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A short descriptive analysis of the European evolutions of input price indices of agricultural products between 2008 – 2017: patterns, trends and implications

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Abstract

Background: The evolutions of the inputs price and investment indices of the products in agriculture are not only determinant elements in understanding the fluctuations of the food price and the market instability, specific to the agricultural sector but also affects the agricultural production and traceability. Analyzing the European evolutions of the inputs price indices of agricultural products offer the possibility to understand the main trends and tendencies in the agricultural system by reviling the main trend tenancies during a nine year period long.

Purpose: The main aim of the study is to investigate the evolution of input price indices of agricultural products in order to underline the specific patterns, trends and implications of the agricultural policies. In addition, the research pays a special attention to the investigation of the Romanian agricultural policy evolution on the most relevant time frame of economic conformity with the European agricultural model. The descriptive analysis is based on the specific annual datasets of price indices of the means of inputs in agricultural production, and the index of real prices of goods and services for investments in agriculture during 2008 – 2017, reported to 2010 as the baseline year.

Findings/conclusions: The analyses confirms that the agricultural sector evolution has generated significant input and investment prince changes and unprecedented trend evolutions that led to the massive changes on the agricultural pattern. We strongly advocate and recommend for promoting a solid capacity and durable

agricultural production systems and policies through sustainable and long term investments in order to avoid disruptive tendencies in the agricultural market system.
Limitations/future research: The research explore the evolutions of the inputs price and investments indices of the products in the European agriculture only form the descriptive analysis without covering an extensive framework or considering other additional variables which consist the main limitation of this study. In a future research the authors will address and extend the research framework by inserting additional variables and items and propose a large and integrative model of analysys.

Keywords
Agriculture, products, input price, evolution, market, volatility.

Introduction

Obtaining competitive, advantageous pricing policies with a low level of food prices requires the adoption of resilient measures to improve the food supply and production chain and, at the same time, to increase the efficiency and competitiveness of the agricultural sector. In the literature of this domain there are numerous papers that argue the need to increase the competitiveness of agriculture by improving the price mechanism as in (Serra, Goodwin & Featherstone, 2005; Sckokai & Moro, 2006; Cardwell, 2015; Saghaian, Nemati, Walters & Chen, 2018; Hill, 2018; Dong, 2019). Such an approach would require a constructive trajectory of the production and supply chain, especially from the perspective of maintaining the price/value ratio that remains at a realistic level to reflect the specific phenomena of the agricultural market.

In a market economy, the production processes specific for agriculture feature a special complexity arising not only from the functionality of the processes of this economic branch, but also from the nature of the mobilised factors, of the attracted resources that give a certain dynamics and complexity. The agricultural production process is a dynamic one, defining certain traceability along the entire value chain. The transformation of the acquired production factors, for example of the inputs into final products to be traded on the market, requires a certain production time, a certain production process and a certain market value. This is how prices of products (PP) and factors of production (FP) are formed in the mix of market forces traded on the market, which include the production effort and the newly created value.

Obtaining and anticipating low prices in the agricultural production chain requires not only the application of adequate management in terms of inputs and training of primary production factors, but also a wide capacity for innovation and investment in the agricultural sector. Gohin and Zheng (2020) argue that, by their nature, price and source risk expectations are often neglected in static analyses, while the dynamic analyses often argue with a high degree of generality that they are critical. On the other hand, the realization of the production imposes a combination and use of the production factors as close as possible to the optimum, having in the background an adequate training of these factors, which validates exclusively the immediate benefits generated by the low prices.

As argued in Timmer, 2002; Webb and Block, 2012; Andrei and Drăgoi, 2019 and Nowak and Różańska-Boczula, 2022, the analysis of the role, place, and influence of the agricultural sector and agriculture in general in the contemporary economy cannot be achieved without a deep understanding of the system of specific sectoral flows and determinants.

The performance of agriculture and its ability to provide the necessary volumes of food, raw materials and fodder are inextricably linked to the evolution of agricultural inputs. From this perspective, the evolution of agricultural performance at the European level is closely linked to the manifestations and restrictions imposed by both the Common Agricultural Policy (CAP) and national specificities. From the perspective of economic practice, it is often impossible to restrict the decision to attract new factors of production into the system, and agricultural consumption is determined by the production structure, the type of production, the targeted volume or the production system, without listing the influencing factors exhaustively. Identifying ways to mitigate or even reduce factors that have a low degree of influence or that do not adequately reflect the demand for agricultural products is essential, given that food production and food security of the population is important. As evidenced by Manski (2004) there have been many debates about the nature of farmers' expectations regarding the evolution of prices and the degree to which they compensate the effort, and, more generally, about the expectations

of trading entities regarding the evolution of the market.

The structural factors that determine and contribute equally to the increase in agricultural prices, including inputs, persist over a medium period of time and the fluctuations generated highlight an increase in the degree of volatility of both input and output agricultural prices. Agricultural markets are volatile and they have a considerable absorption of the increase in demand in global markets, being even less predictable in terms of evolution or behaviour. As Hansen (2022) argues, the supportive mechanism shown in the case of market prices and payments to compensate for market dysfunctions are two very important tools in agricultural policy at the European level. Specialized studies (Berry & Schlenker, 2011; Hendricks, Smith & Sumner, 2014; Miao, Khanna & Huang, 2016; Haile, Brockhaus & Kalkuhl, 2016) show that the elasticity of output and input can be understood and applied as sectoral policy tools.

Adaptation to the demand-driven mechanism caused by speculative price manipulation, including input, is severely affected by the limitation of the level of flexibility often incompatible with the characteristics and potential of agricultural production and the degree of effective absorption in the market. Analysing the relationship between energy prices and agricultural products by applying the self-regressive vector model (VECM), Nemati (2017) clearly demonstrates the existence of a long-term decisive relationship between these price categories, especially an intensification for the period 2007–2014.

The reduction of the amplitude of the volatility of prices of agricultural products can be achieved through an adequate management of the input prices, the ratio being a direct and immediate one, with significant consequences in the sphere of production.

The special attention to and focus on the immediate benefits of low prices can often be detrimental to the production system, if due attention is not paid to the system and the mix of inputs as (Bojnec & Swinnen, 1997; Solakoglu & Civan, 2006; Ucak, 2012) claim. Fluctuations in agricultural input prices affect not only the agricultural sector in particular but also the whole economy. Through food prices, all consumers are affected, and from the upstream branch perspective, the other economic branches that use agricultural production as input are affected as well. At the same time, abrupt, difficult-to-control and major fluctuations lead to and impose the need to rethink the position of the agricultural sector in the ensemble of modern economies (Anderson, Cockburn & Martin, 2010).

The correction of the imbalances occurring and existing in the relations specific to the food supply chain generates the need to adopt some functional sectoral policy measures that would contribute to a resilient positioning of the agricultural sector against the consequences of the accentuated opening and liberalization of the national markets. The analysis of the European evolution of the inputs price indices of agricultural products is a topical subject, with multiple influences, which, although they were given special attention in the dedicated literature and specialized studies, still arouse a deep interest. From this perspective, the central objective of this research is the analysis of the European evolution of the inputs price indices of the products in agriculture, from the perspective of the global sectoral transformations. In addition to the introductory section, the paper contains the data and methodology section, the results and discussion section, and ends with the conclusions and references sections. It is therefore structured in a classic, traditional way, trying to offer an integrative approach on the analysed subject. From the perspective of the research subject, it comes in line with the specialized literature, specific to the domain of analysis of agricultural products, in our case the subject of agricultural inputs. The understanding of the evolution of the prices of the inputs of the products in agriculture offers conclusive information for the thorough understanding of the price formation mechanisms for agricultural products, of their fluctuations, and of the impact by which they determine consumers' behaviour patterns.

2. Data, materials and methodology

In this context, one of the ways of analysing and understanding the specific mechanisms of agricultural production and evaluating the intimate specificity of achieving market stability is the analysis of the evolution of real price indices of the inputs of agricultural production processes. In order to achieve the objective of this research, meaning, to deepen, compare and understand the role and place of Romanian agriculture in the European agricultural environment from the perspective of the prices of the inputs of the production processes in agriculture, we decided to

use data compatibility and sustainability, Eurostat database. For this purpose, the data series "Price indices of the means of agricultural production, input (2010 = 100) - annual data" and "Index of real prices of goods and services for investments in agriculture" (2010 = 100 - annual data) were selected and presented in the table below:

Table 1 Description of the variables used and their units of measurement, 2008-2017

Variables	Significance of variables	UM
INCRT_08	Index of real prices of goods and services currently consumed in agriculture (input_1) in 2008, (initial year of analysis)	%
INCRT_12	The index of real prices of goods and services currently consumed in agriculture in 2012	%
INCRT_17	The index of real prices of goods and services currently consumed in agriculture in 2017	%
ININV_08	Index of real prices of goods and services for investment in agriculture (input_2) 2008, (initial year analysis)	%
ININV_12	The index of real prices of goods and services for investments in agriculture, in 2012	%
ININV_17	The index of real prices of goods and services for investments in agriculture, in 2017	%

Source: the authors' own selection based on Eurostat database

On the other hand, although, with the exception of the INCRT_17 variable, the other variables do not have a normal distribution, the very small differences between the mean and median values lead to the conclusion of a uniform distribution of the variable values.

3. Results and discussion. European developments in the input price index of agricultural products.

The first picture of the evolution of indices for real prices of goods and services currently consumed in agriculture (INCRT) and of the goods and services prices for investment in agriculture (ININV) is given by the characteristics of the data series corresponding to them (Table 2).

The first and very important conclusion, resulting from the analysis of the characteristics of the data series on the real prices indices of agricultural inputs, in all the three reference years, is that the averages (mean) of the variables at EU28 level are representative and, as a result, cluster analysis is no longer required. This is evidenced by the low values of the variation coefficient (VC), as well as of the dispersion values (Simple Variance) and the standard error (Standard Error).

Table 2 Main features of the data series on real indices of agricultural input prices for 2008, 2012 and 2017

	INCRT_08	INCRT_12	INCRT_17	ININV_08	ININV_12	ININV_17
Mean	111.07	110.80	99.74	106.56	99.63	103.05
Standard Error	1.26	0.69	0.83	5.20	1.51	1.24
Median	110.65	111.05	99.95	100.05	98.95	101.35
Standard Deviation	5.91	3.63	4.38	23.27	7.97	6.58
Sample Variance	34.98	13.15	19.20	541.57	63.58	43.31
Kurtosis	2.25	8.91	0.65	15.70	22.07	4.55
Skewness	1.22	-2.17	-0.20	3.85	4.42	1.12
Minimum	102.50	96.40	89.80	95.70	91.30	86.90
Maximum	127.50	117.50	109.60	200.50	138.20	125.00
Cnf. Level (95.0%)	2.62	1.41	1.70	10.89	3.09	2.55
VC (%)	5.33	3.27	4.39	21.84	8.00	6.39

Source: the authors' own computations

On the other hand, although, with the exception of the INCRT_17 variable, the other variables do not have a normal distribution, the very small differences between the mean and median values lead to the conclusion of a uniform distribution of the variable values.

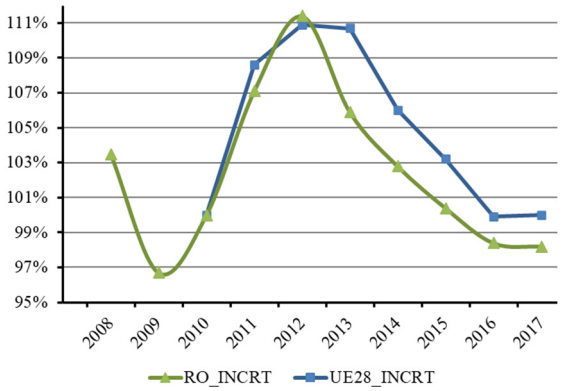

Figure 1 Evolutions of real price indices of goods and services currently consumed in agriculture in Romania and the EU28 in the period 2008-2017 (2010 = 100%)
Source: the authors' calculations

In the period 2008-2017, the index of the real prices of goods and services currently consumed in agriculture in Romania (RO_INCRT) had a fluctuating evolution (Figure 1).

After a decrease by 6.8 percentage points, from 103.5% to 97.5% in 2009 (3.3 percentage points less than in the base year 2010), a period of increase in RO_INCRT followed, reaching 111.4% in 2012. One of the causes of the increase is the economic and financial crisis that started in 2009.

It is notable that the increase in real prices of this input in the agriculture of Romania is in line with the increase in the average annual index of real prices of goods and services currently consumed in agriculture in the EU28, the differences being insignificant.

From 2013 until the end of the analysed period, there is a trend of stability, both in Romania and at EU28 level, so that they reach, in the case of the EU28 average, the level recorded in 2010; in Romania they reached a level just 0.2 percentage points lower than in 2010. A positive fact is that the reduction of real prices of goods and services currently consumed in agriculture in Romania happened at a faster pace than in the European Union. This feature remained constant from 2013 until the end of the analysed period.

In relation to the other states included in the analysis, from the point of view of the index of real prices of goods and services currently consumed in agriculture (input_1) calculated on the basis of 2010 (INCRT), Romania was in the group of states where INCRT recorded relatively low values, which is a positive fact.

Thus, in 2012, only Cyprus recorded a lower value compared to 2010 (96.4%), while in the other states (Figure 2) INCRT values went up from 2010 values in a range between 107.6% in Sweden, and 117.5% in Lithuania.

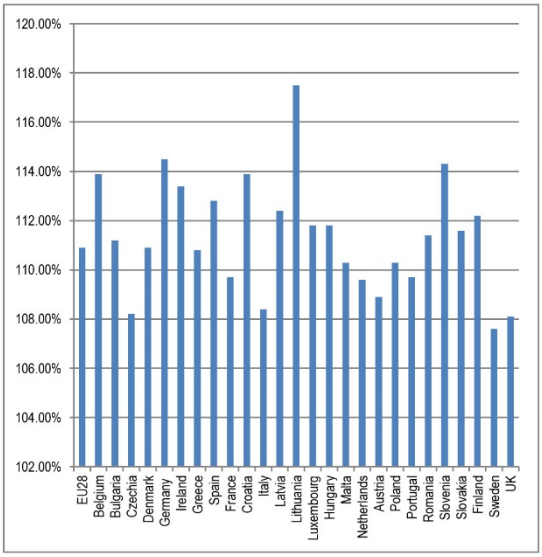

Figure 2 Romania's place among the EU28 states, with the exception of Cyprus, in terms of INCRT values in 2012, compared to 2010.
Source: the authors' calculations

Romania, in 2012, recorded an INCRT value of 111.4%, ranking 14th, 0.5 percentage points above the EU28 average (110.9%) and 3.8 percentage points higher than Sweden. It should be noted that Romania, in terms of INCRT value, recorded in 2012, is ahead of countries such as Spain (by 1.4 percentage points) and Germany (by 3.1 percentage points).

The economic developments in the EU28 countries during the period from 2012 to 2017 have led to changes in the positions occupied in relation to the changes in the index of real prices of goods and services currently consumed in agriculture. This period was one of return to economic stability, so that while in 2012 only Cyprus recorded lower INCRT values compared to 2010 (100%), in 2017, the number of countries increased to 14.

In 2017, INCRT values, compared to 2010, ranged from 89.8% in Slovakia to 109.6% in Denmark (Figure 3).

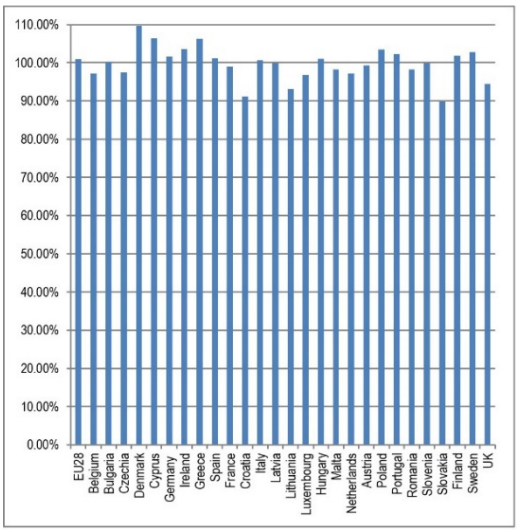

Figure 3 Romania's place among the EU28 states, in terms of INCRT values in 2017, compared to 2010.
Source: the authors' calculations

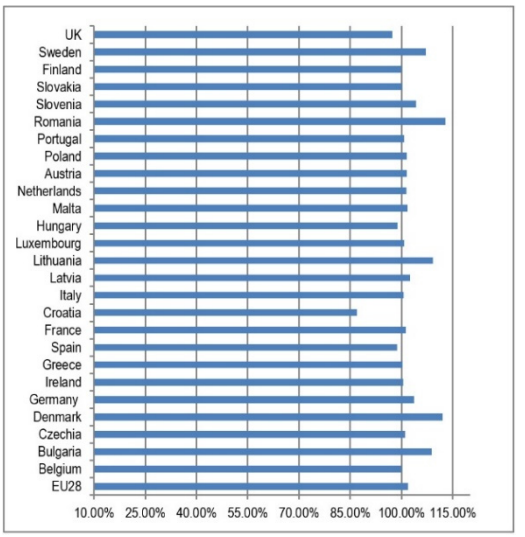

Figure 4 The places occupied by Romania among the EU28 states, in terms of ININV values in 2012 and 2017, compared to the values recorded in 2010.
Source: the authors' calculations

In the new hierarchy, Romania comes 10th, with an INCRT value of 98.2% (1.8 percentage points below the EU28 average), ahead of countries such as France (by 0.9 percentage points), Spain (by 3.0 percentage points), Germany (by 3.4 percentage points) or Poland (by 5.3 percentage points), although in 2012, France and Poland were ahead of Romania.

If there were favourable results from the point of view of INCRT in Romania, the same cannot be said about the evolution and position of Romania within the EU28 from the point of view of the index of real prices of goods and services for investments in agriculture (ININV).

From the point of view of the second category of inputs, regarding the index of real prices of goods and services for investments in agriculture, in Romania the 2012 value on record was 99.5% of the 2010 value, 0.02 percentage points above the EU28 average. ININV values for EU Member States in 2012 ranged from a low of 91.3% in Slovakia to a high of 138.2% in Lithuania. It should be noted that the value recorded in Lithuania, which is the last, is an exception given that in Malta, the penultimate state in the classification, the ININV value was 102.7%.

In terms of position among the other EU states, Romania held the 17th place in 2012, with Hungary in the second place with an ININV_12 value of 92.6%, and Bulgaria coming fifth with an ININV_12 value of 95.8%.

A specific feature of 2012 is the fact that in 20 EU countries the values of the indices of real prices of goods and services for investment in agriculture were lower than in the top year (2010 = 100%) and, with the exception of Lithuania, the others exceeded very little the value of 100%.

In the period 2012-2017, in contrast to the tendency of stability in terms of prices in the first category of inputs (INCRT), the ININV was marked by divergent tendencies, meaning that, while in some states there were reductions in the real prices of goods and in the investment services in agriculture, in others the trend was to increase them.

In 2017, the lowest value of ININV was recorded in Croatia (86.9%) and the highest in Cyprus (125.0%). Due to the very high value of ININV registered in Cyprus, which placed this state on the last place in terms of performance for this criterion, compared to the ININV value of 112.8%, recorded in the penultimate state in terms of this performance criterion (Romania), Cyprus is not entered in Graph 2.14.b.

Unlike in 2012, a characteristic of ININV in 2017 is that most EU countries have higher values of real prices of goods and services for investment in agriculture than in 2010, as demonstrated by the existence of 21 values of ININV greater than 100%, including the EU28 average (101.8%).

Regarding Romania, the period 2012-2017 was particularly unfavourable for agriculture due to the significant increase in the prices of goods and services for investment. While in 2012 the value of ININV was 99.5% of the one recorded in 2010, in

2017 the value of investment was just 25.5% higher.

Rising prices of agricultural inputs generally affect small producers, who have to allocate a significant share of their revenues to purchasing inputs and starting agricultural production. This phenomenon is specific and indissolubly linked to the degree of development and solidity of the agricultural sector, which leads to rising food prices, including a limited access to the specific market. On the other hand, the high level of agricultural input price also affects the level of inflation in EU28 member states. Although agricultural input prices have a degree of sensitivity to market information, they may remain volatile and sometimes difficult to adapt.

As can be seen from the analysis, the fluctuation of agricultural input prices is also determined by the existence of possible major dysfunctions in the production and supply chain with production factors, including the ability to produce food.

The dispersion and evolution of prices at specific agricultural inputs closely and equally reflects the ability of each link in the production and supply chain to protect and promote its specific interests.

According to Muflikh, Smith, Brown and Aziz (2021), the high volatility of prices in agricultural goods often bear a negative effect on the business entities that operate along the value chain in agriculture. Due to this, the prices of agricultural inputs trigger a long sequence of factors in contemporary agricultural systems, adding to their dynamics and complexity. Several dedicated studies (De Roest, Ferrari & Knickel, 2018; Morales, 2018; Lanfranchi, Giannetto, Rotondo, Ivanova & Dimitrova, 2019; Yan, Cai, Lin & Ambaw, 2021; Viganò, Maccaroni & Righi, 2022) claim that the analysis of inputs price indices of agricultural products makes it necessary to render a no lesser attention to the degree of volatility of this category of prices, which, in agriculture as a complex economic system, must be able to reflect the sector's capacity to mobilise specific resources. When analyzing the drivers of grain price volatility, (Gaetano, Emilia, Francesco, Gianluca & Antonio, 2018) point out that a thorough analysis of the critical factors of price instability is mandatory, because the interpretation of the curve of prices of farm inputs will help predict the role and dynamics of demand and supply for agricultural produce in complex economic markets.

Conclusions

The analysis of the evolution of agricultural product input price indices at EU28 Member State level reflects the significant, massive and important changes that the European agricultural sector has undergone over the period of reference.

During the time span analysed, the index of the real price of goods and services currently consumed in Romanian agriculture had a fluctuating evolution, often in the form of "saw teeth", reflecting the high degree of volatility of sectoral prices, although there was a significant increase of the prices of goods and services for investments in agriculture. At European level, the developments in the positions of the Member States were different, due to significant changes in relation to the real price index of goods and services currently consumed in agriculture as a result of counteracting significant fluctuations in agriculture. From the analyses performed, one can notice, in the entire reference period, but particularly during the time segment 2012-2017, a tendency to return to economic stability, and, along with it, a tendency to stabilize prices. In 2012, only Cyprus recorded lower INCRT values compared to 2010 (100%); in 2017, at the end of the analysed period, the number of states had increased to 14.

Given the data presented in the results and discussion section, we can say that in the case of the two elements analysed – the real prices of goods and services currently consumed in agriculture and real prices of goods and services for investments in agriculture – we can see the evolution of specific sectoral trends and we can better understand the nature of fluctuations in agricultural and food prices in the European space. In this context, the results of the analysis so conducted complement the overall picture deriving from the general survey specific for complex agricultural markets in terms of inputs price indices of agricultural products. An in-depth approach of the central issue of this research may act as the ground for further, extended, research, with a widening of the scope of the data series used herein. The analysis of the inputs price indices of agricultural products opens up more relevant avenues of research, all promising interesting prospects for the entire domain.SM

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