Analysis of the Dynamics of Productive Performance of Organic Farming in the European Union

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Abstract: This research is focused on identifying the potential of organic farming by testing the efficiency of productive yields and identifying pragmatic means to quantify it such as the function of the productive yield of organic farming. The results of the study are concretized in the definition of a new tool (the organic productivity function) and its testing in order to capture the evolution of organic farming in relation to external influencing factors (economic and epidemiological crises) during the analyzed period and the influence of support measures adopted at European level. The study is useful to national and supranational decision makers for adjusting organic agriculture development strategies.

Keywords: organic farming; productive yield; sustainable development

1. Introduction

In the context of the Green Deal, with reference to organic farming, proposals have been launched for development strategies based on competitive rationales [1] to ensure the sustainable development of food production and consumption while minimizing the impact on the environment and ensuring the well-being of the population.

Under the European Biodiversity Strategy, the shift to organic farming by 2030 [2] involves restoring habitats and ecosystems by limiting the risk of pesticide use and increasing the area under organic farming. Thus, the future of the CAP in Europe becomes certain which, for the period 2023–2027 [3], reforms policies to support the transition towards sustainable agriculture and forestry in the EU, maximize opportunities to move to organic farming, and contribute to the Green Deal and rural development objectives including improving competitiveness.

Improving competitiveness is mainly based on increasing agricultural performance by strengthening cooperation in production, orienting towards the agricultural green market and creating new financial reserves amounting to at least €450 million per year.

In this context, we consider the approach of productivity of organic farming to be of real interest, and our scientific approach is based on research objectives anchored in the current performance context as follows:
O1: Determining the trends of evolution at national level compared to the European average for representative indicators of effectiveness and efficiency in the branch, respectively; index of the real income of factors in ecological agriculture per annual work unit; organic producers registered at the end of the year; and organic crop production by crops.

O2: Identifying performance models proposed in the scientific literature.

O3: Creating an organic agricultural performance function and integrating it into an econometric model.

O4: Testing, validating, and proposing implementation of the econometric model.

We appreciate that the function proposed as a novel element of the research is of real interest to specialists and decision makers and that it will contribute to better performance monitoring that it will ultimately ensure faster achievement of Green Deal and CAP targets.

Some authors [4] show that eco-efficiency can be achieved through the rational and eco-friendly use of utilities (energy, water) while limiting the use of fertilizers and pesticides, reducing greenhouse gas emissions, and reducing pollution.

Another approach to organic farming is presented by [5] in relation to food security and environmental objectives. The authors produce an overview of prohibited and required activities in both the agricultural and livestock production segments. The result of applying this strategy is to increase the quality of organic production.

Other authors [6] map European countries in which the eco-farm models were applied. According to the authors, organic farming models are successfully implemented in France, Greece, and Spain. However, in Romania and the Baltic States, the performance of organic farming is very low and there is no uniform model applied to ensure the sustainability of agriculture in these countries.

The paradigm of sustainable development of organic vs. conventional agriculture is analyzed by [7], who show that among the unfavorable factors that hinder sustainable prospects and generate production variability are intensive use of fertilizers, lack of use of organic farming practices, re-introduction of new technologies, and intensive use of herbicides and pesticides.

Analyzing the risks and opportunities of growing organic agriculture, the authors [8] consider that in order to ensure the sustainability of organic production, the principles must be approached in a novel way. This could be achieved by using new nutrients provided by agricultural crops through newly discovered plants in combination with recycling of residues, improving renewable resources by limiting the impact of fertilizers, and changing agricultural production from livestock to less polluting alternative sources.

In the opinion of some authors [5], organic farming benefits from added sustainability compared to conventional farming, with a large number of farmers who would like to switch to organic practices. The authors believe that organic agriculture is not a paradigm for sustainable development and food security but a smart combination of conventional and novel methods that contribute to sustainable productivity growth in global agriculture.

In the authors’ opinion [9], modelling the impact of productivity as a result of conversion to organic farming can be achieved by means of a programmable model; the authors carried out this study for England and Wales. The model can be applied, but it requires significant changes in diet and reductions in food waste. As a result of the study, the authors show the dependence of the organic system on the quality of the stealers/producers but also on the logistics of production which can add transport costs and increase the risk of product spoilage.

Global food security and population health goals are undergoing major changes in the current context according to [10]. In addition to climate change and the characteristics of conventional agriculture that require extensive use of irrigation and fertilization, mankind is facing an increasing demand for nutrients, and thus, pressure on the agricultural system. Switching to organic farming is a strategy for providing healthier food and reducing environmental impact.
A topic of interest in organic agriculture is the study of climate change which, in their opinion [11], generates complex causal relationships between production factors and climate change. At EU level, a number of countries such as Austria, Denmark, Finland, Ireland, Netherlands, and Sweden are part of the high-performance cluster of sustainable agriculture. In the low performance cluster are Croatia, Greece, Italy, Slovakia, and Romania. These countries, in particular Greece, have been affected by extreme weather events that have had a negative impact on all agricultural production.

Some authors [12] argues on the basis of the 2030 Agenda for Sustainable Development that agricultural practices should be adapted to these goals and proposes a policy framework to provide tools to make the proposed transition a reality. Thus, in the author’s opinion, based on the sustainability curve, supportive measures are needed for the implementation of performance-enhancing transformations in the sector (organic and agro-ecological agriculture) to increase citizens’ awareness of the benefits of using sustainable products, follow up improvements, including financial support measures, and to create a legal framework with specific rules and requirements for the agricultural sector.

Other authors [13] conducts an impact study on organic food supply chains, showing that logistics costs and marketing barriers decrease the competitiveness of products offered by organic farms in developed countries. The authors use modeling to simulate fair distribution and profit generation among organic food supply chains. This approach allows to decrease the logistic cost pressure and increase the benefits of peer-to-peer sharing features.

In a meta-analysis on organic agriculture, the authors [14] highlight the benefits of organic farming development in terms of environmental impact but there are some shortcomings related to production variability. Thus, at lower yields, organic production achieves similar production costs to conventional systems and promotional measures are needed to increase the consumer’s choice to consume organic products. The authors present in an interesting econometric manner the correlations between the main elements of yield, costs, and benefits, showing that the environmental component is the most important benefit of promoting organic farming, while costs and diversity of production remain at low levels of correlation. In the same way, [15] makes a classification of the importance of economic and non-economic factors of organic farming in Poland. The study shows that farmers’ perceptions of organic farming development face institutional and communication barriers that affect farmers’ management decisions. These barriers relate to legislative instability, which entails risks of uncertainty and a need for coherent public policy support for organic production.

The authors [16] analyze, through an impact study, agricultural practices and highlight the apparent antagonism between productivity and environmental performance. The analysis focuses on Ecosystem Service which shows large variation under conservation agriculture.

A meta-analysis (153 articles) by [17] is focused on Governing Transitions towards Sustainable Agriculture. The authors point out that the fundamental need for change to achieve sustainability goals manifests itself in the agricultural sector in terms of technological elements, habitats, and the environment, but also in terms of commercial and legislative structures. The main issues facing global agriculture are urbanization, food crises, R&D, reducing environmental impact, and increasing quality of life.

Agricultural entrepreneurship is, in their opinion [18], a solution for the sustainable development of the sector. It highlights the regional disparities both in terms of agricultural policy and in terms of sustainable development, as well as emphasizing through meta-analysis that agricultural entrepreneurship is much more exposed to stress and it is influenced by the particularities and approaches in organic agriculture which are not similar to those in other economic sectors, for example in the industry.

An efficiency model based on identifying and maximizing the advantages offered by organic farming and reducing until eliminating disadvantages and vulnerabilities is carried out by [19] in an interesting approach. It highlights organic farming as a desideratum
but also as a way to achieve environmental objectives (decreasing fossil fuel consumption, reducing greenhouse gas emissions, stabilizing and reducing soil erosion) and quality objectives by improving soil quality and increasing soil fertility and nutrients. However, these issues need to be addressed in a competitive manner as they are threatened by increasing pressure on the management of entities both due to the need for a rigorous technical approach (soil management) and the need for a competitive commercial approach; competition with conventional firms is strong and cost is a disadvantage of organic production.

In another approach based on the objectives of sustainable development, the authors [20] propose new ways in which the distribution of organic products can reach consumers’ requirements and gain their trust. The authors identify the importance of marketing in this area and conclude that development is inherently linked to agricultural marketing. Thus, they show that consumer opinions, the trust-based relationship between producers and distributors of organic products, and the aggressive MK to stimulate sales in the sector are significant prerequisites for improving the consumption of healthy products and the development of the organic agricultural market.

In their opinion [21], eco-efficiency in EU agriculture relies mainly on technological progress which should ensure protection from the risks of climate change impacts and limit regional disparities.

Analyzing circular economy policies, [22] conducted qualitative and quantitative research to determine the dichotomy between policies and solutions at the ecological and sustainable level. The results of the study show that, as far as green public procurement is concerned, only 50% of the proposed actions were carried out in 2021. With regard to Goal 12 of the Sustainable Development Strategy (Elimination of food waste) compared to the proposed 2030 targets, there 70 million tonnes of waste per year which is not yet targeted for 2030.

In Europe, the situation of agricultural producers in organic farming is analyzed [23] for the period 2007–2018 and shows that there is low European production potential compared to conventional farms and a less favorable relationship between production factors and production itself. Moreover, the productive yields of organic livestock farms are even lower and bring economic results far below expectations. The authors conclude that there is a high level of economic inefficiency of organic farms and their dependence on public support.

Some authors [24] conduct a systematic review of the influencing factors for the adoption of organic farming, showing that there is a classification of influencing factors in the literature that contains household factors, psycho-behavioral and social factors, support factors, and factors related to farmers’ experiences in the field. Thus, based on this classification, the authors argue that producer associations play a significant role in organic farming. Within the framework of associations, the conditions for sustainable development can be created by increasing the support offered by government bodies.

In this context, the taxation of organic farming becomes, in their opinion [25], a significant factor for the development of the sector and it must be based on a system of tax incentives for organic production. The same approach is presented in a study on regional development as a factor of sustainable development where the authors [26] highlight the impact of fiscal policies and the constant need to update them in order to develop economic entities as a factor of sustainability.

A study of the literature indicates that organic farming is subjected to multiple vulnerabilities, in particular due to the low efficiency of economic yields (in competition with conventional agriculture) and the intensity of management actions required for the vitality of this sector which is dependent on public aid.

2. Materials and Methods

We aim to define the organic agricultural performance function following research into the performance indicators of organic farming, as reported by Eurostat [25]. Through
the study of the database for the period 2012–2021, it was possible to identify the main changes in the dynamics of organic production indicators at Member State level as follows:

As far as the dynamics of organic producers are concerned, we note that the biggest producers of organic products are Italy, Spain, France, and Greece. Poland and Romania recorded the most significant decline in this chapter, and Germany the greatest progress;

In terms of processing capacity, processors are mainly found in countries such as Germany, France, and Italy, while the opposite is true for Malta and Romania;

Importers of organic products operate in countries such as Germany, Italy, and the Netherlands. However, in the context of maximizing production in Italy, the number of importers decreased by 50% between 2012 and 2021;

Organic farming as a factor of economic growth through exports is maximizing its effects in Italy, Germany, and Spain. However, there was a shift in the ranking of the top three exporters over the period, with Germany improving its performance by about 30%, while Italy decreased its number of exporters by 35%;

Organic agricultural production is at good and very good levels in Italy, France, Germany, Austria, and Romania. At the other end of the scale, low yields are recorded in northern countries or in countries that are at a disadvantage due to soil aridity (Malta);

In terms of organic livestock capacity, the main producers are Germany, France, Denmark, Greece, and Italy.

Following the dynamic analysis of European organic production capacities, certain regional disparities have emerged which should be reduced in order to achieve the Green Deal and CAP targets uniformly in all Member States. In this respect, we formulate the following working hypotheses:

According to [23,25], the non-performance of organic agriculture is closely linked to the branch’s dependence on state financial support. In this sense, we define a hypothesis as follows:

**H1:** Periods of economic crisis which interfere with the productivity of organic farming, generating systemic changes in yields as resources are relocated according to the need for financial support for the continued operation of the industry.

In their opinion [23], organic farming faces multiple challenges as the economic yield of this branch is low at EU level. Thus, we can hypothesize H1 as follows:

**H2:** Periods of food crisis significantly influence the yield of organic agricultural production in the sense of decreasing it.

According to [7], the promotion of conventional farming techniques has a direct negative effect on agricultural productivity both through negative effects on the environment and by decreasing the quality of production. We can define a hypothesis as follows:

**H3:** Increasing the centralized promotion of organic farming through European policies and strategies contributes to reducing the negative impact of conventional agricultural development measures and indirectly increases the productivity of the sector.

The analyzed indicators allowed the authors to create a consolidated database, which analyzed dynamics in the period 2021–2021 that could favor the modelling of the organic agricultural performance function, a function that from a methodological point of view can be represented according to the following formula:

\[ F = \frac{\bar{Y}_{E,Q}}{\bar{Z}_{E,P}} = \alpha \cdot Q + \beta \]

\[ \gamma \cdot P + \delta \]

\( F = \) organic agricultural performance function (dependent variable DEPIVER).
\( \bar{Y}_{E,Q} = \) regression function of economic yield adjusted with variation in organic agricultural productivity.
\( \hat{Z}_{E,P} \) = regression function of economic efficiency adjusted with the variation of the labor factor expressed in number of organic producers per year and Member State.

\( \alpha, \beta, \gamma, \delta \) = regression coefficients of the function.

\( Q \) = organic agricultural productivity expressed in tonnes of organic cereals (OCrop) produced in each Member State per year.

\( P \) = number of organic producers (OAGProducer) per Member State and year.

To build the econometric model, statistical modelling procedures were applied to the consolidated database using the least squares method and linear regression using SPSS 25 statistical software.

The results are described in the next section.

3. Results

By applying the methodology, we have projected the organic efficiency function of organic farming for the period 2012–2021 using the consolidated database.

The carried-out observations allowed the identification of changes in the dynamics of productive yields both in terms of the value of agricultural production and in terms of quantitative indicators such as the level of production and the number of organic producers. The analysis was carried out on 27 Member States \((n = 27)\) and the results are interpreted in the Table 1.

### Table 1. Components of the organic productivity function averaged.

<table>
<thead>
<tr>
<th>Year</th>
<th>( \text{OCrop (Organic Agricultural Productivity Expressed in Tonnes of Organic Cereals)} )</th>
<th>( \text{OAGProducer (Number of Organic Producers)} )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Equation (^{(^DEPVAR_{\text{year}})})</td>
<td>Std. Errors</td>
</tr>
<tr>
<td>2012</td>
<td>+7.89×OCrop2012</td>
<td>2.46</td>
</tr>
<tr>
<td>2013</td>
<td>+11.7×OCrop2013</td>
<td>2.65</td>
</tr>
<tr>
<td>2014</td>
<td>+11.2×OCrop2014</td>
<td>2.65</td>
</tr>
<tr>
<td>2015</td>
<td>+10.6×OCrop2015</td>
<td>2.65</td>
</tr>
<tr>
<td>2016</td>
<td>+9.03×OCrop2016</td>
<td>2.68</td>
</tr>
<tr>
<td>2017</td>
<td>+8.67×OCrop2017</td>
<td>2.58</td>
</tr>
<tr>
<td>2018</td>
<td>+9.39×OCrop2018</td>
<td>2.61</td>
</tr>
<tr>
<td>2019</td>
<td>+10.7×OCrop2019</td>
<td>2.77</td>
</tr>
<tr>
<td>2020</td>
<td>+11.0×OCrop2020</td>
<td>2.98</td>
</tr>
<tr>
<td>2021</td>
<td>+10.8×OCrop2021</td>
<td>3.13</td>
</tr>
</tbody>
</table>

Source: Own calculation on the basis of SPSS 25.

Based on the regression functions, at the level of 2012, the efficiency level of the productive regression function was 7.89 euro/tonne for each additional tonne produced, while the labor efficiency level was one step higher, i.e., 10.9 euro/tonne for each new
producer entering the system. This data allows the configuration of the organic yield function for 2012 as follows:

\[ F_{2012} = \frac{7.89 \times \text{OCrop2012}}{10.9 \times \text{OAGProducer2012}} = \mu R_{2012} = 0.723R_{2012} \]

\( R \) = productive yield of organic farming in the year under review, \( \mu < 1 \).

According to the function, a subunit \( \mu \) coefficient of the productive output is observed which leads to the assessment of insufficiently efficient approaches in the period being appreciated, according to our opinion, in the light of the socio-economic conditions at that time, namely the exit from the economic crisis, the labor market damage, and the increase of the inflationary phenomenon.

The values of the regression functions for productive output and labor efficiency were modelled using the linear regression method, obtained through one-sided critical probability to test the validation of the model by rejecting the null hypothesis and keeping the alternative hypothesis confirmed by tests of normality of residuals (the error is normally distributed) and a test of heteroskedasticity (the phenomenon is not present). The results are shown in Table 2.

**Table 2. Results of the statistical tests of the models of productive efficiency and labor efficiency.**

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Independent Variable</th>
<th>Coefficient</th>
<th>( p )-Value</th>
<th>Test for Normality of Residuals *</th>
<th>Breusch-Pagan Test for Heteroscedasticity **</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hi Square</td>
<td>( p )-Value</td>
</tr>
<tr>
<td>DEPVAR2012</td>
<td>OCrop2012</td>
<td>7.8907</td>
<td>0.0035</td>
<td>19.0437</td>
<td>7.32342 \times 10^{-5}</td>
</tr>
<tr>
<td>DEPVAR2013</td>
<td>OCrop2013</td>
<td>11.7288</td>
<td>0.0002</td>
<td>9.54357</td>
<td>0.00846527</td>
</tr>
<tr>
<td>DEPVAR2014</td>
<td>OCrop2014</td>
<td>11.2058</td>
<td>0.0003</td>
<td>4.8633</td>
<td>0.0878916</td>
</tr>
<tr>
<td>DEPVAR2015</td>
<td>OCrop2015</td>
<td>10.6495</td>
<td>0.0004</td>
<td>9.3592</td>
<td>0.00928273</td>
</tr>
<tr>
<td>DEPVAR2016</td>
<td>OCrop2016</td>
<td>9.03008</td>
<td>0.0024</td>
<td>4.14594</td>
<td>0.125812</td>
</tr>
<tr>
<td>DEPVAR2017</td>
<td>OCrop2017</td>
<td>8.67395</td>
<td>0.0024</td>
<td>7.13376</td>
<td>0.0282438</td>
</tr>
<tr>
<td>DEPVAR2018</td>
<td>OCrop2018</td>
<td>9.3913</td>
<td>0.0013</td>
<td>4.12213</td>
<td>0.127319</td>
</tr>
<tr>
<td>DEPVAR2019</td>
<td>OCrop2019</td>
<td>10.6847</td>
<td>0.0007</td>
<td>3.23506</td>
<td>0.198388</td>
</tr>
<tr>
<td>DEPVAR2020</td>
<td>OCrop2020</td>
<td>11.0123</td>
<td>0.001</td>
<td>3.22244</td>
<td>0.19964</td>
</tr>
<tr>
<td>DEPVAR2021</td>
<td>OCrop2021</td>
<td>10.7538</td>
<td>0.002</td>
<td>6.82022</td>
<td>0.0330376</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Independent Variable</th>
<th>Coefficient</th>
<th>( p )-Value</th>
<th>Test for Normality of Residuals *</th>
<th>Breusch-Pagan test for heteroscedasticity **</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hi Square</td>
<td>( p )-Value</td>
</tr>
<tr>
<td>DEPVAR2012</td>
<td>OAGProducer2012</td>
<td>10.9205</td>
<td>0.0005</td>
<td>9.15683</td>
<td>0.0102711</td>
</tr>
<tr>
<td>DEPVAR2013</td>
<td>OAGProducer2013</td>
<td>10.3447</td>
<td>0.0004</td>
<td>7.19273</td>
<td>0.0274323</td>
</tr>
<tr>
<td>DEPVAR2014</td>
<td>OAGProducer2014</td>
<td>9.89604</td>
<td>0.0008</td>
<td>5.01604</td>
<td>0.0814292</td>
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<tr>
<td>DEPVAR2015</td>
<td>OAGProducer2015</td>
<td>9.84434</td>
<td>0.0007</td>
<td>8.21048</td>
<td>0.0164861</td>
</tr>
<tr>
<td>DEPVAR2016</td>
<td>OAGProducer2016</td>
<td>9.51867</td>
<td>0.0013</td>
<td>3.82845</td>
<td>0.147456</td>
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<tr>
<td>DEPVAR2017</td>
<td>OAGProducer2017</td>
<td>9.68983</td>
<td>0.0011</td>
<td>3.76469</td>
<td>0.152233</td>
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<tr>
<td>DEPVAR2018</td>
<td>OAGProducer2018</td>
<td>9.40918</td>
<td>0.0013</td>
<td>2.39439</td>
<td>0.302041</td>
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<tr>
<td>DEPVAR2019</td>
<td>OAGProducer2019</td>
<td>9.47625</td>
<td>0.0016</td>
<td>3.20643</td>
<td>0.201249</td>
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<td>DEPVAR2020</td>
<td>OAGProducer2020</td>
<td>9.48646</td>
<td>0.0028</td>
<td>2.26217</td>
<td>0.322684</td>
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<tr>
<td>DEPVAR2021</td>
<td>OAGProducer2021</td>
<td>9.22070</td>
<td>0.005</td>
<td>1.49395</td>
<td>0.473799</td>
</tr>
</tbody>
</table>

* Null hypothesis: the error is normally distributed. ** Null hypothesis: heteroscedasticity is not present.

Similarly, for the year 2013, the organic yield function becomes the following:
It is found that once the economic crisis and its effects are overcome, the coefficient of the productive yield of the function tends to be restored to supra-unit values, ensuring the efficiency of the organic farming sector; the degree of efficiency is maximized under the condition of maximizing the $\mu$ coefficient. This validates the following hypothesis: *Periods of economic crisis which interfere with the productivity of organic farming, generating systemic changes in yields as resources are relocated according to the need for financial support for the continued operation of the industry.*

Based on the regression functions, at the level of 2014, the efficiency level of the productive regression function was 11.2 euro/tonne for each additional tonne produced, while the labor efficiency level was on a higher step, i.e., 9.9 euro/tonne for each new producer entering the system. This data allows the configuration of the organic yield function for 2014 as follows:

$$F_{2014} = \frac{11.2 \cdot \text{Crop2014}}{9.9 \cdot \text{OAGProducer2014}} = \mu R_{2014} = 1.131 R_{2014}, \mu > 1.$$  

For the year 2015, we can observe a slight equalization in the efficiency and effectiveness functions due to the outbreak of risk aspects caused by the influence of epidemics (swine flu and avian influenza) with deaths among the population due to these epidemics.  

Based on the regression functions, at the 2015 level, the efficiency level of the productive regression function was 10.6 euro/tonne for each additional tonne produced, down 10% from the previous year.

$$F_{2015} = \frac{10.6 \cdot \text{Crop2015}}{9.84 \cdot \text{OAGProducer2015}} = \mu R_{2015} = 1.077 R_{2015}, \mu > 1.$$  

For the human resource effectiveness function, the return is constant and maintained at the 2014 level. This validates the following hypothesis:

*Periods of food crisis significantly influence the yield of organic agricultural production in the sense of decreasing it.*

In 2016, due to the continuing effects of swine flu and the security measures adopted at European level, there was a destabilization of the function.

The organic productivity function of organic farming reversed its efficiency coefficient, which becomes a subunit according to the following formula:

$$F_{2016} = \frac{9.03 \cdot \text{Crop2016}}{9.52 \cdot \text{OAGProducer2016}} = \mu R_{2016} = 0.948 R_{2016}, \mu < 1.$$  

The obtained results are supported by statistical tests, as shown in Table 2.  

The year 2017 was marked by multiple events with an impact on organic farming, with food safety committees set up at European level, and European directives developed to monitor events such as the Charter of the EU zoning/emergency measures [27]. The results of the regression functions in Table 1 show that the negative trend in productivity is maintained at 9%, with the efficiency of the labor factor also being affected and with the caveat that the frequency-adjusted series show a higher reflexive inertia for the labor factor than for productive output.

The function can be defined at the 2017 level according to the following formula:

$$F_{2017} = \frac{8.67 \cdot \text{Crop2017}}{9.69 \cdot \text{OAGProducer2017}} = \mu R_{2017} = 0.895 R_{2017}, \mu < 1.$$  

The values of the regression functions for productive output and labor efficiency were modelled using the linear regression method, obtained through one-sided critical probability to test the validation of the model by rejecting the null hypothesis and keeping the alternative hypothesis, confirmed by tests of normality of residuals (the error is normally distributed) and the test of heteroskedasticity (the phenomenon is not present).
Since 2018, organic farming, intensively promoted at EU level through concrete strategies and funding, is back on an upward trend, although still marked by food crisis issues. The function related to this evolution is as follows:

\[
F_{2018} = \frac{9.39 \times \text{OCrop2018}}{9.41 \times \text{OAGProducer2018}} = \mu R_{2018} = 0.998 R_{2018}, \mu \approx 1.
\]

This aspect indicating the revival of productive yield under conditions of public intervention validates the following hypothesis: The intensification of the centralized promotion of organic farming through European policies and strategies contributes to reduce the negative impact of the development measures of conventional agriculture and indirectly increases the productivity of the sector.

The year 2019 marks the first year of organic agricultural productivity in terms of sustainability, adopting measures reaching a maturity in implementation, monitoring structures [28] of sustainability objectives in relation to the reduction of environmental impact, and reduction of pollution have already been created, which leads to an increase in productivity.

The super-unit function is defined as follows:

\[
F_{2019} = \frac{10.7 \times \text{OCrop2019}}{9.48 \times \text{OAGProducer2019}} = \mu R_{2019} = 1.128 R_{2019}, \mu > 1.
\]

Hypothesis H1 is validated by the results obtained in the year 2020, when although, pandemic conditions occurred, the productive output of the function remains at a high level of efficiency.

\[
F_{2020} = \frac{11 \times \text{OCrop2020}}{9.49 \times \text{OAGProducer2020}} = \mu R_{2020} = 1.159 R_{2020}, \mu > 1.
\]

The same positive upward trend is also observed in 2021 against the background of effective intervention measures.

\[
F_{2021} = \frac{10.8 \times \text{OCrop2021}}{9.22 \times \text{OAGProducer2021}} = \mu R_{2021} = 1.171 R_{2021}, \mu > 1.
\]

Additionally, at the level of the static results, we find validation of the model by the one-sided critical likelihood test.

The proposed function has characteristics sensitive to economic and epidemiological risks; it is able to capture the evolution of productive yield through forecasting and to project the future evolution of the dynamics of organic agriculture, contributing to a better systematization of the options of national and supranational decision makers.

### 4. Discussion

Agricultural performance is a European challenge for the implementation of CAP [3] and sustainability objectives [2], with significant steps involved in changing consumer preferences, raising awareness of the sustainable effects of moving towards organic farming [5,23] and green farming, and increasing the overall efficiency [21] of this activity. It can be seen that performance through maximization of agricultural production, as well as through producer co-interest (results in Figure 1) show oscillating trends of evolution that still entail significant improvements. Looking at the dynamics over the period 2012–2021, we can say that the producers’ co-interest was predominant in the years of precrisis stability, with multiple facilities offered by European programmes to associations of agricultural organizations with an effect on performance. On the other hand, the cultivation of consumers’ attraction towards organic products and the increase of productive yields, although intensively promoted, have faced certain barriers [7] which have made them higher from a productive point of view than the components of management strategy and organization of agricultural entities until the period of economic stability. With the onset of the pandemic, productivity calculations have resulted in a complete paradigm shift, with production functions being greatly improved in terms of productivity and impact on sustainable development.
From Figure 1, it can be seen that the distribution of the dependent variable experiences an accumulation of errors with respect to the trend line in years 2012–2015, after which, the trend tends to stabilize due to being normalized under the impact of distribution errors which have destructive effects on the trend curve including in 2019. The years 2020 and 2021 represent the paradigm shift in the productivity function with the fewest deviations, demonstrating that in the long term the orientation towards organic production is a viable solution within the reach of supranational decision makers to improve the sustainable parameters of the industry and achieve the interests of the Green Deal policies.

5. Conclusions

The authors have presented in an analytical-descriptive way a novel concept, namely the organic efficiency function of the productive yield of the organic agriculture branch and have analyzed the dimension of the evolution of the branch in the period 2012–2021 from the perspective of the three aggregates (productive component, human resource, and economic component). The authors achieve traceability with vulnerable factors (influence of the international context, economic, and epidemiological crises), but also traceability of
the function to the measures of structured promotion of organic farming in relation to the sustainability objectives proposed at European level.

The results are useful to national and supranational decision makers for adjusting sustainable development and CAP strategies.

The limitations of the study lie in the relatively small number of variables; the authors propose to extend them and to test the predictive capacity of the function based on an estimated trend line for ex-ante evaluation of the dynamics of the organic agricultural sector.


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**References**