Development of Total Factor Productivity of dairy farms in Germany

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Abstract

In this paper we analyse the development of Total Factor Productivity (TFP) of dairy farms in Germany using the Fisher Index Method. Balanced farm panels are selected from the German Farm Accounting Data Network representing about half of dairy farms and two thirds of milk production. Fisher indexes are computed at the farm level and normalized for each farm; results are aggregated by regions and size classes, weighted by the farm individual weighting factors. Normalized TFP Indices show similar tendencies over time for most regions: a low increase in the first two years, then a decrease in 2007/08, the year with highest milk prices in the underlying period, and an upward tendency of TFP when milk prices reached their lowest levels. In most regions positive scale effects on TFP can be considered; annual increasing rates are generally lower than 1 %. The variation of subsidies shows that TFP's are slightly higher in small farms with subsidies and vice versa for large farms without subsidies.

Keywords: *Total Factor Productivity, dairy farms, subsidies, Farm Accountancy Data Network*

Zusammenfassung

Entwicklung der totalen Faktorproduktivität in Milchviehbetrieben in Deutschland

In diesem Beitrag wird die Entwicklung der totalen Faktorproduktivität in Milchviehbetrieben in Deutschland unter Verwendung der Fisher-Index-Methode analysiert. Aus dem Datensatz des Testbetriebsnetzes werden identische Betriebe mit Milchviehhaltung im Zeitraum 2005/06 bis 2012/13 selektiert. Diese repräsentieren etwa die Hälfte der Milchviehbetriebe und zwei Drittel der Milchproduktion in Deutschland. Fisher-Indizes werden auf Betriebsebene berechnet und auf das Basisjahr normiert. Die Ergebnisse werden mit den Hochrechnungsfaktoren gewichtet und nach Regionen und Größenklassen aggregiert.

Im Vergleich zu kleinen Betrieben weisen große Betriebe einen stark steigenden Vorleistungseinsatz auf, durch Preiserhöhungen einerseits und Ausdehnung der Milchproduktion andererseits. Bei den Erlösen gibt es einen klaren Aufwärtstrend vor allem in großen Betrieben. Betriebe im Westen Deutschlands zeigen eine größere Dynamik beim Vorleistungseinsatz und Erlösen als Betriebe in den östlichen Ländern.

Die normierten TFP Indizes zeigen eine ähnliche zeitliche Entwicklung auf regionaler Ebene, und zwar eine geringe Zunahme in den ersten zwei Jahren, dann eine Abnahme in 2007/08, dem Jahr mit der höchsten Milchpreisen im zurückliegenden Zeitraum, und eine Aufwärtstendenz bei niedrigen Milchpreisen. In den meisten Regionen sind positive Skaleneffekte zu verzeichnen. Die Wachstumsraten der TFP's belaufen sich auf unter 1 % pro Jahr.

Schlüsselworte: *Faktorproduktivität, Milchviehbetriebe, Subventionen, Testbetriebsnetz*

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1 Introduction

Agricultural productivity is an important performance indicator of the agricultural sector. Improvement of productivity is a factor for farmers to make profits and keep their businesses competitive. Therefore, analyses of development of productivity are of interest for farmers and policy makers.

The underlying paper is a contribution to the activity of the OECD Farm Level Analysis network (Kimura, 2015), dealing with the analysis of productivity in some OECD Member States. The focus is on farm level analysis which can be seen as a complement to analyses at sector and regional levels, i.e. Ball et al. (2010). Referring to the importance of sectors of production, the dairy sector has been chosen for the first project phase.

Beside the conception work of Sheng et al. (2013b), Gray et al. (2014), the OECD commissioned a software tool in SAS to compute Fisher TFP Indexes for both, the aggregated sector level and the farm level. The model is used to estimate TFP's for a balanced panel of dairy farms drawn from the German Farm Accounting Data network, covering about half of dairy farms in Germany.

Beside the theoretical concept, the method and data are briefly described in Section 2. Section 3 describes characteristics of farms differing by size, location and the development during the underlying period from 2005/06 to 2012/13. TFP estimates are presented in Section 4, where policy variables are considered by simulations with and without direct payments. Conclusions on the development of TFP and referring to the method are given in Section 5.

2 Method and data

2.1 Method

The estimation methods for productive indexes can be categorized into parametric and non-parametric methods (Grilliches, 1996). 'The former involves econometric modelling of a production function and often uses regression techniques to estimate the relationships between total outputs and major types of inputs, […] The residual of these regressions can be used as a measure of total factor productivity' (Zhao et al., 2011). An example is the analysis of TFP between organic and conventional farms in Germany based on Stochastic Frontier Analysis (Tiedemann and Latacz-Lohmann, 2011). Index methods as Laspeyres, Paasche, Fischer, Tornqvist indexes as well as the Malmquist, Lowe, Hicks-Moorsteen and Färe-Primont indexes, – are non-parametric methods, the latter mainly computed based on Data Envelopment Analysis (O'Donnell, 2011, 2012a, b).

The Fischer Index is recommended by Zhao et al. (2011). It is a combination of the square root of the product of the Laspeyres and Paasche Index. Diewert (1992) shows that the 'Fischer Index is exact for a quadratic cost function […] while the 'Tornqvist index is exact for a Translog cost function'. With regard to data requirements, an advantage is that the Fischer Index can work with missing or negative data and is therefore more appropriate for individual farm data. Analyses for US Agriculture based on the Fischer Index were realised by Ball et al. (2010) and Sheng et al. (2013a).

The Fisher price index is computed as the geometric mean of the Laspeyres index and the Paasche index referring to Sheng et al. 2013b; it is composed by the Fisher output index $P^{F}_{t\text{-}1,\,t}$ and the Fisher input index $W^{F}_{t\text{-}1,\,t}$:

$$P^{F}_{t\text{-}1,\,t} = \left(P^{L}_{t\text{-}1,t} P^{P}_{t\text{-}1,t}\right)^{1/2} = \left(\frac{\sum_{i=1}^{N} p_{it} q_{i,t\text{-}1}}{\sum_{i=1}^{N} p_{i,t\text{-}1} q_{i,t\text{-}1}} \frac{\sum_{i=1}^{N} p_{it} q_{it}}{\sum_{i=1}^{N} p_{it\text{-}1}\, q_{it}}\right)^{1/2}$$

$$W^{F}_{t\text{-}1,\,t} = \left(W^{L}_{t\text{-}1,t} W^{P}_{t\text{-}1,t}\right)^{1/2} = \left(\frac{\sum_{j=1}^{M} w_{jt} x_{j,t\text{-}1}}{\sum_{j=1}^{M} w_{j,t\text{-}1} x_{j,t\text{-}1}} \frac{\sum_{j=1}^{M} w_{jt} x_{jt}}{\sum_{j=1}^{M} w_{jt\text{-}1}\, x_{jt}}\right)^{1/2}$$

where

$$P^{L}_{t\text{-}1,\,f} = \frac{\sum_{i=1}^{N} p_{it} q_{i,t\text{-}1}}{\sum_{i=1}^{N} p_{i,t\text{-}1} q_{i,t\text{-}1}} \quad \text{and} \quad W^{L}_{t\text{-}1,t} = \frac{\sum_{j=1}^{M} W_{jt} x_{j,t\text{-}1}}{\sum_{j=1}^{N} w_{j,t\text{-}1} x_{j,t\text{-}1}}$$

are the Laspeyres index

and

$$P^{P}_{t\text{-}1,\,t} = \frac{\sum_{i=1}^{N} p_{it} q_{it}}{\sum_{i=1}^{N} p_{it\text{-}1} x q_{it}} \quad \text{and} \quad W^{P}_{t\text{-}1,\,t} = \frac{\sum_{j=1}^{M} w_{jt} x_{jt}}{\sum_{j=1}^{M} w_{jt\text{-}1} x_{jt}}$$

are the Paasche index.

$p_{it\text{-}1}$, p_{it}, $w_{jt\text{-}1}$ and w_{jt} represent the prices of the *i*th output or *j*th input items in the base (*t-1*) and current periods (*t*), and $q_{it\text{-}1}$, q_{it}, $x_{jt\text{-}1}$ and x_{jt} are the quantity of the *i*th or *j*th item in the two periods. TFP is computed as $P^{F}_{t\text{-}1,\,t} / W^{F}_{t\text{-}1,\,t}$.

TFP Indexes are computed at farm level using the program provided from OECD [1]. As the indexes are related to a reference farm and a base period, TFP indexes are normalized for each farm to base period in a next step. Results are further aggregated by four regions and five size classes using the farm individual weighting factors.

2.2 Data preparation

Farm data are taken from the German FADN (Farm Accountancy Data Network). [2] For the selection of farm samples there are two options. With focus on representativeness all (representative) farms with milk production should be included. If the focus is on farm development balanced samples of farms with milk production over the whole period are preferred. Otherwise – in case of resampling farms in FADN – the calculation of normalized indexes referring to the first year is not possible (see section 4.2). Effects of resource allocation due to considerable structural change are implicitly included in the sample, as can be seen by trends of milk production by regions and size classes in Figure 1.

Balanced samples of farms were selected for the period of the economic years 2005/06 to 2012/13. To take account

[1] The OECD secretariat provided software for the calculation of aggregated and farm level TFP indexes. Test calculations show that results are similar, but farm level TFP calculations allows for more dis-aggregated results. In this paper we only describe farm level TFP results.

[2] BMELV-Testbetriebsnetz.

of shares of size classes on milk production in Germany, a minimum farm size of 25 dairy cows is considered. The sample covers about half of dairy farms with two thirds of milk production in Germany. To distinguish by locations and farm size, farms are clustered into five size categories based on average milk production [3] and four regions [4]. Further distinctions are made by farms with negative or positive balances of total output minus total inputs, exclusive direct payments as output or inclusive of them [5].

The application of the Fisher index requires quantities and prices for both, outputs and inputs. The aggregation of outputs and inputs were defined by the OECD Farm Level Network, and templates specified for US, Australian and EU data bases (Kimura, 2015). Farm data are taken from the German Farm Accounting Data network, where model variables are computed referring to the EU FADN template. Quantities and prices are available in the data for the main outputs, while the latter are derived from sales values and quantities. In case of aggregated output, i.e., for beef, pigs etc., the monetary values were split into quantities and price vectors using price indexes of the German Statistical Office. Plausibility checks are made and observations with extreme values and missing data for milk are cancelled.

In contrast to output figures, all inputs are only available as monetary values at the whole farm level. Further, own factors such as family labour, own land and capital have to be evaluated by opportunity costs. Monetary inputs are split into quantities and prices referring to price indexes from the Statistical Office. They are only available at the national level and might in time deviate from real price conditions at the farm and regional levels. Opportunity costs of family labour and own land are computed based on land rental prices (for land rented) and wages of hired labour by administrative regions of the Länder, main farming types and years. This seems to be a good approximation, as the computation at a more disaggregated level would cause a considerable share of outliers. Own capital is valued close to the key interest rate of the European Central Bank.

Table 1 describes selected output and input variables used as well as some structural characteristics of farms. The farm sample includes 2,904 farms annually, representing 57,100 farms with milk production in Germany, or two third of German milk production.

[3] Size categories in tons of milk production (averages over the years): '<250': < = 250 tons; '<500': >250 …<500 tons; '<750': >500 … < = 750 tons; '<1000': >750 … < = 1000 tons; '>1000': >1000 tons.

[4] North/West: Schleswig Holstein, Niedersachsen, Nordrhein-Westfalen; Centre: Hessen, Rheinland-Pfalz, Saarland; South: Baden-Württemberg, Bayern; East: Mecklenburg-Vorpommern, Brandenburg, Sachsen, Sachsen-Anhalt, Thüringen.

[5] While subsidies are often excluded in TFP analyses (Kimura, 2015) it seems to be worthwhile to include them in time series analyses, to take account of milk market reform from 2003 to 2007, where support prices were reduced and milk premia were introduced, being coupled in the first period and decoupled since 2005/06. However, the effect of subsidies on TFP is rather marginal, as has been proved by test calculations and results shown in Figure 10.

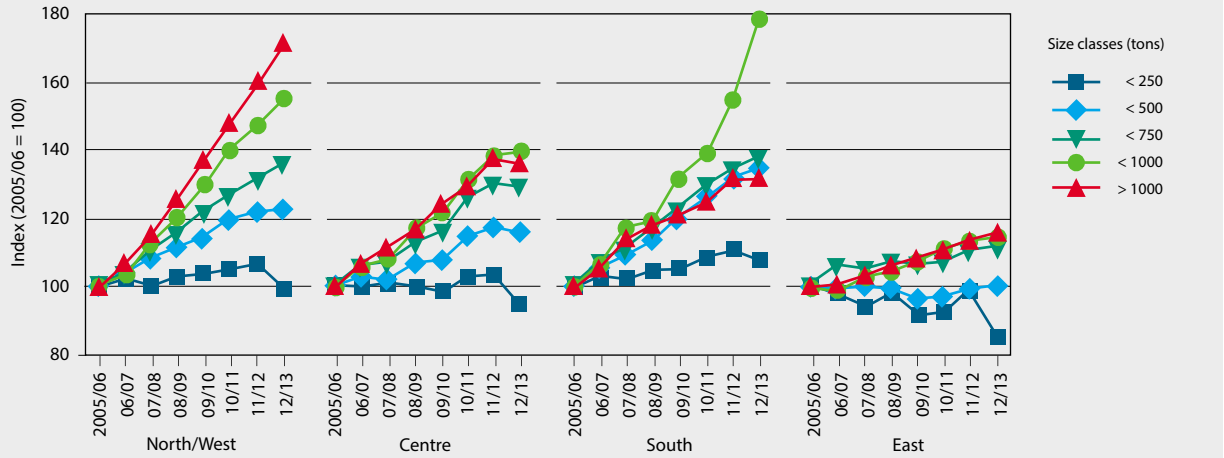
Table 1
Characteristics of farms by size classes (2012/13)

Size class milk	tons	<250	<500	<750	<1000	>1000
Farms	n	1.229	833	354	135	353
Farms represented	n	35.311	14.099	4.550	1.324	1.840
Milk production						
Mean	kg	134.645	353.135	598.426	861.972	2.704.294
StdErr	kg	611	1.085	2.095	5.112	45.099
Land use						
Mean	ha	37	66	94	144	904
StdErr	ha	0	0	1	6	17
Labour unpaid						
Mean	AWU	1	2	2	2	1
StdErr	AWU	0	0	0	0	0
Labour hired						
Mean	AWU	0	0	1	1	19
StdErr	AWU	0	0	0	0	0
Aggr. Output						
Mean	€	85.642	193.086	305.916	441.003	1.873.046
StdErr	€	592	1.007	1.845	7.132	33.759
Aggr. Input						
Mean	€	126.584	226.627	325.020	434.765	2.401.480
StdErr	€	667	1.112	2.357	7.730	57.768

Source: Author's calculation based on BMEL Testbetriebsnetz.

3 Structural indicators and farm development

As mentioned before, farms are clustered by regions and five size categories. The sample covers two thirds of milk production in Germany in 2012/13, where 33 % are located in region North/West, 6 % in region Centre, 36 % in region South and 24 % in region East. Referring to size, about 25 to 27 % each is produced in size categories <250, <500 and >1000 tons, while 15 % is produced in category <750 and 7 % in category <1000. The development of milk production is quite diverse due to quota trade at the regional level, as well as by scale effects, especially for farm buildings and machinery. Small farms (<250 t) in the regions of Germany West increase production up to 10 %, whilst lowering production in 2012/13 shortly before phasing out of the milk quota regulation. In the South, farms in size categories <500 and <750 successively increase milk production up to one third in 2012/13, but with an increase of 80 % in size class <1000 and therefore much more than of the largest size class. This indicates, that reallocation of production in this region is in favour of farms below 100 dairy cows. Large farms (>1000 t) in region North/West increase milk production by 70 to 80 %, indicating a reallocation of production from small to farms with more than 100 dairy cows. The situation is less dynamic in the East, where large farms are dominating. Small farms reduce milk production and large farms increase their size only by 15 %. The latter might be an effect of competition on the land market, where large scale arable production is favoured by decoupled direct payments – against dairy and (other) cattle production (Kleinhanss, 2013; 2012; 2011). A similar development can be seen for land use (but on a lower level): small



Source: Author's calculation based on BMEL Testbetriebsnetz.

Figure 1
Development of milk production (2005/06 = 100)

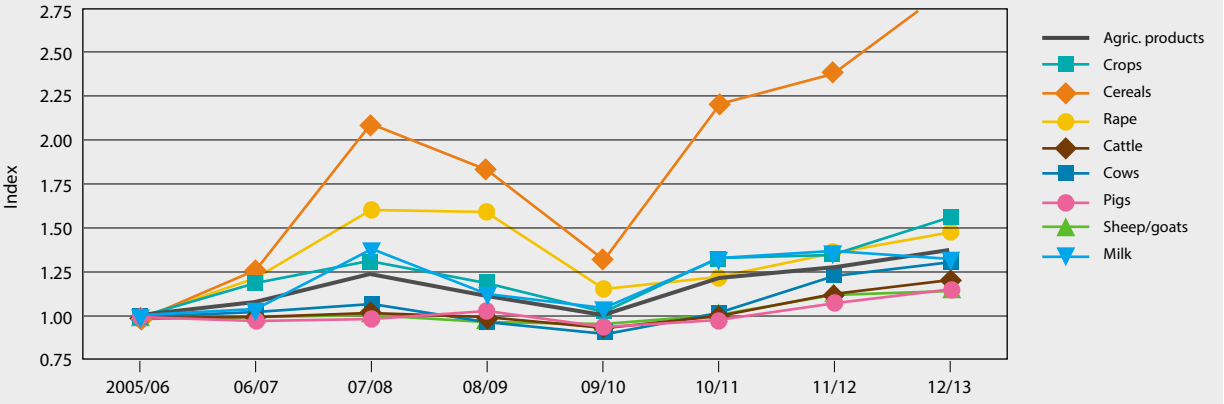


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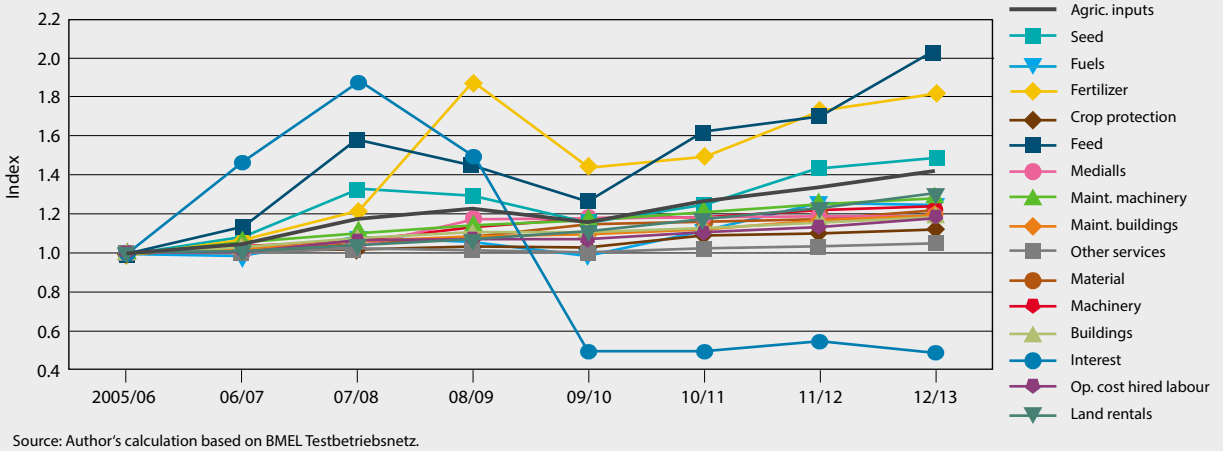
Figure 2
Development of output prices (index 2005/06 = 1)



Source: Author's calculation based on BMEL Testbetriebsnetz.

Figure 3
Price index of inputs (index 2005/06 = 1)

farms in the West as well all farms in the East are stagnating, while large farms increase land use by up to 20 %.

Overall trends of output and input prices are expressed by price indexes referring to the first period. For products, price for cereals shows the highest increase, followed by oilseeds and milk. The development is characterized by a large increase during the price boom in 2007/08, a drastic fall during the economic crisis, and a further boom for cereals since 2010/11

Within inputs prices of fertilizer and feed increased most, the latter correlated with cereals. While interest rates increased until 2007/08, they fell strongly under the monetary policy of the European Central Bank.

Details on milk prices and land rental prices by regions, derived from farm accounting data, are given in Figures 4 and 5. **Milk prices** show a rather high variation in time: levels of the first two years were determined by intervention prices, and then a price boom in 2007/08 determined by globalization and a strong demand from the world market; followed by very low prices under the economic crisis, and a recovery and stabilisation at an above average level since 2011. Region South shows higher milk prices thanks to higher shares of hard cheese processing and milk exports to Italy.

The change of **land rental prices** is significant; changes in absolute terms are about 40 to 50 €/ha. There are considerable regional differences with highest levels in North/West and low levels in the Centre and East, while the latter is an effect of transformation of agriculture since reunification and often long term rental contracts.

Based on the underlying data the totals of outputs and inputs, as well as margins of total outputs minus total inputs, are calculated. This results in the interesting insight that (including direct payments) less than 20 % of farms have positive margins with high variation in time and by regions (Figure 6). In the North/West and East shares are above average, while in the South only 5 % of all dairy farms reach positive margins.

The situation becomes much worse if subsidies (direct payments) are excluded from the output. In this case less than 10 % of farms reach positive margins. This is the

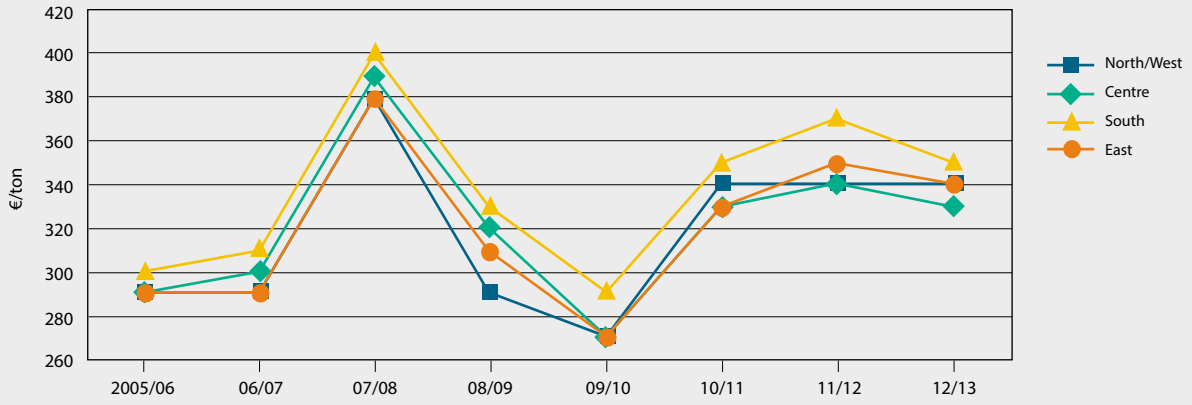


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Figure 4
Development of milk price

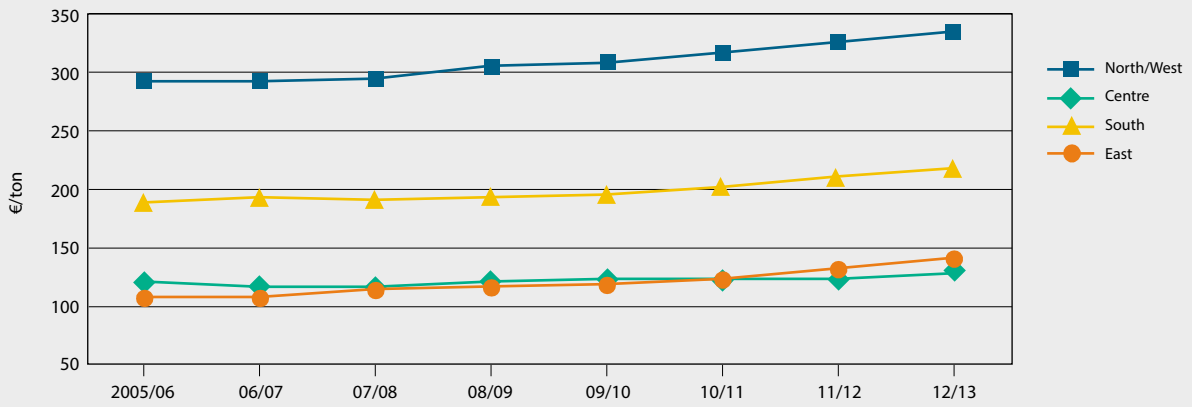

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Figure 5
Development of land rental price

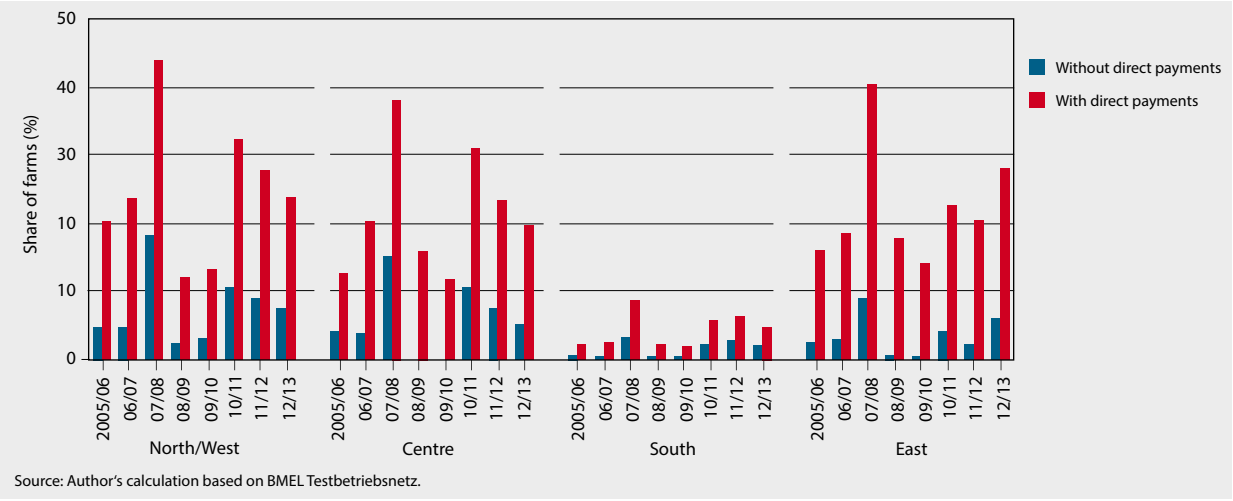


Figure 6
Share of farms with positive margins (total output minus total input) with or without direct payments

situation for TFP analysis where by standard definition – all factors are remunerated (own factors by opportunity costs) and subsidies not considered.

As a consequence we run the model including direct payments as output in the standard version, and without direct payments in an alternative scenario. Further we differentiate TFP results by farms with negative and positive margins.

4 TFP results

All TFP results shown in the following are based on farm individual indexes, weighted by the individual weighting factors. At first we discuss the direct outcome of TFP's calculations, referring to a reference farm in the first year. Then we show normalized TFP's, as well as of aggregated input and output. Further differentiations are made with and without direct payments and clusters with positive or negative margins. Outputs including direct payments are used as standard TFP model.

4.1 Absolute TFP indexes

Absolute TFP indexes, differentiated by four regions and five size classes, are shown in Figure 7. TFP levels show a clear ranking up to size class <750, with lowest levels for small farms and higher levels for next size classes. TFP levels of farm <250 tons are 0.8 in region North/West, 0.7 in Centre, 0.75 in region South and 0.6 in region East. They are rather stable in time, beside the South with a slight increase since 2009/10. Size class <500 shows a slight increase of TFP with the exception of region East. The development is similar for size class <750 in Germany West. Scale effects are not at all clear for size categories <1000 and >1000 referring to the ranking and tendency. This is especially the case in region East, where size class <750 shows the highest TFP level, while the largest category is even lower than of size class < 500.

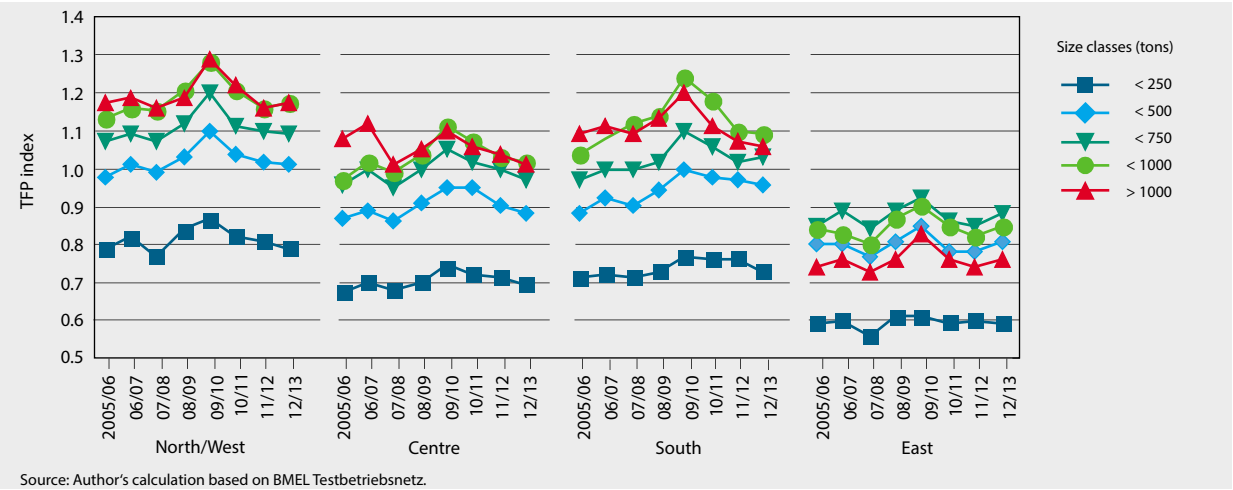


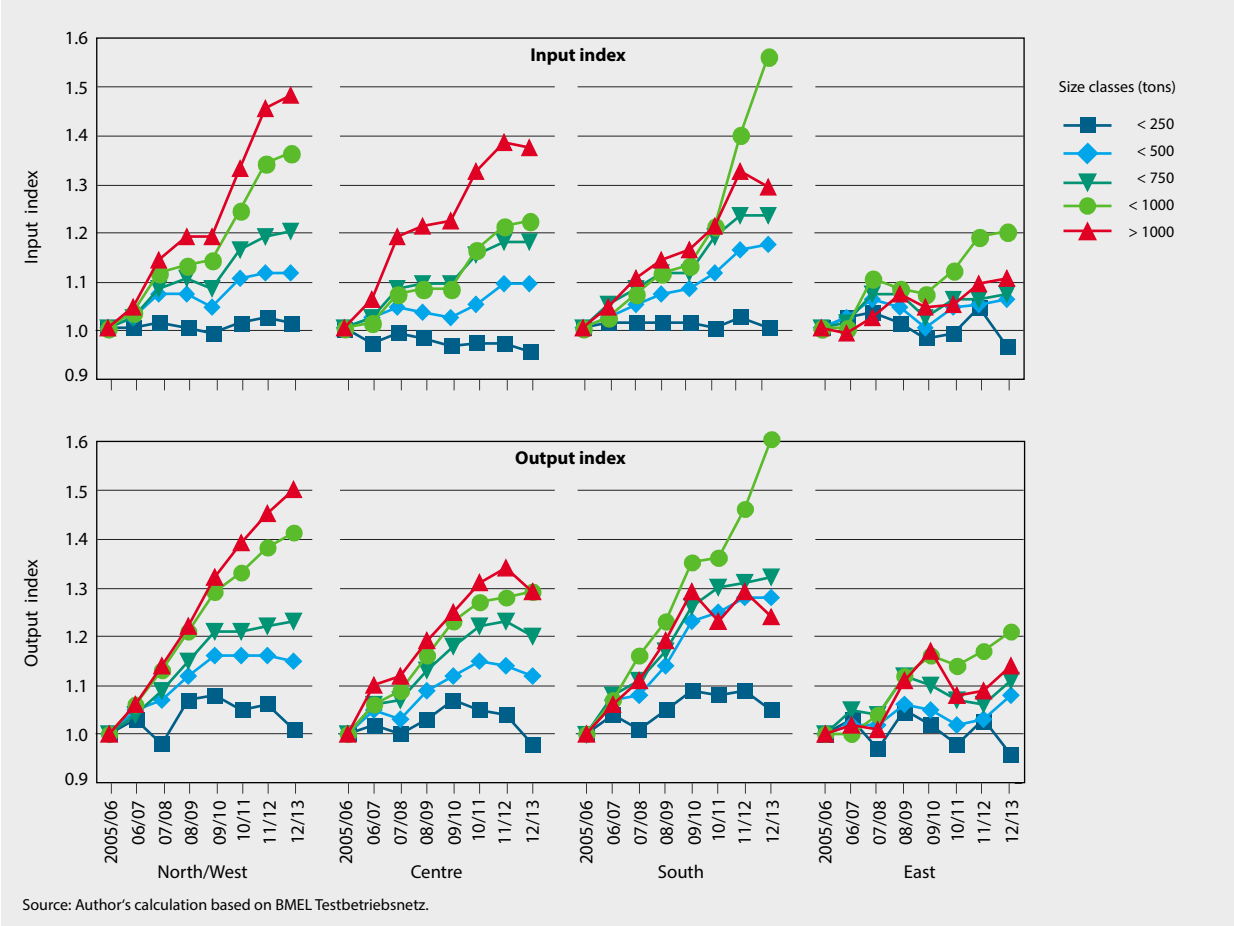
Figure 7
Development of TFP (abs.) by regions and size classes

Concerning the development in time there are similarities, with rather low levels in the first year, when the economic performance of dairy farms was rather weak. Next an unexceptional slow-down in 2007/08 when milk prices as well as profits [6] [7] were most favourable and then an upward tendency under the economic conditions of the economic crisis, expressed by low milk prices, but higher input prices, especially for fertilizer and feed.

4.2 TFP's normalized

Development of TFP can better be explained based on normalized indexes (see Section 2.1). Input, output and TFP indexes are normalized for each farm referring to the first period; results are summarized in Figure 8.

Concerning the development of **inputs** it's interesting to see that small farms have a rather constant input level, meaning that they don't use many chemical inputs, energy and purchased feed. Another factor could be that price effects are outbalanced by shrinking production especially for milk (see Figure 1). The development can be summarized as follows: an increase from 2006/07 to 2007/08, then a slowdown in following two years (economic crisis), and a further significant increase since 2009/10, mainly due to rising feed costs. Referring to region North/West, input indices increase – until the last period – by 10 % in size class <500, 20 % in class <750, 35 % in class <1000 and 50 % in largest farms. Increases are slightly lower in region Centre and higher in region South with an exceptional increase of size class <1000. This is also a signal of a rather dynamic farm development towards increasing milk production by 80 % (see Figure 1). Changes of aggregated input is rather low in region East with an increase of 5 to 10 % in medium sized farms and only 20 % in large farms. This is an indication that farms are more diversified in milk and crop production; about half of Legal Entities are classified as farm type 'Mixed'.

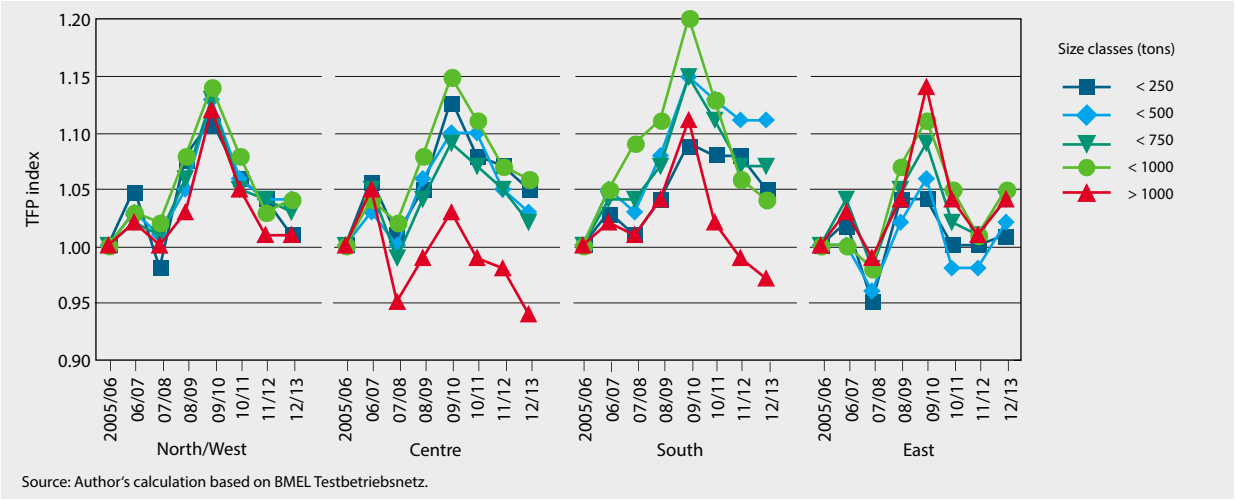


Source: Author's calculation based on BMEL Testbetriebsnetz.

Figure 8
Development of TFP input and output index (normalized) by regions and size classes

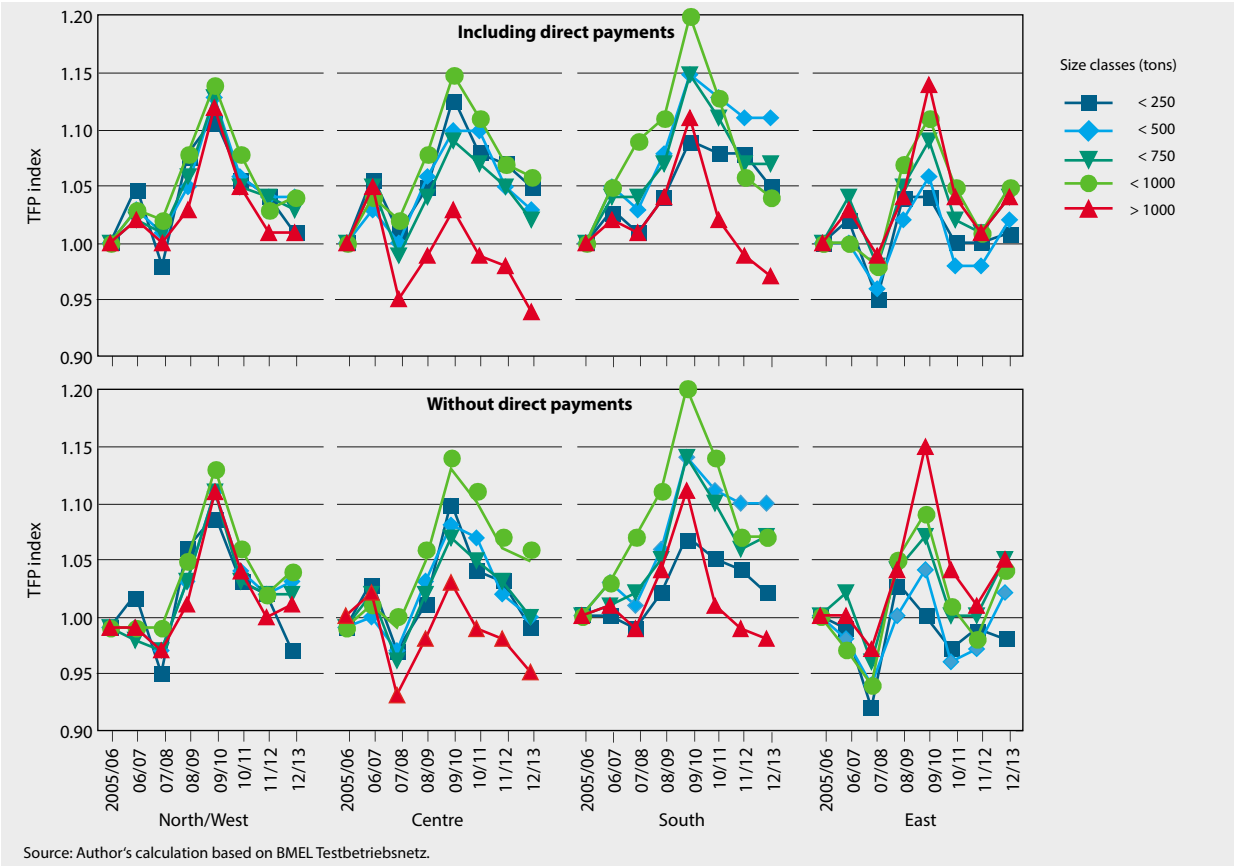
[6] https://www.ti.bund.de/de/thema/einkommen-und-beschaeftigung/einkommen-in-der-landwirtschaft-ein-dauerbrenner/einkommens-und-betriebsentwicklung/

[7] http://www.bmelv-statistik.de/fileadmin/user_upload/monatsberichte/BFB-0111101-2011.pdf



Source: Author's calculation based on BMEL Testbetriebsnetz.

Figure 9
Development of TFP (normalized) by regions and size classes



Source: Author's calculation based on BMEL Testbetriebsnetz.

Figure 10
Development of TFP (normalized) with and without direct payments by regions and size classes

The development of **output** is also rather dynamic. An exceptional situation is given for small farms, where output becomes lower in 2007/08 when milk prices were highest. This can also be an indication that these farms are more diversified in livestock production, i. e., versus beef cattle and pigs, where the prices were very low in this year. Output successively increased in the following years, becoming flatter and even slightly decreasing. Especially the large farms in regions North/West and South increase their output by 50 and 60 %, mainly driven by specialisation and expanding milk production. As for input the development of output is much less dynamic in region East; even the large farm increased output by only 10 and 20 % till the end of period.

The **TFP** index is calculated as aggregated output divided by aggregated input; results are shown in Figure 9. In contrast to output and input, the development is different and shows lower variations. Due to heights and drops it makes no sense to econometrically estimate trends. Instead we evaluate the development by comparing TFP of the last year with the first period.

TFP for most size classes show similar tendencies:

- a slight upward tendency in the 2nd year
- then a significant decrease in 2007/08, meaning that changes of aggregated output were higher than of aggregated inputs
- A continuous rise in next two years, reaching highest TFP's in 2009/10. This might be a result that inputs decreased more than outputs.
- A continuous decrease of TFP at least until 2011/12 and – in a few cases – a slight increase in the last year

In region **North/West** small farms have a rather insignificant increase of TFP in 2012/13. Unexceptionally, this is also the case for size class >1000. Three size classes (<500, <750 and <1000) show similar tendencies and levels in the last year with TFP of 1.04, meaning that annual TFP change is about 0.6 %.

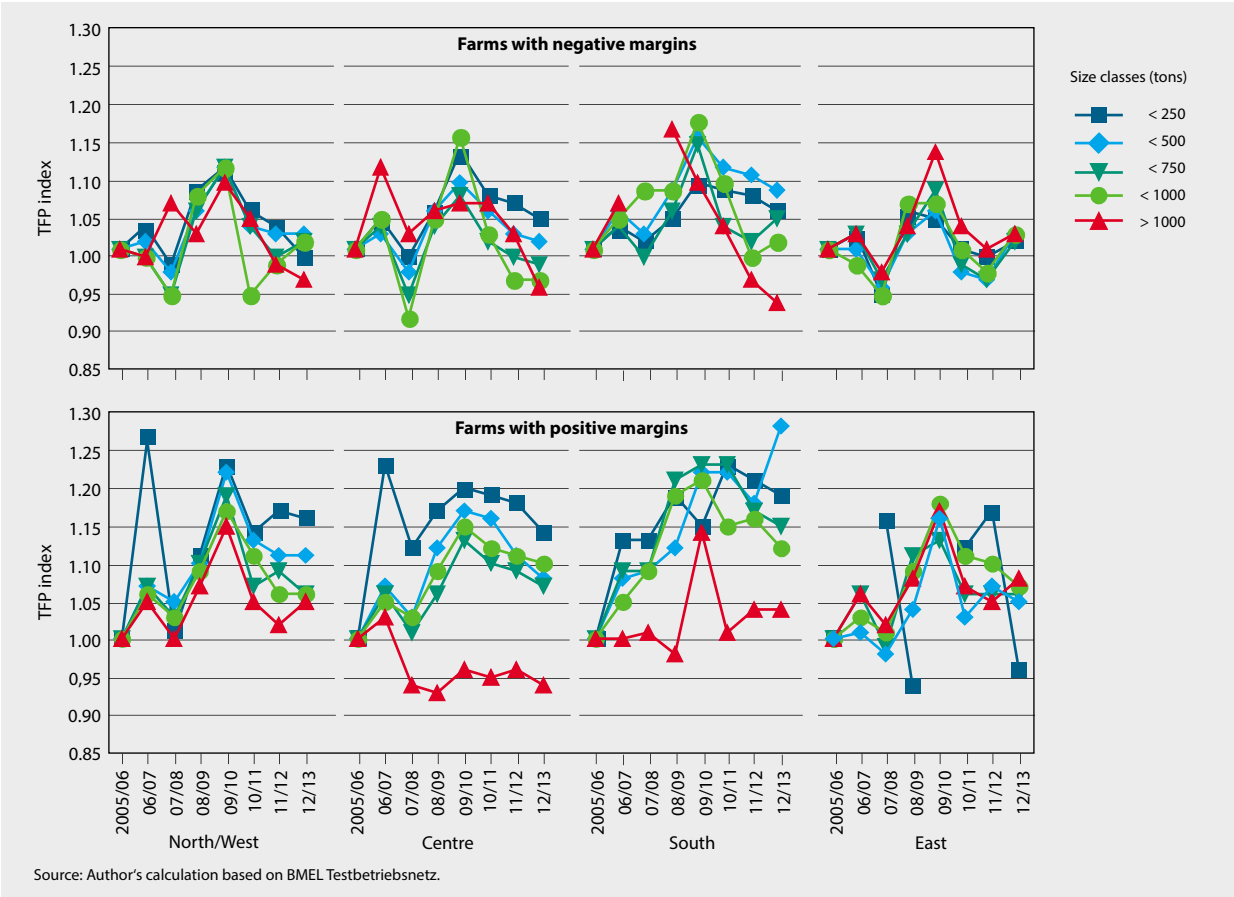
In region **Centre** TFP in farms size class <1000 reach 1.05, which is rather equal to those of small farms. Unexceptionally, the TFP of large farms (>1000) drops to 0.94, indicating an annual decrease of TFP by 1 %.

TFP development in region **South** shows a broader variation. Size class <1000 shows the highest TFP in 2009/10, but then becomes less than of other farms except >1000. The annual TFP increases of three size classes are about 1 % per year. Only in the large farms changes are about -0.5 % per year. Against other regions scale effects with regard to milk are not so clear, because especially the small farms often produce milk and beef (based on Simmental breeds), while large farms are more specialized towards milk, mainly using Holstein Friesian dairy breeds.

Results in region **East** show (<250 and <500) lower variation and lower TFP indexes size class. Large farms approaching TFP levels of 1.05, which is an annual increase of about 0.8 %.

4.3 Further differentiations

The first option considered is the effect of **subsidies**. In the following simulation direct payments are excluded and results compared with the above-mentioned conditions (see Figure 10). TFP changes are rather insignificant from those including direct payments. As a general rule it can be concluded, that TFP in small farms is slightly lower (at the end of period), while it becomes slightly higher in large farms. This indicates a lower dependency of large farms from direct payments, but the differences can hardly be proved by statistical significance.



Source: Author's calculation based on BMEL Testbetriebsnetz.

Figure 11
Development of TFP of farms with negative or positive margins by regions and size classes

The next aspect being tested is the clustering between farms with **negative and positive margins** (total output minus inputs). In this case the number of farms in clusters varies between the years (Figure 11). In general TFP's vary less in farms with negative margins, and the ending level is close to one, meaning almost no change of TFP. In case of positive margins there has been an upward tendency since 2007/08 and a stabilisation until the end of the period. The change of TFP is about 1 to 2.5 % per year.

5 Summary and conclusions

In this paper the development of Total Factor Productivity (TFP) of dairy farms in Germany is analysed using Fisher TFP Indexes. Farm data are taken from the German Farm Accounting Data Network, where a balanced panel of dairy farms over the period 2005/06 to 2012/13 is selected. Templates for data specification have been worked out by the OECD Farm Level Network and software provided by OECD. Due to balanced panels and small farms excluded, the sample represents about half of dairy farms and two thirds of milk production in Germany. The contribution fits into the OECD work program, where cross-country analysis is done for some OECD Member States.

Fisher TFP Indexes are computed at the farm level and normalized for each farm referring to the first year; results are aggregated by regions and size classes weighted by the farm individual weighting factors. Data preparation shows that the total cost assumption deviates from classical farm accounting calculating profit or other income indicators, indicating the remuneration of own factors under the existing economic conditions, i. e., including subsidies from the Common Agricultural Policy. In the classical Total Factor Productivity approaches, there are following significant differences: subsidies are not included in the outputs, while costs of all factors are included, and own factors valuated by opportunity costs. In the case of dairy farms in Germany only 20 % of farms would have positive margins of outputs minus inputs including subsidies.

Aggregated input indexes show almost no variation in small farms, where price changes might be outbalanced by structural change. High input levels for feed, fertilizer and energy, and the strong price increase, induce a considerable increase on aggregated inputs in large farms, underlined by increase of milk production. There is a clear upward tendency for the development of output, especially in large farms. Farms in the West of Germany are more dynamic with regard to inputs and outputs.

Normalized TFP Indices show similar tendencies at regional level over time: a low increase in the first two years, then a decrease in 2007/08, the year with highest milk prices in the underlying period, an upward tendency of TFP when milk prices reached their lowest levels during the economic crisis. In most regions positive scale effects on TFP can be considered; annual increasing rates are generally lower than 1 %. In some cases TFP's of large farms are lower than those of smaller farms. Variation of subsidies show, that with subsidies TFP's are slightly higher in small farms and vice versa for large farms without subsidies.

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