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Jean-Philippe BOUSSEMART
Univ. Lille, CNRS, IESEG School of Management and LEM-UMR 9221

Raluca PARVULESCU
IESEG School of Management and LEM-CNRS (UMR 9221)

IESEG School of Management
Lille Catholic University
3, rue de la Digue
F-59000 Lille

www.ieseg.fr

Tel: 33(0)3 20 54 58 92

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Jean-Philippe BOUSSEMART
Univ. Lille, CNRS, IESEG School of Management, LEM-UMR 9221 - LEM, F-59000 Lille, France
3, rue de la Digue, 59000 Lille, France

Raluca PARVULESCU
IESEG School of Management, LEM-UMR 9221 - LEM, F-59000 Lille, France
3, rue de la Digue, 59000 Lille, France
corresponding author, email address: r.parvulescu@ieseg.fr

Abstract

This article seeks to highlight the performance of the farm sector in the main EU countries. Based on the productivity surplus account method (PSAM), our performance analysis includes all elements of the profit and loss account, which is one of the limits of the traditional index number approach. Moreover, this method also shows the way in which productivity gains observed in each country have been distributed among the main stakeholders. A specific focus is on the state's as well as the farmers' roles in this distribution game.

Keywords: productivity surplus accounting method, total factor productivity, agricultural sector, common agricultural policy

JEL codes: D24, N54, O13, Q18

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1. Introduction

European Union (EU) countries are experiencing a turbulent and uncertain period. Be it from a political or an economic perspective, the stability of the EU and its institutions is severely threatened. Considered as a cornerstone of the European construction, the common agricultural policy (CAP) is at the heart of this turmoil. Since its launch in 1962, CAP has undergone different changes in line with the evolution of economic and environmental policies, yet its first aim, according to the official EU website, is to 'support farmers and improve agricultural productivity, ensuring a stable supply of affordable food'[1]. The present article seeks to shed some light on how individual countries in the EU have coped with the objective of agricultural productivity improvement. Because productivity can be analysed as both a variation in quantities (of outputs produced and inputs used in the production process) and as an equivalent variation in prices, productivity gains and their distribution among the main stakeholders represent two faces of the same coin. This duality will allow us to analyse the roles fulfilled by the main stakeholders in this distribution game. Of particular interest will be the farmers' share. Did their price advantages follow the same evolution as the one observed for productivity improvement? In line with CAP's objective mentioned above, what can be said about upstream professionals of the agricultural sector and indirectly consumers? Did the productivity gains observed benefit them? Finally, from this perspective, one of the main actors is the state, as it provides subsidies and collects taxes. To what extent did state policies fuel the recent national resentment towards CAP? From this point of view, one should separately analyse state intervention through the taxes collected (mainly done at the national government level) and state impact through the subsidies provided (mainly at the EU level).

To answer these questions, this article is organized as follows. In the following section, it presents briefly some of the main work dealing with the productivity surplus account method (PSAM) and its applications for agricultural studies. Then, PSAM is presented in more detail, and the relationship between the calculated accounting surplus and the estimation of the total factor productivity is revealed. The data used for our calculations are presented in the fourth section. Our main results deal with the case of six European countries for the period 1991 to 2017 — namely, France, Germany, Italy, Netherlands, Spain and the United Kingdom (UK). A more in-depth analysis is performed for the UK and France starting from 1973. Finally, the last section discusses the main results and concludes the article.

2. Literature review

Much literature deals with productivity of the agricultural sector. The work of Ball et al. (2001), for example, uses a measure based on the Fisher price index to provide international comparisons on total factor productivity (TFP) levels between the United States and nine European countries (Germany, France, Italy, the Netherlands, Belgium, the UK, Ireland, Denmark and Greece) for the period 1973 to 1993. They show that during this period only Denmark and France increased productivity levels relative to the United States. Moreover, France underwent the largest gain in relative productivity. In a more recent study covering the period 1973 to 2002, Ball et al. (2010) show that Denmark, Belgium, Netherlands and Spain

[1] https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/cap-glance_en

were the most productive countries. Spain had the most impressive performance. One explanation put forward is that countries that do not possess the most productive technology gain from the diffusion of technical information and, hence, grow most rapidly.

In a document published by the EU (EU Agricultural Markets *Briefs*, 2016), the TFP growth rate at the EU level was above 1% per year between 1995 and 2005. However, the growth slowed down for the next ten years to around 0.8% per year. Baráth and Fertő (2017) studied the differences in the farm sector's TFP growth between old EU members (EU-15) and new ones (EU-N12). Using the Färe-Primont methodology for TFP calculations, they show that the most productive countries in 2004 and in 2013 were Belgium, the Netherlands and Denmark. On the contrary, the UK and Sweden had the lowest TFP growth. The poorer results observed for the UK farm sector were also obtained by Schimmelpfennig and Thirtle (1999) for the period 1973 to 1993. Investigating a more in-depth case of the UK farm sector, Thirtle at al. (2004) show that between 1953 and 1984, the TFP yearly rate was 1.7%, whereas afterwards, it dropped to 0.26% per year.

Although the above literature deals with the productivity index theory based on a multi-output and multi-input technology, the underlying framework does not take into account all of the elements listed in the profit and loss account of the farm sector. Particularly, banks through their access to credit and the state through its taxes and subsidies are two main stakeholders, and, therefore, they should be incorporated into the analysis as explicit input resources. Moreover, none of the previous works studied the reversed side of the productivity coin —that is, the distribution of productivity gains through output an input price changes.

In this context, PSAM by linking productivity surplus (PS) and distribution of output/input price advantages is of particular interest. Notwithstanding, the contributions of Kendrick (1961) and Kendrick and Sato (1963) for relating the generation and distribution of TFP gains through quantity and price variations simultaneously, the formal link between the two components was established in 1964 through studies conducted by the group *Electricité de France* (Puiseaux and Bernard, 1965). In the same vein, the *Centre d'étude des revenus et des coûts (CERC)* established theoretical insights of the PSAM method and applied them to four big state-owned and quasi-monopoly companies in France: *Société nationale des chemins de fer, Gaz de France, Charbonnage de France and Electricité de France*. These case studies improved the initial methodology published later by *CERC* in 1980. Grifell-Tatjé and Lovell (1999, 2015) further refined the accounting method by relating it to the non-parametric productivity approach based on directional distance functions.

Essentially, the PSAM analyses the exchange of goods and services between a firm and other economic units (suppliers, customers, employees, shareholders, etc.) over a given period of time. Each transaction expressed in value terms is decomposed along two dimensions: volume and price. All items present in the operating account are considered, and, therefore, the strict balance of the operating account is respected. On the one hand, this method calculates PS, which relates the time differentiation of outputs produced with the factors of production used. On the other hand, it measures changes in the price of outputs and the remuneration of inputs, which reflects the exchange of goods and services between the firm and its stakeholders. By considering these two concepts as two faces of the same coin, this method enables the decision making unit (DMU) to create a coherent framework for conducting retrospective and forecasting studies on its policies.
The study of productivity gains and their distribution within 63 American industries from 1987 to 2012 (Boussemart et al. 2016) is a concrete example. Among the articles based on the PSAM

detailed by the *CERC* and applied to the agricultural sector, we are reminded here off the study conducted in India by Dorin et al. (2001).

Another concrete example is the analysis of the evolution of productivity gains and their distribution within 164 farms for suckling cattle from the French Charolais area from 1980 to 2015 (Veysset, et al., 2019). In line with *CERC* recommendations, this article applies a bottom-up approach in which price advantages of different outputs and factors of production are first calculated for each individual farm. These individual price advantages are then aggregated to help identify long-term trends. The cumulative TFP index observed a positive growth rate of + 0.17% per year. This slight increase is linked to the increase in the partial labour productivity, whereas the other inputs show a drop in their respective partial productivity. The analysis of the distribution of productivity gains shows that the main beneficiary is the upstream of the beef sector, which is followed by the upstream of the other sectors, especially cereals, through a decrease of the unitary prices in both cases. Farm managers, due to the stagnation of their incomes, are among the losers of this distribution game. Finally, the results reflect the various CAP agricultural reforms that have had a considerable impact on the distribution of price advantages. Boussemart et al. (2017) studied the agricultural sector as a whole; their study deals with the generation and distribution of productivity gains of the French agricultural sector from 1959 to 2011, and is based on annual national economic accounts established by the *Institut national de la statistique et des études économiques (INSEE).*

However, to our knowledge, no study has compared the generation and distribution of productivity gains among different agricultural sectors within the EU. Indeed, it seems crucial to include both the generation and distribution of TFP changes in a debate about industrial policies (Fluet, Lefebvre, 1987), which is especially the case for the agricultural sectors of the EU. Since the EU, through CAP, clearly interferes with market prices and provides support to producers and customers, value advantages stemming from growth in TFP should be taken into account by policies designed to control prices and deliver subsidies. For example, in countries where farmers can retain a significant share of their productivity gains through increased profitability, subsidies could be downsized over time in a relatively painless way for this sector. Conversely, in countries where farm managers do not benefit from productivity gains because they face high production costs and lower profit levels, subsidies could be justified in the short run to increase direct payments to producers.

Our first objective is to adapt this methodology to make international comparisons. Our second objective is to compare EU agricultural sectors among themselves, whether in terms of productivity gains or in terms of different ways they distribute their price advantages. Given the specific impact of CAP policies in the countries studied, a special focus will be on state performance, both at the national level (mainly through taxes) and at the European level (through subsidies).

3. Methodology

3.1 Surplus accounting

Surplus accounting extends the index number approach by describing how the economic surplus resulting from productivity growth is shared between various agents (Kendrick and Sato, 1963; Courbis and Temple, 1975; *CERC*, 1980). Consider a DMU (here an economic sector, i.e.

agriculture) produces a row vector $\mathbf{Y}$ of dimension O of different outputs out of a row vector $\mathbf{X}$ of dimension I of different inputs. Note that the I^{th} input in the input vector is the residual profit, which encompasses dividends, interest costs or managers' remunerations before tax. In the following, $\mathbf{P}$ is the dimension O row vector for output real prices, and $\mathbf{W}$ is the dimension I row vector for input real prices[2]. Thus, the sector's balanced operating account is given in every period t by the equality between total revenue (R_t) and total costs incurred (C_t), where the latter includes residual profit:

$$\begin{matrix} \mathbf{Y}_t \mathbf{P}_t^T = \mathbf{X}_t \mathbf{W}_t^T \\ R_t = C_t \end{matrix} \quad (1),$$

where superscript T stands for the transpose of the output and input vectors, respectively.

The above equation (1) must be verified for any period change. Thus, the change between the period s and t concerning the revenue must be exactly compensated by the change in the cost. Revenue change can be decomposed as the sum of a pure output quantity change (weighted by the output price in the initial period) and of a pure output price change (weighted by the output quantity in the final period). Likewise, the total cost change can be obtained as the sum of a pure input quantity change (weighted by the input price in the initial period) and of a pure input price change (weighted by the output quantity in the final period). Note that $\Delta\mathbf{Y}$ is the output quantity change vector and that $\Delta\mathbf{P}$ is the output price change vector. Likewise, $\Delta\mathbf{X}$ and $\Delta\mathbf{W}$ represent the vectors for the input quantity change and input price change, respectively. These are all row vectors of dimension O for outputs and I for inputs. Rearranging terms so that output and input quantities changes appear on the left-hand side and output and input prices changes appear on the right-hand side, we show that the left-hand side result corresponds to the Laspeyres productivity surplus (PS^L), whereas the right-hand side measures the sum of the Paasche price advantages (PA^P).

$$\begin{matrix} \Delta\mathbf{Y}\ \mathbf{P}_s^T + \mathbf{Y}_t\ \ \Delta\mathbf{P}\ ^T = \ \Delta\mathbf{X}\ \mathbf{W}_s^T + \mathbf{X}_t\ \ \Delta\mathbf{W}\ ^T \\ \Delta\mathbf{Y}\ \mathbf{P}_s^T - \ \Delta\mathbf{X}\ \mathbf{W}_s^T = -\mathbf{Y}_t\ \ \Delta\mathbf{P}\ ^T + \mathbf{X}_t\ \ \Delta\mathbf{W}\ ^T \\ PS^L = PA^P \end{matrix} \quad (2).$$

In equation (2), PS is defined as the Laspeyres output and input quantity changes weighted by price levels from the initial period s, whereas PA is equal to the Paasche output and input price variations weighted by quantity levels from the final period t. These two components can be similarly defined through Paasche quantity changes and Laspeyres price variations, respectively:

$$\begin{matrix} \Delta\mathbf{Y}\ \mathbf{P}_t^T + \mathbf{Y}_s\ \ \Delta\mathbf{P}\ ^T = \ \Delta\mathbf{X}\ \mathbf{W}_t^T + \mathbf{X}_s\ \ \Delta\mathbf{W}\ ^T \\ \Delta\mathbf{Y}\ \mathbf{P}_t^T - \ \Delta\mathbf{X}\ \mathbf{W}_t^T = -\mathbf{Y}_s\ \ \Delta\mathbf{P}\ ^T + \mathbf{X}_s\ \ \Delta\mathbf{W}\ ^T \\ PS^P = PA^L \end{matrix}$$

The equivalent relationship could be expressed in terms of the Bennet additive index, which relies on an arithmetic average of the two Laspeyres and Paasche expressions of PS and/or PA

[2] Nominal input and output prices are deflated by a general price index, such as the GDP price index.

$$\frac{1}{2}\,\Delta\mathbf{Y}\,\left[\mathbf{P}_s^T+\mathbf{P}_t^T\right]-\frac{1}{2}\,\Delta\mathbf{X}\,\left[\mathbf{W}_s^T+\mathbf{W}_t^T\right]=-\frac{1}{2}\left[\mathbf{Y}_s+\mathbf{Y}_t\right]\,\Delta\mathbf{P}^{\,T}+\frac{1}{2}\left[\mathbf{X}_s+\mathbf{X}_t\right]\,\Delta\mathbf{W}^{\,T}$$

$$\Delta\mathbf{Y}\;\overline{\mathbf{P}}^T-\;\Delta\mathbf{X}\;\overline{\mathbf{W}}^T=-\overline{\mathbf{Y}}\;\Delta\mathbf{P}^{\,T}+\overline{\mathbf{X}}\;\Delta\mathbf{W}^{\,T} \qquad (3),$$

$$PS=PA$$

with $\overline{\mathbf{P}}$ and $\overline{\mathbf{W}}$ representing, respectively, the arithmetic mean vector of the input and output prices of the two periods.

This productivity surplus decomposition does not depend on any arbitrary choice between the two periods. It can be referred to as the superlative index concept, notably the Fisher index, whereas the additivity property of the aggregation formula enables the decomposition of value changes into price and quantity effects in level terms. Although this Bennet-based productivity surplus decomposition has not received a great deal of attention in the literature, its usefulness can be proven. As stressed by Diewert (2005), dealing with profit or, in this case, with production accounts means retaining additive decomposition, since the addition of output changes is equal to the addition of cost changes in value terms. Whereas the traditional Fisher index is based on a multiplicative decomposition, the Bennet indicator is additive[3] and presents the same relevant properties of equicharacteristicity[4]. We refer to Diewert (2005) for a thorough discussion of the properties and merits of each type of index in various economic contexts. For revenue or cost and for profit decomposition, Diewert unequivocally favours the Bennet indicator (Bennet, 1920), which appears as the most appropriate tool.
Additionally, Caves et al. (1982) showed that the Bennet indicator closely approximates the true TFP change, just as much as the Fisher index does, which is considered as the most general and satisfactory index (Diewert, 1992). In practice, both measures lead to extremely similar results (and so does the Törnqvist index). This has been observed by all researchers who have made empirical comparisons of index numbers in a time series as well as in cross-section analyses (see for example Bureau et al, 1990).

In equation (3), the price advantage or remuneration change over time for any stakeholder is equal to the difference between the changes in its related output or input price weighted by the respective quantities. Such price variations result in transfers between agents that add to the value of PS. More fundamentally, equation (3) implies that the sum of remuneration changes distributed among the different stakeholders (*PA*) cannot exceed the total productivity surplus (*PS*). By regrouping positive price advantages along absolute value of PS (if PS<0) on the left-hand side and on the right-hand side, all price disadvantages (negative price advantages in absolute value) along PS (if PS>0), one can establish the following balanced surplus account, which is shown in Table 1:

Table 1. Balanced surplus account

USES	**RESOURCES**
• - PS (if < 0)	• PS (if> 0)
• $-\Delta(p_o y_o)$ for any price decrease of output *o*	• $+\Delta(p_o y_o)$ for any price increase of output *o*
• $+\Delta(w_i x_i)$ for any price increase of input *i*	• $-\Delta\ w_i x_i$ for any price decrease of input *i*
Total uses distributed	**Total resources collected**

[3]The additivity property means that the real value (or volume) of an aggregate is equal to that obtained by adding the real values of the components at any aggregation sub-level.
[4]This property states that an index should not be dependent on the basket of goods of one particular period.

The equality obtained in equation (3) implies that in situations where PS is negative (i.e., a productivity loss), the loss has to be compensated either by a price increase for some outputs and/or by a price decrease for some inputs. Overall, the various changes in quantities and prices correspond to either a 'collection' (resources) or a 'distribution' (uses) of the total economic surplus. For instance, using the economic accounts for the agriculture sector of the main EU countries, we can decompose value changes into quantity and price effects. This enables us to analyse all the corresponding transfers among customers (through output prices); suppliers of intermediate inputs (via their unit costs); fixed capital consumption (inferred depreciation costs); compensation of employees (wages + social taxes); landowners (tenant farming rate); the state (net taxes paid); banks (net interest paid); and farm managers (net operating surplus).

3.2 Productivity surplus (PS), Price advantages (PA) and Total factor productivity (TFP) changes

According to equation (3), productivity gains measured by PS are defined as the difference between output and input quantity variations expressed in level terms (i.e., in real euros). They can also be directly equated to the usual Törnqvist index as a measure of the TFP growth rate expressed in relative terms (%). For this, $\mathbf{GY}$ and $\mathbf{GX}$ are, respectively, the two row vectors of dimension *O* and *I* containing the growth rates of the output and input quantities[5]. The Törnqvist TFP change is obtained as the weighted output time variations net of weighted input changes:

$$\frac{\Delta TFP}{TFP} = \bar{\boldsymbol{\alpha}}^{\mathbf{T}}\ \mathbf{GY}\ - \bar{\boldsymbol{\beta}}^{\mathbf{T}}\ \mathbf{GX}\quad (4),$$

where $\bar{\boldsymbol{\alpha}}^{\mathbf{T}}$ and $\bar{\boldsymbol{\beta}}^{\mathbf{T}}$ are the transposed of the row vectors of the respective between periods' mean output and between periods' mean input shares in the total revenue. After calculating each vector product in the right-hand side of equation (4), the Törnqvist TFP change can be obtained as the productivity surplus rate defined by the ratio of *PS* and the mean of total output value between the two periods:

$$\frac{\Delta TFP}{TFP} = \left[\frac{1}{\overline{\overline{R}}}\right]\left[\bar{\mathbf{P}}^{T}\ \Delta\mathbf{Y}\ - \overline{\mathbf{W}}^{T}\ \Delta\mathbf{X}\right] \quad (5).$$
$$\frac{\Delta TFP}{TFP} = \frac{PS}{\overline{\overline{R}}}$$

Moreover, an interesting link between TFP growth rate and price advantage changes can be established. Through the equality between PS and PA, the TFP rate is equal to the summation of price advantage rates (defined as the ratio between price advantages and the total output value):

$$\frac{\Delta TFP}{TFP} = \frac{PS}{\overline{\overline{R}}} = \frac{PA}{\overline{\overline{R}}} = \frac{1}{\overline{\overline{R}}}\left[-\ \Delta\mathbf{P}^{\ T}\ \overline{\mathbf{Y}} + \ \Delta\mathbf{W}^{\ T}\ \overline{\mathbf{X}}\right] \quad (6).$$

[5] The denominator for each growth rate is the computed arithmetic mean of the variable between periods under concern.

4. Data

This study focuses on productivity gains generated by the agricultural sector in six EU countries from 1992 to 2017. Value, quantity and price indexes were collected from the agriculture sector accounts, which were published by the European Statistical Office (Eurostat).

Complete and relevant economic accounts for agriculture are expressed in current national currency and in quantity or price indexes (base year 100=2010) for six EU countries (the UK, France, Germany, Italy, Spain and Netherlands) from 1991 to 2017. For two countries (the UK and France), these accounts cover the period from 1973 to 2017. The agricultural output vector is formed by the following categories: crops (cereals, including seeds, industrial crops, forage plants, vegetable and horticultural products, potatoes, fruits, wine, olive oil and other crop products); animal output (animals and animal products); agricultural goods output; and agricultural services output. In all, there are 66 different sub-accounts for the agricultural output. Each type of product is measured in producer prices — that is, the production value net of taxes on production plus subsidies[6].

The input vector contains five categories of traditional inputs. (1) intermediate inputs (seeds and planting stocks, energy and lubricants, fertilizers and soil improvements, herbicides, insecticides, pesticides, veterinary expenses, feeding stuffs, maintenance of materials, maintenance of buildings, agricultural services and financial intermediation services); (2) fixed capital consumption (equipment, buildings and plantations); (3) salaried work; (4)utilized land; and (5) non-salaried farm labour, defined as the aggregate ability of farmers to generate profitability. Although these inputs are relatively standard for an agriculture production function, we have added a net bank account (the difference between interests paid and interest received) and a state account (the difference between the total taxes paid by farmers and the total subsidies received). Therefore, a balanced production account can be established, as seen in Table 2.

Table 2: Inputs and outputs retained in the surplus decomposition

Inputs	Outputs
Intermediate inputs + Fixed capital consumption Labour + Land + Bank net interest + State (taxes paid- subsidies received) + Operating surplus (non-salaried labour input)	Output measured at producer prices= Crop output + Animal product + Agricultural goods output + Agricultural goods output
Total cost	**Total revenue**

The volume of intermediate inputs is obtained using the quantity index for each component of this account. The volume of capital consumption is calculated by the depreciation at a constant price. The quantity of salaried labour is estimated in full-time equivalent employee. The volume

[6] Output in producer price= production value – (taxes - subsidies).

of net interest is obtained by assuming that the price for this account was equal to the long-term interest rate (ILN), available on the site of the annual macro-economic database (AMECO database)[7]. Taxes and subsidies on production volumes are directly linked to their related quantity output indexes[8]. Finally, the volume of the managerial input compensation is obtained by applying the non-salaried employment quantity index to the net operating surplus.

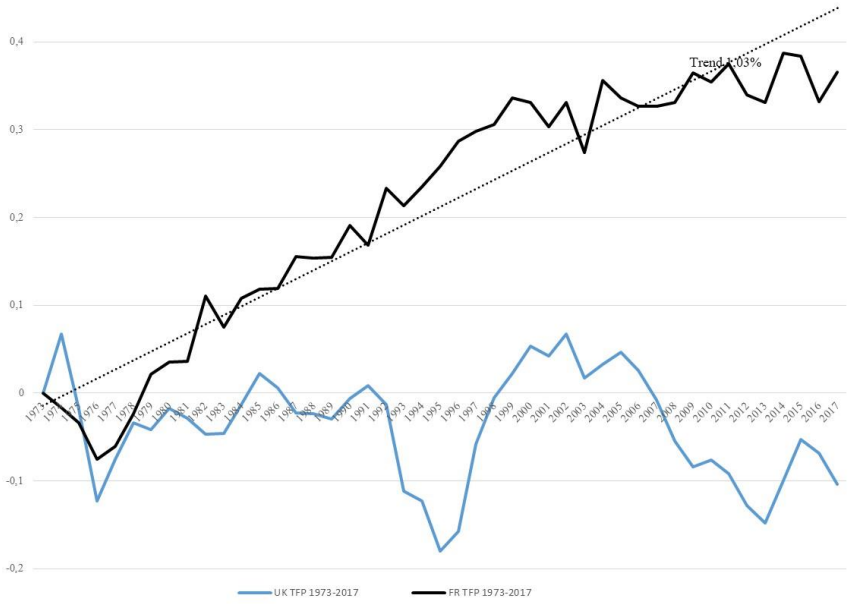
5. Results

5.1. France and the UK at a glance for the 1973 to 2017 period

For two countries in our dataset, France and the UK, data were available for the period from 1973 to 2017. This section presents their respective TFP evolutions and distribution of price advantages. We believe that this analysis is useful for understanding the more recent evolutions affecting EU economies after the MacSharry reform from 1991 to 2017.

Figure 1 presents the TFP evolutions between 1973 and 2017 using the Bennet PS formulation. Over the whole period, the average productivity gains of the French agricultural sector followed a positive trend (+1.03%) resulting from the difference between output and input quantity changes (0.68% and -0.35%, respectively). The time trend for the average productivity gains for the UK agricultural sector followed a more erratic path during the same period. (The time trend is not significant for this time series.) However, the calculated time trend for output growth is positive and significant (+0.46%), but too weak to overcome the constant increase in the quantity of input used over the same period, for which the time trend is also positive and significant (0.44%). Whereas productivity gains have been relatively constant (though negative) between 1973 and 1992, a clear negative trend can be seen after 2002.

Figure 1. TFP index for France and the UK between 1973 and 2017 (in logarithm terms 1=1973)

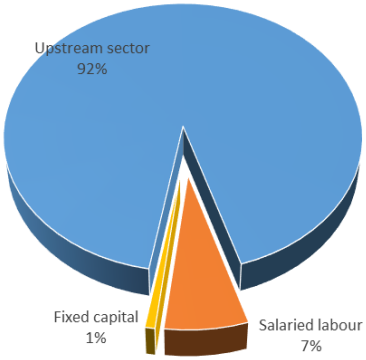


[7] In this respect, our assumption is different from the one made in Boussemart, Butault and Ojo (2017), who used the general price index in order to obtain the volume of net interest.
[8] This assumption is similar to the one formulated by Boussemart, Butault and Ojo (2017).

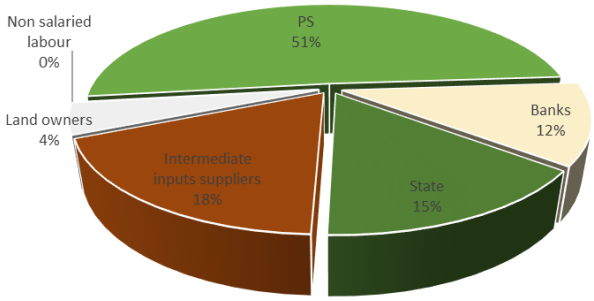
As shown previously, the balanced surplus account for this period indicates how price advantages have been collected and then distributed among the main stakeholders. Thus, in the French agricultural sector, the main contributor is PS, which represents, on average, half of the main resources (51%); this is followed by intermediate inputs suppliers (18%), the state (15%), banks (12%) and landowners (4%). Profitability appears to be almost null in this account (0.03% of the total resources). On the uses side, the main winners of price advantages are upstream sector (92%), followed by employees (7%) and fixed capital (1%).

Figure 2. Average annual balanced surplus account in percentages for French agricultural sector, 1973–2017

Uses= 1,45 billion of 2010 national currency



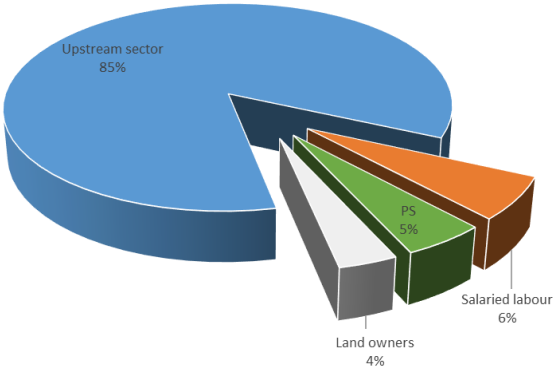
Resources= 1,45 billion of 2010 national currency



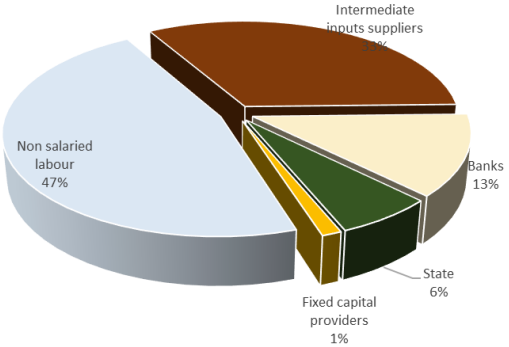
There are some noteworthy differences with the UK average annual balanced surplus account. For one, the PS is no longer on the resource side but on the uses side (5%). Another difference lies in the fact that the landowners are also beneficiaries of price advantages (4%). The upstream sector remains the main beneficiary of price advantages but to a lesser extent (85%), whereas employees preserve a relatively comparable share (6%). Obviously, on the resource side, the main contributors are also different as compared to the French case above. The increase in the UK farmers' price disadvantages, for example, was 47%, whereas for their French counterparts, it was close to 0%. Another important contributor is the intermediate inputs suppliers, totalling 33% of the total resources. The weightings of banks and the state as resources for the UK surplus account are comparable to the ones observed in France (13% and 6%, respectively).

Figure 3. Average annual balanced surplus account in percentages for UK agricultural sector, 1973–2017

Uses= 0.6 billion of 2010 national currency



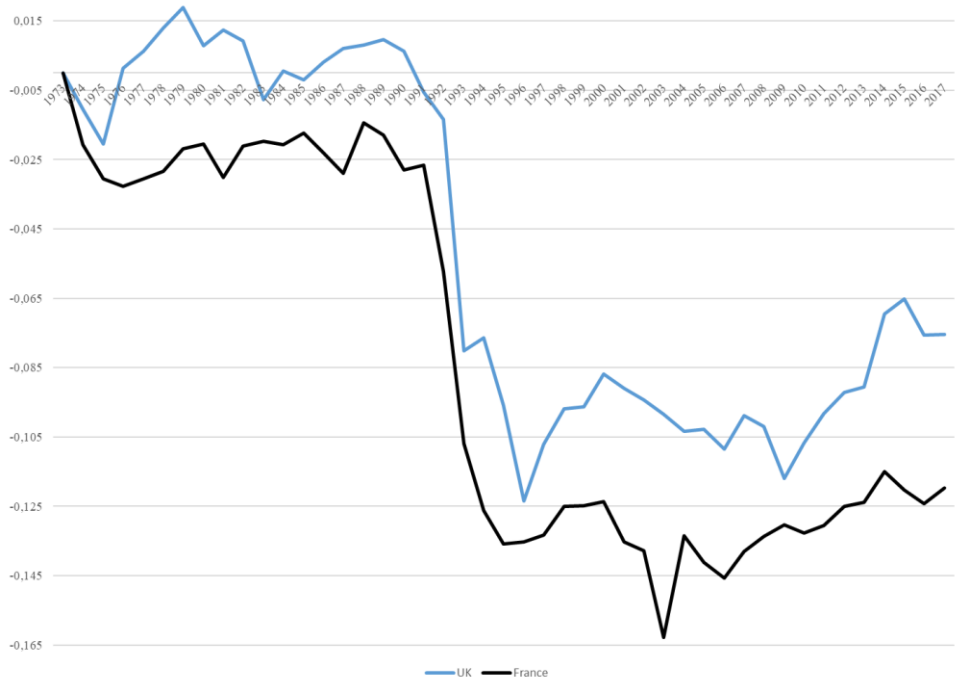
Resources= 0.6 billion of 2010 national currency



The state-related price disadvantages deserve further inquiry. From the above figures, one would be tempted to conclude that the state impact in terms of price disadvantages was similar

in the two countries studied. Figure 4, however, shows that time trends are not entirely similar. Whereas in France the state has always contributed positively to the agricultural sector, only since 1992 has the UK state played a favourable role for the sector[9]. It is interesting to note that this financial contribution is more stressed after 1992, which corresponds to the adoption of the MAcSharry reform of the CAP. This reform was one of the first attempts towards a free agricultural market. In this sense, it reduced guaranteed prices for cereals and beef. At the same time, this reform also initiated decoupled payments to farmers, whereby the subsides granted were no longer directly linked to production. This form of explicit subsidies that substitute to previously "implicit" subsidies granted through the guaranteed prices might be the cause for the severe decline in state price advantages after 1992. Finally, the weight of the price advantages conceded by the state is consistently lower in the UK than in France.

Figure 4. Price advantage indexes (in logarithm terms 1=1973) collected from the French and UK state, 1973–2017

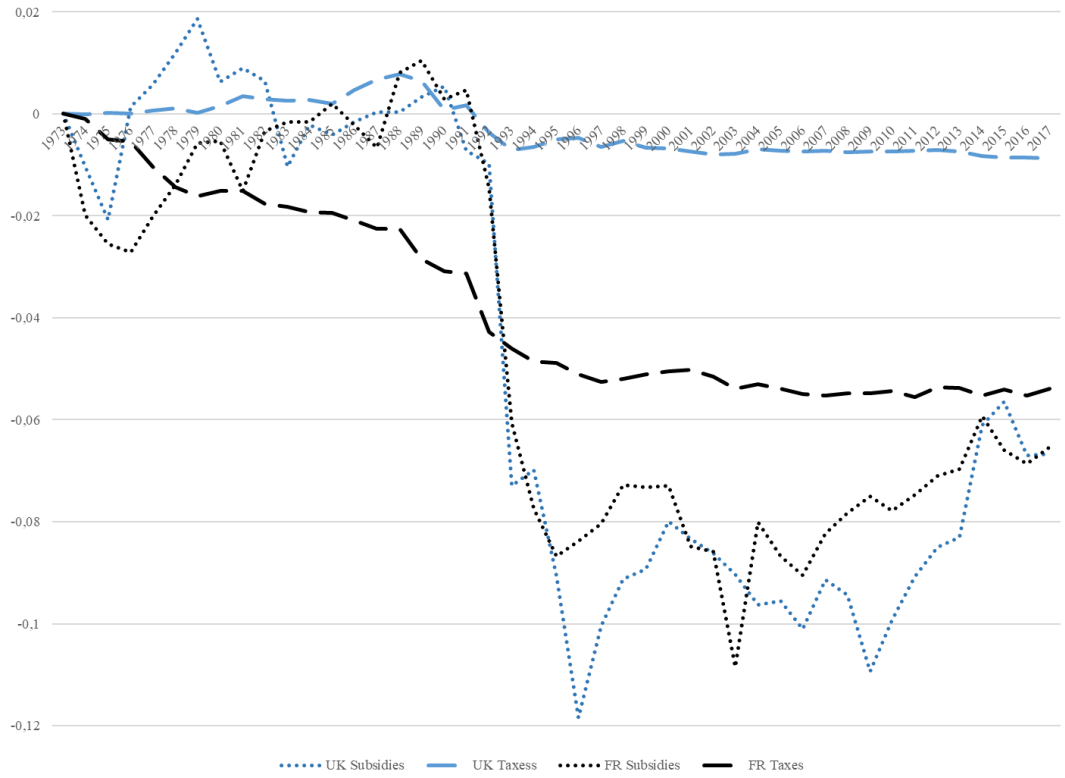


In the operating account, the state item is obtained from the difference between the total taxes paid and the total subsidies granted to the agricultural sector in each country. In France, the relative weights of these two sub-items are comparable (7% for subsidies and 8% for taxes). Although the state, on average, underwent subsidy-related price disadvantages at a comparable level (6%) in the UK, tax-related price disadvantages represented only 1%. We can, thus, conclude that relative to the agricultural sector, the UK state has enjoyed fewer price disadvantages from their tax-related system as compared to the French state. At the same time, the tax-related price disadvantages incurred by the UK state are also less important compared to UK's subsidy-related system. (For the entire period, the average for the taxes related to the price disadvantages was equal to 3.97 billion in 2010 pounds, whereas the period average for subsidy-related price disadvantages was equal to 33.81 billion in 2010 pounds.)

[9] In the operating account, the state item is computed as the difference between taxes paid and subsidies received. Therefore, the more negative the state price advantage, the higher the benefit obtained by the sector.

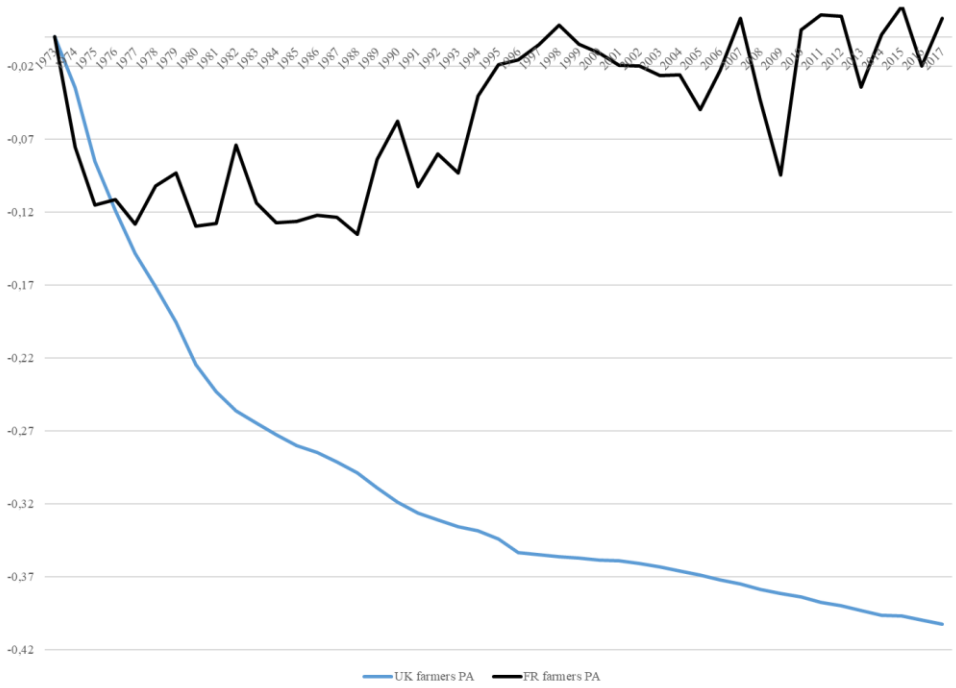
These distinctions between the different systems are further highlighted by a time evolution analysis of these two sub-items. Figure 5 shows that the state in both countries suffers from price disadvantages relative to the subsidies granted. Moreover, starting from 1997, subsidy-related price disadvantages seem to be even more important in the UK than in France. The time trends for the subsidy-related price disadvantage index are comparable in the two countries, even though the disadvantages incurred by the UK state seem to be deteriorating at a slightly higher speed (-0.21% in France and -0.28% in UK). Turning to the tax-related price disadvantages, we notice that they have steadily increased in France (the trend is -0.13%), whereas in the UK, they remained relatively constant (the trend is -0.03%).

Figure 5. Price advantages indexes (in logarithm terms 1=1973) relative to taxes paid and subsidies received France and UK, 1973–2017



The time evolution for the farmers' respective price disadvantages in the two countries also shows distinct paths. Although France has observed a highly fluctuating path, the general trend is towards an improvement. Since 2010, the price advantages have been positive for French farmers (with the exception of 2013). This has not been the case in the UK, where the farmers' price disadvantages have been steadily decreasing since 1973, with a trend of -0.67% on average per year. These results can be related to the productivity gains observed in the two countries. Thus, in the case of UK farmers, their own price disadvantages have more than compensated for the productivity losses observed over the same period.

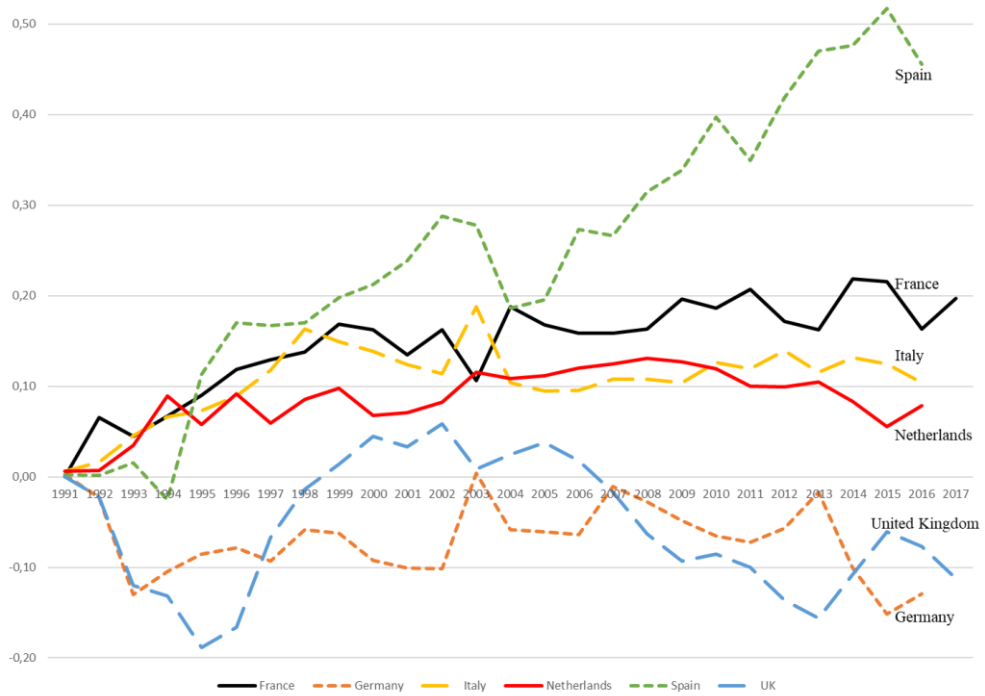
Figure 6. Price advantages indexes (in logarithm terms 1=1973) relative to non-salaried labour in France and the UK, 1973–2017



5.2 Analysis of agricultural sectors in six EU countries, 1991–2017

The time evolution of the agricultural sector's TFP in Figure 7 below shows two contrasting paths. On the one hand, in Spain, France, Italy and the Netherlands, productivity improved over the period studied, and the TFP was positive. The agricultural sector observing the highest and most rapid TFP growth was Spain, followed by France. Although Italy's and Netherland's respective TFP rates increased until 2004 and 2010 respectively, they declined afterwards. On the other hand, for Germany and UK, their agricultural sector TFP has declined since 1991. In the UK, after a period of growth between 1995 and 2002, the TFP index declined severely. In the case of Germany, productivity growth has been below its 1991 level, except for 2003. However, its evolution path was relatively stagnant until 2013, when deterioration is observed.

Figure 7. TFP index of agricultural sector (in logarithm terms, 1991=1) in six EU countries



A more detailed analysis relates TFP growth to input and output changes. Here too, we observe some structural patterns. In our dataset, positive TFP growth rates have been identified for four countries: Spain, France, Italy and the Netherlands. Yet different output and input trend patterns have been observed in each of them. The first pattern of TFP growth consists of a steady increase in outputs coupled with a steady decrease in inputs. The conjunction of the two leads to an improvement of TFP growth. This pattern has been observed for Spain. In France, the TFP index registered a positive trend, yet only the output index observed steady growth while the input evolution was non-significant. In Italy, on the other hand, both input and output indexes decreased over the period of study. However, the output decrease rate was lower than that of the inputs and as a result, Italy registered a positive TFP growth rate on average. In the Netherlands, the opposite occurred: both outputs and inputs observed positive growth rates, but the output growth more than compensated for the input growth.

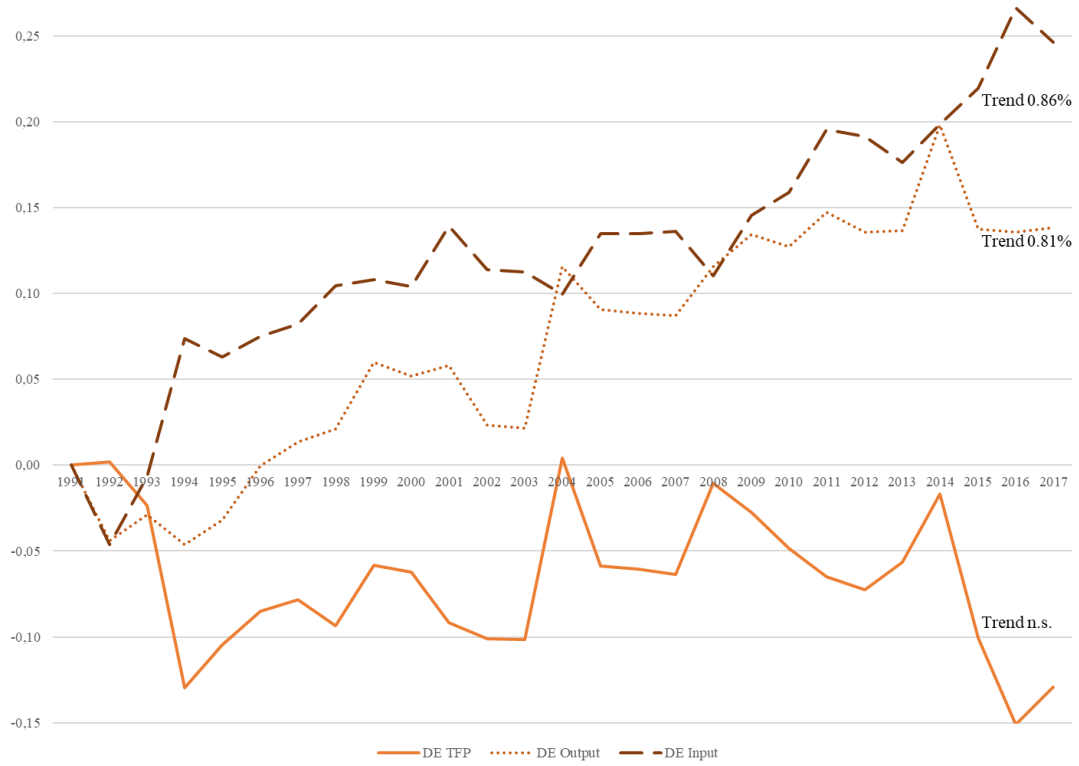
Table 3. Time trends for TFP, output and input indexes for six EU agricultural sectors[10]

	TFP index time trend	**Output index time trend**	**Input index time trend**
Spain	1.92%	1.59%	-0.33%
France	0.57%	n.s.	-0.45%
Italy	0.32%	-0.19%	-0.51%
Netherlands	0.29%	1.01%	0.71%
Germany	n.s.	+0.81%	+.86%
United Kingdom	n.s	n.s.	n.s.

[10] Time trends are calculated from time trend linear regression models. Figures presented here are sig. at <5%.

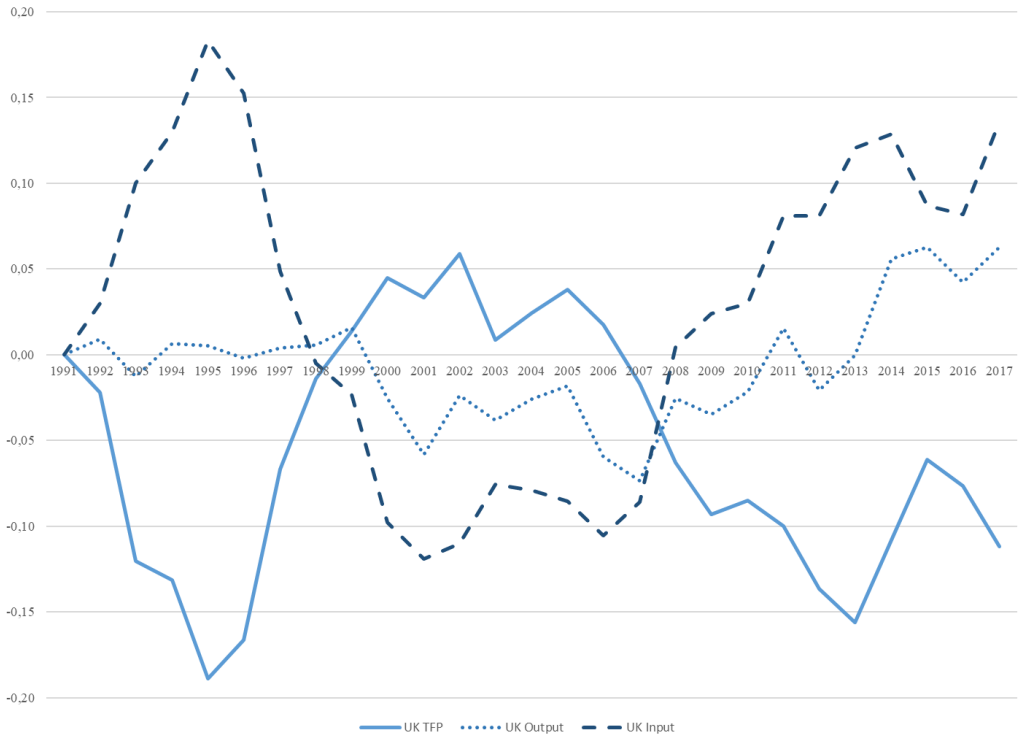
In Germany, the TFP rates are generally negative. This is consistent with positive time trends for both output and input, where the input trend is greater than output one.

Figure 8. TFP, output and input indexes for German agricultural sector (in logarithm terms, 1991=1)



In the case of UK agriculture, three different patterns can be noted. The first one, covering the period from 1991 to 1999, saw an increase in the use of input and practically no change in the output obtained. As a result, the TFP decreased dramatically over this period. Between 2000 and 2006 both inputs and outputs decreased, but the input use did so more rapidly, which helped ameliorate the TFP. Finally, during the last sub-period (2007–2017) and despite an output increase observed, a more than proportional input use had a detrimental effect on the TFP.

Figure 9. TFP, output and input indexes for UK agricultural sector (in logarithm terms, 1991=1)



For the six countries studied, their balanced surplus accounts give relatively contrasting results. Countries that have experienced increasing productivity gains, registered their PS as a significant share of the total resources in the surplus account. This is the case for Spain (70% on average for the entire period), France (60%), Italy (36%) and the Netherlands (20%). When PS was important, non-salaried input was compensated to a large degree. Therefore, it appears as a use in Spain (51% of the average price advantages distributed), France (35%) and Italy (39%). With the exception of Italy, price advantages distributed to farmers remained lower than their corresponding productivity gains. In the Netherlands, the weakness of productivity gains did not translate into positive price advantages for farmers, who experienced price disadvantages (23%).

For countries that experienced negative productivity rates, the PS represents a use, and it amounted to 22% on average for Germany and 38% for the UK. In Germany, despite severe productivity losses, farmers extracted positive price advantages, which represented 27% of the total uses in the surplus account. UK farmers experienced a contrasting situation, in which their own price disadvantages represented, on average, 34% of all the resources.

We notice that for the first group of countries (obtaining positive productivity growth), landowners' price advantages are negative on average. They appear, therefore, as a resource for the sector of varied importance. Whereas they are almost null in France, they amount to 23% in Italy. In the Netherlands, Germany and the UK, where productivity growth was very slow and even negative, landowners experienced price advantages (which appear, therefore, as an use) amounting to 22% in the Netherlands and 14% in the UK.

Positive PS in Spain and France translated into relatively low positive price advantages for providers of fixed capital. Indeed, they represented 6% of the total uses in Spain and 2% in France. For countries with lower or negative productivity growth, fixed capital providers

incurred price disadvantages as follows: 4% in Italy, 7% in the Netherlands and 17% in Germany. The only exception to this pattern was the UK, where despite negative productivity growth, fixed capital providers enjoyed positive price advantages (2%).

In all countries studied, upstream sector extracted positive price advantages, with an average ranging from 29% in the UK to 74% in the Netherlands. Another noticeable result is that for all countries, the balanced surplus accounts indicate that the banking system underwent negative price advantages; in all six countries, the bank is a positive financial contributor to the farm sector. Whereas bank price disadvantages represented 9% on average in Spain, they increased to 38% in the Netherlands. Another stakeholder suffering from price disadvantages are the suppliers of intermediate inputs. Their relative share is different in the six countries, but their most important contribution was in Germany (63%), whereas the smallest was in France (2%).

No relationship can be established between the type of price advantages or disadvantages received by salaried labour and the productivity pattern. What is noticeable, however, is that the price advantages remain relatively weak. The UK, France and the Netherlands enjoyed positive price advantages of up to 17%, 6% and 2%, respectively. In Spain, Italy and Germany, employees' price disadvantages were relatively low, ranging from 2% in Spain to 1% in Italy and Germany.

The state suffers from price disadvantages in all countries, except in Spain (1% of the total uses). However, the relative share of state contribution is relatively low in most of the countries (1–5%), with two significant exceptions. In France, the state average's contribution was 25% of the total resources collected. In the UK, state price disadvantages represented 30% of the economic surplus. This result is in line with our previous analysis of these two countries' perceived subsidies and paid taxes for the period from 1973 to 2017 (Figure 5 above). Indeed, we can see that starting from the beginning of the 1990s, state price disadvantages related to subsidies have severely deteriorated in both countries. As stated previously, this evolution should again be related to the explicit form (decoupled payments) under which subsidies were granted after 1992.

Figure 10. Average annual balanced surplus account in percentages for agricultural sector in Spain, 1991–2017

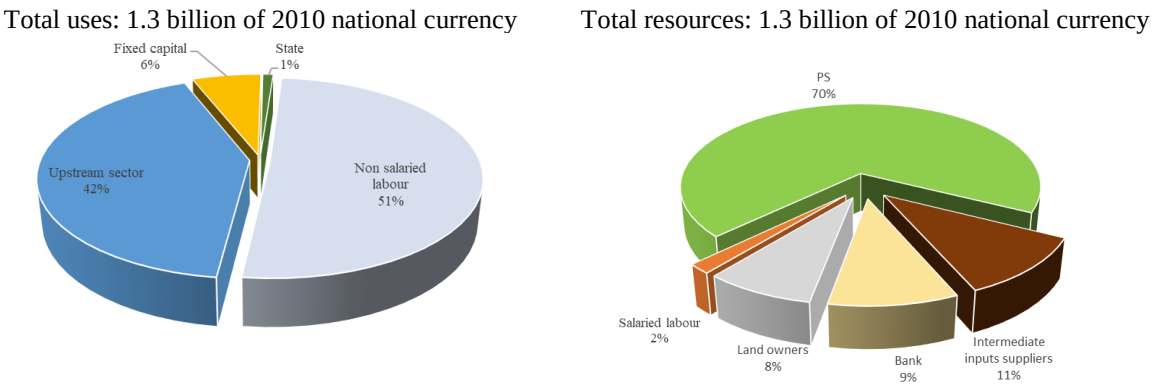
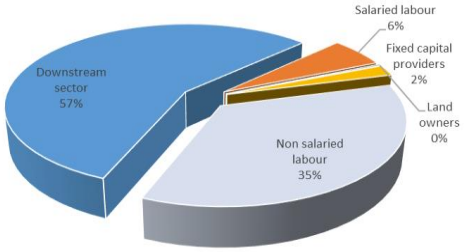


Figure 11. Average annual balanced surplus account in percentages for agricultural sector in France, 1991–2017

Total uses: 1.05 billion of 2010 national currency



Total resources: 1.05 billion of 2010 national currency

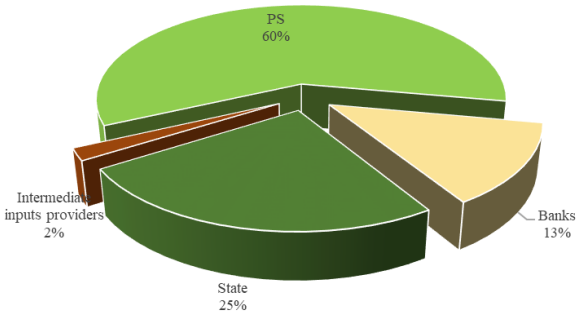
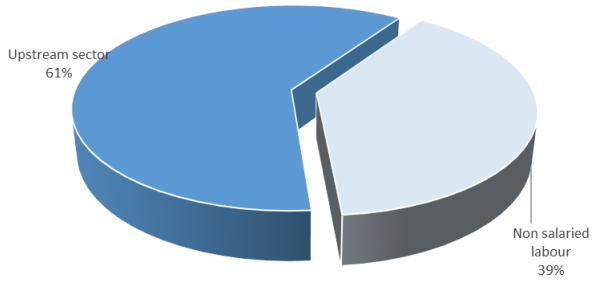


Figure 12. Average annual balanced surplus account in percentages for agricultural sector in Italy, 1991–2017

Total uses: 0.77 billion of 2010 national currency



Total resources: 0.77 billion of 2010 national currency

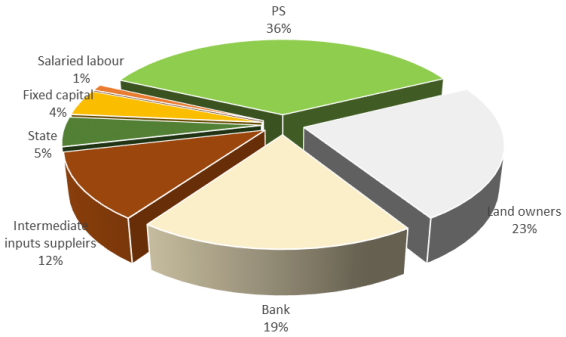
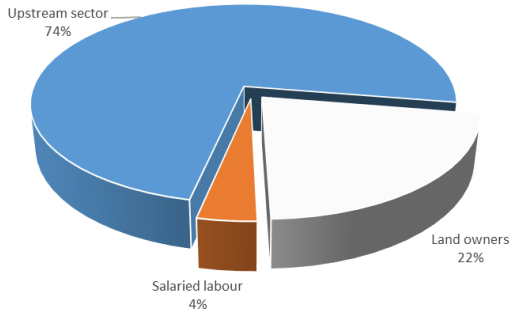


Figure 13. Average annual balanced surplus account in percentages for agricultural sector in the Netherlands, 1991–2017

Total uses: 0.40 billion of 2010 national currency



Total resources: 0.40 billion of 2010 national currency

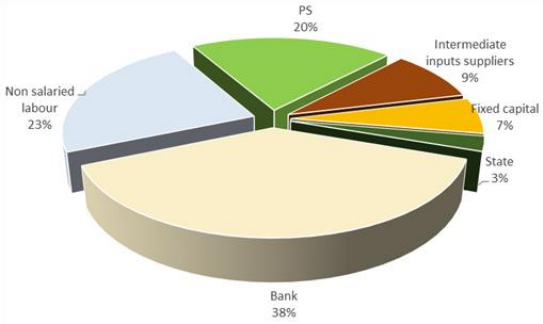


Figure 14. Average annual balanced surplus account in percentages for agricultural sector in Germany, 1991–2017

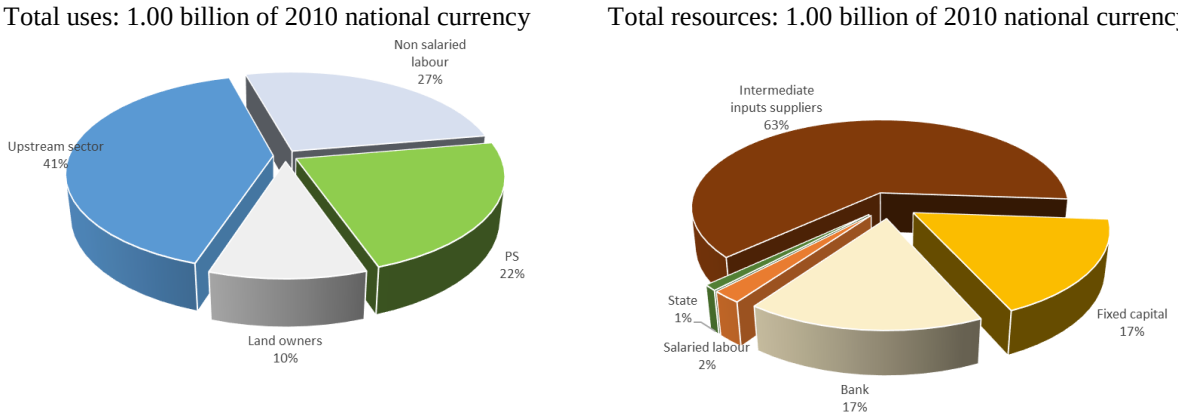
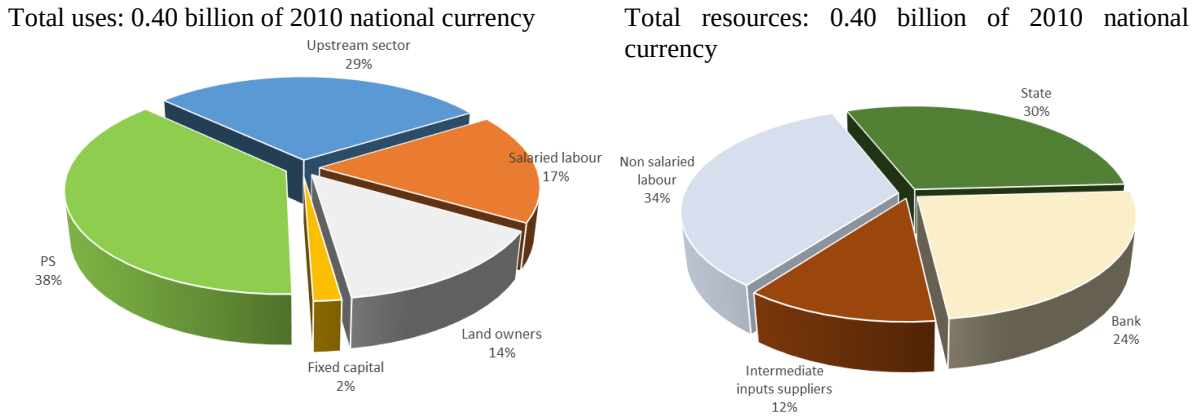


Figure 15. Average annual balanced surplus account in percentages for agricultural sector in the UK, 1991–2017



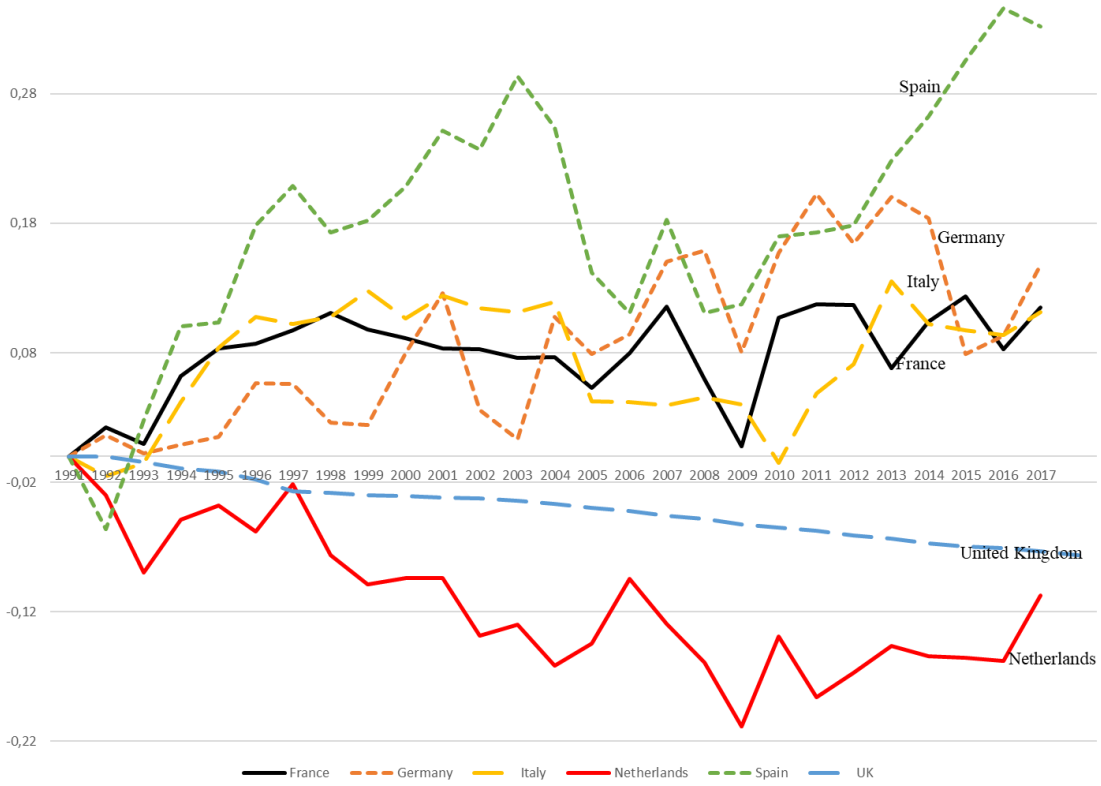
Based on the entire period's averages, one can study the dynamics of price advantages for each stakeholder. Table 4 provides the time trends for the 1991–2017 price advantages.

Table 4. Period trends for each type of price advantage

	Non-salaried labour	Upstream sector	State		Suppliers of intermediate inputs	Salaried labour	Landowners	Fixed capital providers	Banks
			Taxes	Subsidies					
DE	**0.65%**	*n.s*	**-0.07%**	*n.s*	**-0.44%**	*n.s*	**0.18%**	**-0.43%**	**-0.24%**
ES	**0.82%**	**1.15%**	*n.s.*	**0.15%**	**-0.14%**	**-0.05%**	**-0.12%**	**0.22%**	**-0.22%**
FR	**0.22%**	*n.s*	**-0.05%**	*n.s.*	**0.19%**	**0.10%**	*n.s*	**0.07%**	**-0.15%**
IT	*n.s*	**0.51%**	*n.s.*	*n.s*	*n.s*	**-0.04%**	**-0.20%**	*n.s %*	**-0.20%**
NL	**-0.54%**	**0.94%**	**0.94%**	**-0.04%**	*n.s*	**0.07%**	**0.29%**	**-0.07%**	**-0.05%**
UK	**-0.27%**	*n.s.*	**-0.02%**	*n.s*	*n.s*	**0.16%**	**0.11%**	**0.03%**	**-0.18%**

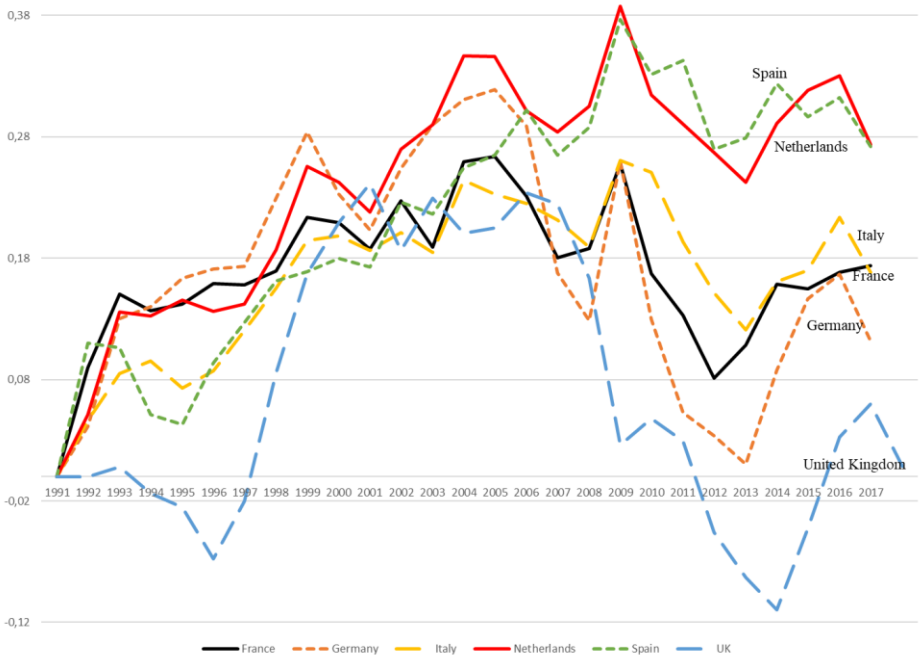
A notable result concerns time evolution for the farmers' price disadvantages (Figure 16). In this respect, the Netherlands and the UK are the only countries for which the trend was negative (0.54% and respectively 0.27% of deterioration per year). The most rapidly improving price advantages trend was Spain (0.82%), followed by Germany (0.65%) and France (0.26%). In Italy, the time trend was not significant throughout the period studied.

Figure 16. Non-salaried labour price advantages indexes for agricultural sectors in the six EU countries (in logarithm terms, 1991=1)



Globally over the period of analysis, the upstream sector was a beneficiary of the distribution game in all countries (Figure 17). However, three sub-periods of evolution can be detected. After a significant increase up to the mid-2000s, the price advantages recorded a substantial deterioration until the early 2010s (except for Spain and Netherlands). Over the last years of analysis, there was an upsurge of these measures. Overall, the most important growth rate was observed in Spain (1.15%), followed by the Netherlands (0.94%) and Italy (0.51%). In Germany and France, the upstream sector's advantages deteriorated severely, and it was only during a few recent years (2012 and 2013) that the trend became positive again. In the UK, the upstream sector started to be positive only in the late 1990s. The UK upstream sector was most seriously affected by the application of the midterm review in the mid-2000s, when the sector's price advantages began to decline, becoming even negative between 2012 and 2015.

Figure 17. Upstream sector price advantages indexes for agricultural sectors in the six EU countries (in logarithm terms, 1991=1)



The stakeholder state intervenes at two levels: first at the national level through the taxes collected and second at the EU level through the subsidies granted. Concerning the first level, whereas the state generally obtained weak tax-related price disadvantages in all countries (Figure 18), in the Netherlands, the price advantages were strongly positive with a significant growth trend (0.94% per year). At the second level, the state incurs a price disadvantage related to subsidies granted (Figure 19). While the state price disadvantages were relatively null in Germany and the Netherlands, they were much more important in France (Figure 11) and in the UK (Figure 15).

Figure 18. Tax-related price advantages indexes for agricultural sectors in the six EU countries (in logarithm terms, 1991=1)

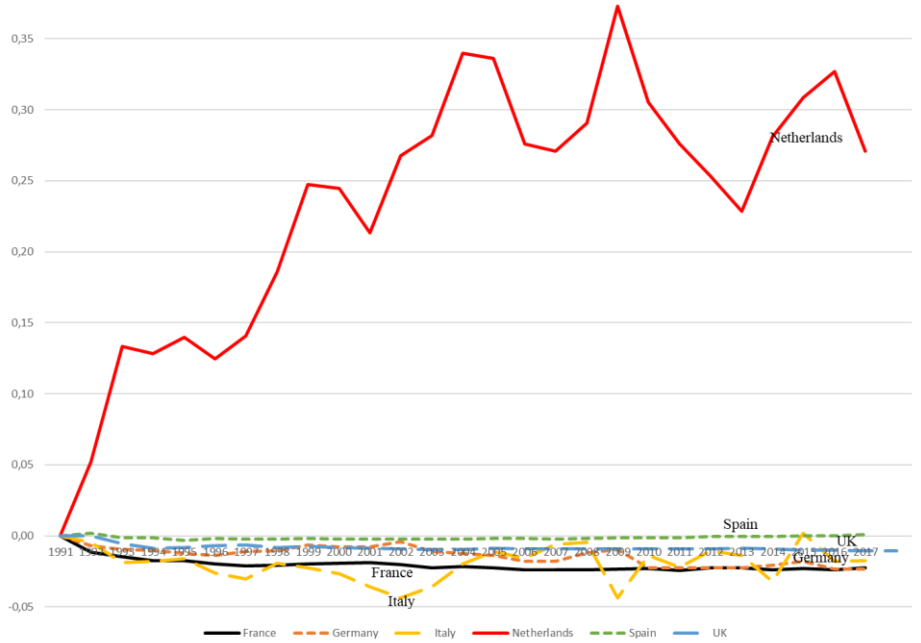
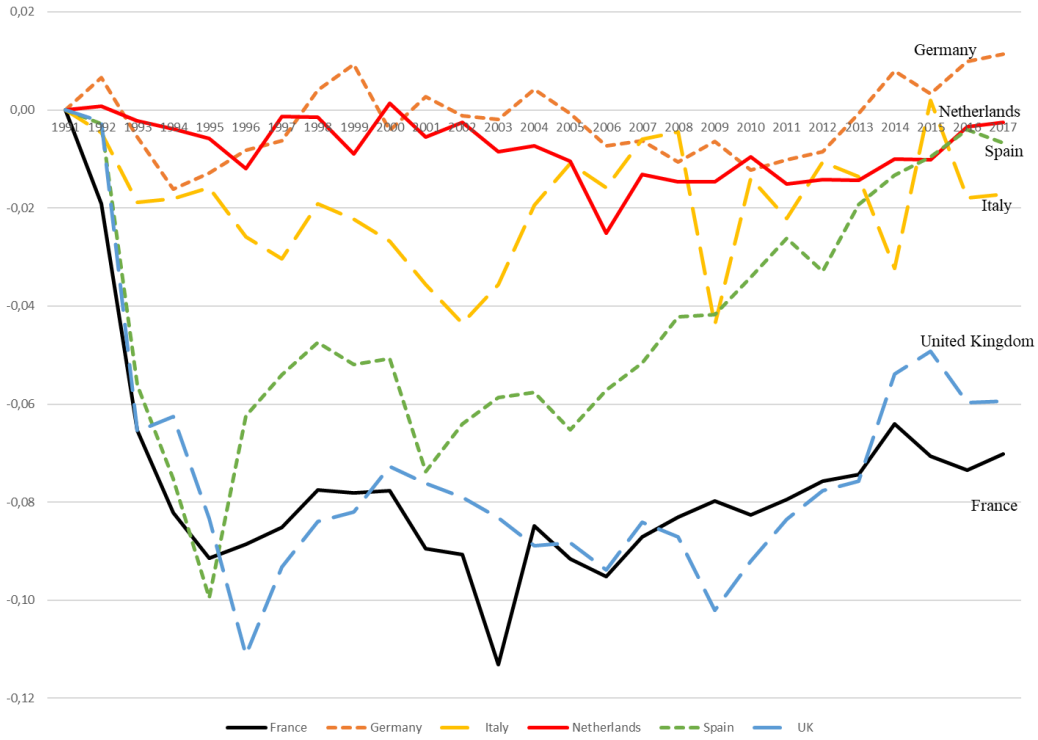


Figure 19. Subsidy-related price advantages indexes for agricultural sectors in the six EU countries (in logarithm terms, 1991=1)



6. Discussion and Conclusion

This article applies the productivity surplus account method (PSAM) to the farm sector for the main EU members and the UK for the period from 1991 to 2017. Compared to traditional methods of calculating TFP growth based on the index number approach, our method proposes to take into account the comprehensiveness of the profit and loss account. Thus, important farm sector stakeholders, such as the banks and the state, which may be ignored in traditional methods, are taken into account with the PSAM. Another characteristic of this approach is that it can determine stakeholder's price advantage, which allows for meaningful comparisons to be made between member states.

This article has shed light on the evolution of the TFP index since 1991 for the six main agricultural sectors in the EU. Whereas productivity gains have been positive, on average, in Spain, France, Italy and the Netherlands, the trend has been non-significant in Germany and the UK. We are not aware of any previous studies at country level covering this exact period of time. However, our results seem to be in line with previous research showing that for major EU members, productivity growth has been relatively low (Baráth and Fertő 2017). Also, previous research (Schimmelpfennig, and Thirtle, 1994; Thirtle et al. 2004) has detected poorer performance for the UK farm sector than the major EU counterparts for a period preceding our period of study. This could explain our results regarding declining productivity growth.

In all countries studied, the main beneficiary of these productivity gains has been the upstream sector. Farmers have benefited to a relatively low extent. For the UK farmers, the price disadvantages have been the most notable, as the productivity losses generated by the UK

agricultural sector are correlated with the decline in farmers' incomes. Moreover, in the perspective of Brexit, the removal of CAP direct payments is likely to have significant effects on profitability for most of the British farms. Therefore, the sustainability of many farms highly dependent on these subsidies, mainly beef and sheep, is uncertain under any trade scenario considered (Hubbard, 2019).

The state has been a net contributor to the farm sector (negative price advantages) in all countries, except for Spain. For France and the UK, the state's share has been the largest, mainly due to the subsidies granted. If, however, we distinguish between tax price advantages (attributed to the national government) and subsidies (granted through the CAP), in the case of the UK agricultural sector, one notices that Europe has suffered more substantial price disadvantages than the UK government.

Our results are consistent with previous studies conducted with industry-level and even farm-level data in France (Boussemart et al., 2012; Veysset et al., 2019). Indeed, TFP gains have been relatively weak in France over the last thirty years, and, moreover, farmers have lost their advantages in the distribution game. The upstream sector has beneficiated to a large extent from these advantages. In the case of France, the main loser has been the state, especially through the subsidies granted.

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