Summary for Dependent Variable 'Price Gap': R= ,98162086 R2= ,96357950 Adjusted R2= ,95548606 F(6,27)=119,06 p					
	b	**Std.Err.of b**	**PartialCor.**	**Tolerance**	**t(27)**	**p-value**
Intercept	0,980323	0,079573	-	-	12,31976	0,000000
Fertilisers and soil improvers*	-0,001320	0,000229	-0,742972	0,390883	-5,76792	0,000004
Feedingstuffs	-0,002655	0,000520	-0,700864	0,234198	-5,10559	0,000023
Maintenance of buildings	-0,002127	0,000652	-0,531591	0,664589	-3,26118	0,003001
Cereals (including seeds)	0,000462	0,000121	0,592693	0,466766	3,82371	0,000704
Cattle	0,003350	0,000205	0,953169	0,764525	16,37637	0,000000
Milk	0,002460	0,000221	0,906232	0,481218	11,13796	0,000000
Price gap mean	**1,000414**					
Std.Dev.	0,046981					
Coef.Var	4,696146					
Minimum; Maximum	0,916816; 1,118661					
Normality tests	K-S d=,10854, p> .20; Lilliefors p> .20 Shapiro-Wilk W=,97594, p=,64168					
Durbin-Watson d; Serial Corr.	2,087203; -0,058186					
Average marginal effects (for absolute value of b)	0,00206					
Correlation matrix for significant variables**						
Var.	**Cereals**		**Cattle**		**Milk**	
Feedingstuffs	**0,460136**		**0,469446**		**0,601096**	
Fertilisers and soil improvers	-0,229452		0,278799		0,065317	
Maintenance of buildings	-0,262104		-0,127763		-0,090392	

* the inputs are marked in grey, ** significant correlations are bolded for α=0,05.

Source: own computations using STATISTICA 11 on the basis of Eurostat (Economic Accounts for Agrculture) and Faostat databases

Considering the assumptions of LS method, they have been also fulfilled in all countries of the cluster 2. The normality tests confirmed the normal distribution of the dependent variable (c.f. tables 5–7) The tolerance coefficients don't indicate any co-linearity, however**,** they are in general lower than in the cluster 1. The Durbin-Watson statistics indicate weak serial correlation (from -0,26 to -0,05).

The marginal effects are also weak in absolute values but an important finding is that they are almost two times lower on average than in the cluster 1 (c.f. the row "average marginal effects" in tables 5–7) . The regularity showing that the marginal effects for inputs are mainly negative whereas they are positive for outputs has been confirmed. The same conclusion as above comes from the analysis of the correlation matrix for the significant variables: the correlations of the inputs and outputs prices are mainly positive with the exception of the fertilizers and crops.

General conclusions

The existence of agricultural price index serves various purposes such as: economic analysis, for estimating general price trends and their relationship with other pertinent variables, for example for the study of domestic price changes in relation to prices observed in external markets, or the movement of agricultural commodity prices compared with the purchase of the means of agricultural production. Another goal is to monitoring the implementation of support prices policy decisions, such as the introduction or modification of support prices, intervention prices, etc. (Food and Agriculture Organization 1988). The agricultural prices indices are mainly used by governments for planning and policy formulation in the agricultural sector, for monitoring of price trends, economic analysis and national accounting. Other business organizations and enterprises use them as well, for planning trade flows, stock levels, investment and related credit demand, and individual farmers use them for planning the structure of production, investment, etc. in view of the price trends and outlook. In this article we used them to estimate the price gap in long-term and its drivers considering different agrarian structures over the EU. The regression models for the countries representing the most significant cluster in Europe pointed out the following findings:

- the prices of significant outputs have in general positive influence on the price gap, while the impact of inputs' prices is mainly negative;
- the positive correlation of inputs and outputs prices has been noticed (apart from the fertilizers and crops);
- the average price gap for the long-term is close to 1 in both clusters but in the cluster 1 slightly unfavorable for farmers and in the cluster 2 the opposite;

- the average marginal effects of the independent variables are two times stronger in the cluster 1 than in the cluster 2.

These observations provoke further discussion and they can be interpreted in several ways. They refute the myth about a long-term depreciation of the small farms by the market prices and by theopeningof theprice scissors. We can see that intensive agriculture is more affected by the market fluctuations. Why the correlation of inputs and outputs prices is mainly positive? We can assume that upward swings of agricultural prices are exploited by the suppliers of the means of agricultural production since they react with rising prices; or maybe higher prices of commodities boost the demand for inputs**.** There is a need for further research in this field.

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Abstract

The index of *agricultural goods output* comprises weighted changes of prices of agricultural commodities whereas *the index of intermediate consumption* describes fluctuations of outlays' prices such as seeds and planting stock, energy, fertilizers, soil improvers, plant protection products or feedingstuffs. The relation of these two indices is defined as "price gap" or "price scissors". There is a lot of price models for agricultural goods investigated in the subject literature. However**,** the issue of modeling drivers for the price gap has been rarely explored. For that reason authors aim to estimate long-term regression models of the agricultural price gap for different European countries that represent varied agrarian structures. The analysis entails few stages. In the first stage,the long-term price indices (from 1980 to 2014) were computed basing on EUROSTAT and FAOSTAT agricultural prices data for all available agricultural products and outlays in the EU-27 countries. Then, the aggregated indices were weighted with a volume of production or intermediate consumption on thebasis of the averageprice indicesfor the respectiveoutputs or inputs. In the second stage, a cluster analysis was performed with regard to the utilization of a land factor by individual farms in the subsequent European countries. In the third stage, three countries were chosen for case studies from the each of the distinguished clusters and the econometric models of price gap were estimated where the indices of outputs and inputs are independent variables. An interesting finding was discovered that marginal effects for price gap drivers are much stronger in the countries of an intensive and large scale agriculture (as France, Great Britain and Denmark) than in the countries of fragmented agrarian structures such as Greece, Portugal and Ireland.

Key words: agricultural prices, price gap, price scissors

Czynniki wpływające na rolniczą lukę cenową w różnych strukturach agrarnych UE

Streszczenie

Indeks produkcji towarów rolniczych obejmuje ważone zmiany towarów rolnych podczas gdy *indeks konsumpcji pośredniej* opisuje fluktuacje cen produktów takich jak nasiona i rośliny, energia, nawozy, polepszacze gleby, środki ochrony roślin i pasze. Relacja między tymi dwoma indeksami jest definiowana jako "luka cenowa" lub "nożyce cenowe". Istnieje wiele modeli cenowych przebadanych dla towarów rolniczych w literaturze przedmiotu, jednakże sprawa czynników modelujących lukę cenową jest rzadko poruszana. Z tego powodu autorzy zamierzają oszacować długoterminowy model regresji luki cenowej dla rolnictwa różnych krajów europejskich reprezentujących zróżnicowane struktury agrarne. Niniejsza analiza zawiera kilka etapów. W pierwszym, długoterminowe indeksy cenowe (od 1980 do 2014) zostały obliczone przy użyciu danych cen rolnictwa według EUROSTAT i FAOSTAT dla wszystkich dostępnych produktów i nakładów w krajach EU-27. Następnie indeksy są ważone zgodnie z poziomem produkcji lub konsumpcji pośredniej na podstawie średnich indeksów cenowych dla odpowiedniej wielkości wejściowej lub wyjściowej. W drugim etapie została dokonana analiza klasterowa w odniesieniu do czynnika ziemi przez indywidualne farmy w kolejnych krajach europejskich. W trzecim kroku zostały wybrane trzy kraje z wybranych grup (klasterów) i modele ekonomiczne luk cenowych zostały oszacowane gdzie indeksy wartości wejściowych i wyjściowych były zmiennymi niezależnymi. Dokonano interesującego spostrzeżenia, że efekty marginalne czynników luk cenowych są znacznie silniejsze w krajach o intensywniejszym i wielkoskalowym rolnictwie (jak Francja, Wielka Brytania i Dania) niż w krajach of rozczłonkowanej strukturze rolnej jak Grecja, Portugalia i Irlandia.

Słowa kluczowe: ceny produktów rolnych, luka cenowa, nożyce cenowe

Факторы, влияющие на разрыв цен на сельскохозяйственные в различных структурах аграрного ЕС

Краткое содержание

Индекс производства сельскохозяйственной продукции включает в себя взвешенное изменение сельскохозяйственных товаров, в то время как индекс промежуточного потребления описывает колебания цен на продукты, такие как семена и растения, энергии, удобрений, почвы улучшителей, пестицидов и кормов для животных. Отношения между этими двумя показателями определяется как «ценовой разрыв» или «ножниц цен». Есть много моделей ценообразования, проверенные на сельскохозяйственные товары в литературе, однако, факторы материи моделирования ценовой разрыв редко перемещается. По этой причине авторы намерены оценить долгосрочную регрессионной модели ценовой разрыв для сельского хозяйства различных европейских стран, представляющих разнообразную аграрную структуру. Этот анализ включает в себя несколько этапов. В первом случае, долгосрочных индексов цен (с 1980 до 2014 года) не были рассчитаны с использованием данных цен сельского хозяйства Евростатом и ФАОСТАТ для всех доступных продуктов и инвестиций в ЕС-27. Затем индексы взвешиваются в соответствии с уровнем производства или промежуточного потребления на основе средних индексов цен для соответствующего размера входа или выхода. На втором этапе был сделан Кластерный анализ в отношении фактора земли отдельными хозяйствами в других европейских странах. На третьем этапе были отобраны из трех стран, выбранных групп (кластеров) и экономические модели были оценены ценовых разрывов, где индексы входных и выходных значений были независимыми переменными. Там было интересное наблюдение, что влияние маргинальных факторов ценовых разрывов гораздо сильнее в странах с интенсивным и крупного сельского хозяйства (как Франции, Великобритании и Дании), чем в фрагментированной структуры сельского хозяйства, как Греции, Португалии и Ирландии.

Ключевые слова: цены на сельскохозяйственную продукцию, ценовой разрыв, ножницы цена

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