DEVELOPMENT OF PRODUCTIVITY OF PIG FARMS IN GERMANY[1]

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A b s t r a c t. The development and change of productivity, as well as of its influencing factors, is of interest in economic research. In this paper we analyse the development of productivity in pig farms in Germany. Balanced farm panels are selected from the German Farm Accounting Data Network (FADN). As a productivity measure we use the Färe-Primont Index proposed by O'Donnell. Results shows a rather constant productivity level of pig fattening farms and decreasing productivity of farms specialized in piglet production. Due to cyclical pig prices the variation of productivity is rather high in pig farms. Significant scale effects are identified with highest TFP levels of large sized farms. The variation of income over time is much more pronounced than of productivity, which might partially be determined by the rather high aggregation of output and input variables used for the productivity calculations.

INTRODUCTION

The development and change of productivity, as well as its influencing factors, is of interest in economic research. Analysis can be undertaken at the global, sector or micro level. An assessment of productivity changes at the micro level is one of the activities of the OECD 'Network on Farm Level Analyses' for which the author will undertake TFP estimates for Germany. To explore our own experiences in this area, we used a free software package of CEPA[2] which allows the calculation of Total Factor Productivity (TFP) indices, i.e., Laspeyres, Paasche, Fischer, Lowe, Malmquist, Hicks-Moorsteen, and the Färe-Primont Index. However, the free-of charge version is limited to the calculation of the last mentioned tree indices. In this study we use this programme for productivity analysis for balanced samples of farms specialized in pig fattening or piglet production in Germany [Kleinhanss 2012b].

In addition to global productivity development, the question is how productivity is influenced by the huge variation of output and input prices. A further question is whether or not productivity estimates are similar with, for example, income indicators. Our methodology and data are briefly described in the following section. In a further step results of productivity estimates are discussed and finally compared with income indicators.

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METHODS AND DATA

The methods of estimation for productive indices 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. 2012]. An example is the analysis of TFP between organic and conventional farms in Germany based on Stochastic Frontier Analysis [Tiedemann and Latacz-Lohmann 2011]. The so-called index methods – Laspeyres, Paasche, Fischer, Tornqvist – as well as Data Envelopment based Malmquist, Lowe, Hicks-Moorsteen and Färe-Primont indices – are non-parametric methods.

The Fischer Index is recommended by Zhao et al. [2012]. 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, a further advantage is that the Fischer index can work with missing or negative values and is therefore more appropriate for individual farm data. Analyses for US Agriculture based on the Fischer index were conducted by Ball et al. [2010].

Referring to the Lowe and Färe-Primont indices, O'Donnell [2012a] argues that they 'are economically-ideal in the sense that they satisfy all economically relevant axioms and tests from index number theory, including an identity axiom and a transitivity test. This means they can be used to make reliable multi-temporal (i.e., many period) and/or multi-lateral (i.e., many firm) comparisons of TFP and efficiency'. A further advantage of both indices is that prices for inputs and outputs are not required, and shadow prices derived from the Linear Programming solution are used instead. In particular input prices are often lacking at the farm level. An application of the Lowe index for US agriculture at State level was conducted by O'Donnell [2012b].

As the Lowe index can only be calculated with the professional version of DPIN, we focus on the Färe-Primont index, which can be calculated with the free-of charge version [O'Donnell 2011]. Although shadow prices cannot be listed by the free-of-charge version, they are internally calculated.

The Färe-Primont index proposed by O'Donnell [2012a] is composed of two indices developed by Färe and Primont [1995]:

$$TFP_{hs,it} = \frac{D_O(x_0, q_{it}, t_0)}{D_O(x_0, q_{hs}, t_0)} \frac{D_I(x_{hs}, q_0, t_0)}{D_I(x_{it}, q_0, t_0)}$$

The Färe-Primont index is calculated by referring to a reference farm i (to be determined) in the 1st period. To identify a reference farm we used the following procedure. In the 1st run we calculated TFP for all farms referring to farm i. Then we calculated the average TFP for the 1st period over all farms. Next we selected a new reference farm with a TFP closest to the average in period 1. In the 2nd run we used this farm as the reference farm (Ref); therefore TFP's of all other farms and periods are referring to Ref.

Farm data are taken from the German FADN (Farm Accountancy Network).[3] Balanced samples of farms were selected with non-missing data of each input and output used. For pig farms we selected two samples differentiated by farms specialised in fattening or piglet

[3] BMELV-Testbetriebe.

production, covering the economic years 2000_1 to 2010_11. The balanced panel of farms specialized in fattening includes 364 farms, those with piglets 195 farms. Results were stratified with regard to average pig livestock units (LU) over the whole period: <50; 50-100; 100-150 and >150. For the model we used the following set of aggregated variables;

– outputs: pigs (€), other returns including subsidies (€),
– inputs: variable costs of livestock production (€), variable costs of crop production (€), other variable costs (€, excl. land rentals and hired labour costs), land (UAA ha), labour (AWU).

PRODUCTIVITY CHANGE IN PIG FARMS

In this chapter we show first the results for one farm taken as an example. Then we describe changes of productivity for groups of individual farms as well as the variation by farm size.

TFP is calculated at farm level. As an example of the different outcomes of the model run we show changes of TFP and of partial indices for a farm taken as reference in the sample of pig fattening farms. Figure 1 shows the development (change) of productivity (dTFP) over the 11 year period, taking 2000_1[4] as reference. TFP increased in 2001_2, 2006_7 and 2010_11 while it was below 1 in the remaining years. It is the result of changes in output (dQ) referring to changes in inputs (dX). The highest level was reached in 2006_7. TFP shows a rather cyclical development which is partially influenced by pig-price cycles.

Besides TFP, the model also calculates other indicators, of which only changes in technical efficiency (dTech), changes in output-oriented technical efficiency (dOTE) and changes in output-oriented scale mix efficiency (dOSME) are shown. dOTE is close to 1 or greater than 1 indicating a small positive output-oriented efficiency change. While change of technical efficiency (dTech) was less than 1 in 7 years, it significantly increased in the last year.

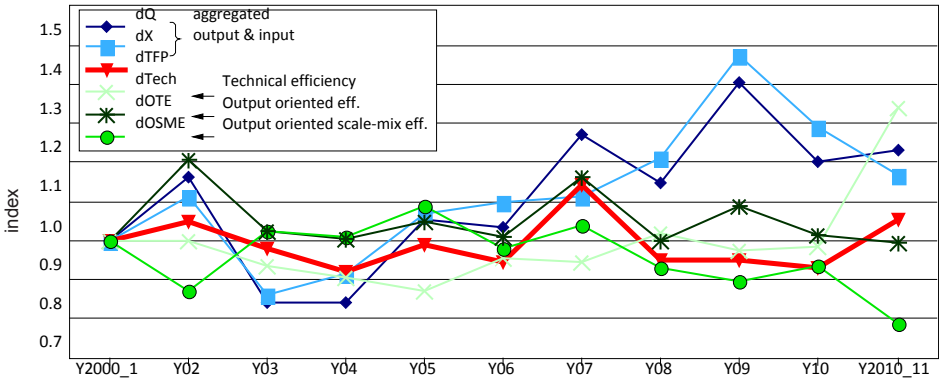

Figure 1. Development and decomposition of productivity – example of one dairy farm
Source: own study based on *BMELV Testbetriebe.*

[4] German FADN data are referring to economic years from July to June. In figures we use the following abbreviation, i.e. Y2000_1, where y: year; 2000: the 2nd half-year of 2000; _1: the 1st half-year of 2001 (or Y02: 1st half-year of 2002. .

TFP BY SPECIALISATION OF FARMS

In the following, TFP results are differentiated between farms specialized in pig fattening or piglet production. Figure 2 shows the development and variation of TFP in farms specialised in pig fattening. The box plot shows the Median and variation (50% of farms between 1st and 3rd Quantile), as well as minimum and maximum TFP's and so called outliers.[5] In the first year, 50% of farms reached TFP levels between 0.94 and 1.07. TFP levels decreased in the following three years and then increased to almost 1.0 on average in 2004_5, 2007_8 and 2010_11. In the interim years, TFP was around 0.95. Referring to the beginning and ending year, there is almost no increase of TFP. The spread of TFP for 50% of farms (box) is almost the same over the years. However, there is large variation from about 0.75 to 1.3 indicated by the vertical bars. Also, many individual coefficients are shown, indicating high TFP's in the upper part and low TFPs in the lower part of the figure. Some farms stay in the same category, i.e., ID=272 with very low TFP and ID=289 with a high TFP.

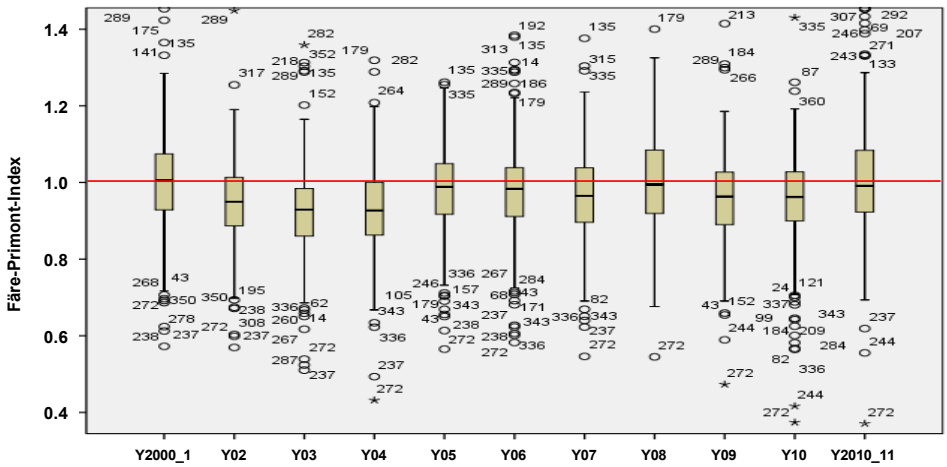

Figure 2. Development and variation of TFP of farms with pig fattening
Source: own study based on *BMELV Testbetriebe,*

TFP of farms specialised in piglet production is shown in Figure 3, indicating a cyclic development of TFP. It reached its highest level in 2000_1, and then decreased to 0.83 in 2002_3 to 2003_4. It increased again to 0.95 in 2004_5, decreased until 2006_7 and fell to the lowest level in 2007_8. Beside the pig price cycle, high price of feed induced this low level of TFP. In 2008_9 TFP increased again to 0.95 and dropped to 0.9 until 2010_11. Therefore TFP decreased 1% annually. Variation of TFP was about 0.2 for 50% of farms; it was rather stable over time. The variation between min and max TFP values was rather high and shows a cyclical development as well. It can be concluded, that the development of TFP in piglet production is more cyclic than in pig fattening with average levels of only 0.8 in 2003_4 and 2007_8.

[5] Minimum and maximum values are defined by 1.5 times of the distance of the box (representing 50% of observations. Outliers are defined by the distance between 1.5 to 3 times of the distance of the box; greater than 3 times of the distance of the box are defined as extreme values.

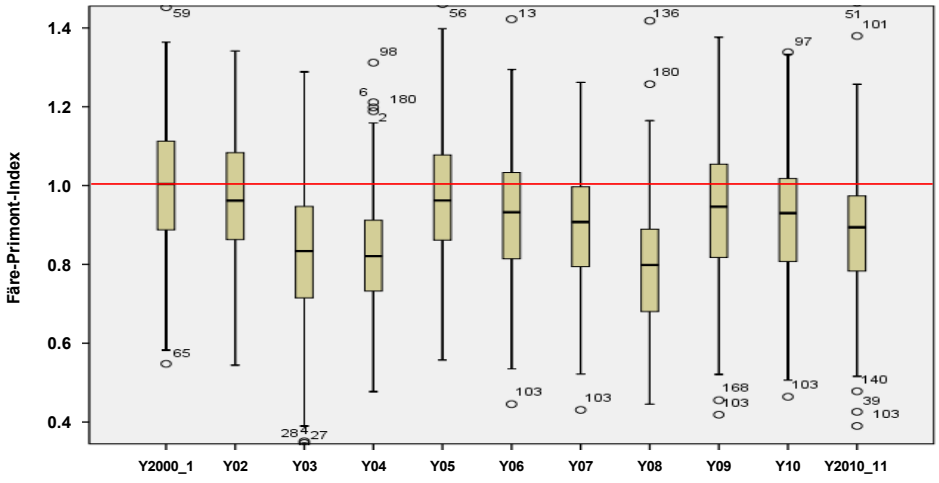

Figure 3. Development and variation of TFP of farms with piglet production
Source: own study based on *BMELV Testbetriebe.*

TFP BY SPECIALISATION AND FARM SIZE

Figure 4 shows average TFP's for both samples as well as by size classes, expressed in pig livestock units (LU). Average TFP of fattening farms is rather constant; it is close to 1 in the beginning, middle and end of the underlying period. It decreased to 0.92 in 2002_3 and the succeeding year and to 0.95 in 2008_9 and 2009_10. Small farms show TFP levels between 0.8 and 0.9. Farms of size class 50 to 100 LU show TFP levels of about 0.05 less than average. TFP for farms with 100 to 150 LU is close to average, while TFP of the largest farms is about 0.03 higher.

Farms specialized in piglet production show a larger variation of TFP by farm size. Small farms show low TFP levels of about 0.85 at the beginning, 0.75 in 2002_3 and 2007_8 and of around 0.8 in the remaining years. The TFP of size class 50-100 LU is slightly below average and those of size class 100-150 LU 0.05 above average. The group of largest farms show a TFP of 1.12 at the beginning and of about 1.05 in 4 other years. It dropped to about 0.85 in 2002_3 and 2007_8. It is worth mentioning that the spread of TFP between large and small farms became rather small at the bottom of a cycle while it broadened to 0.3 under favourable economic conditions.

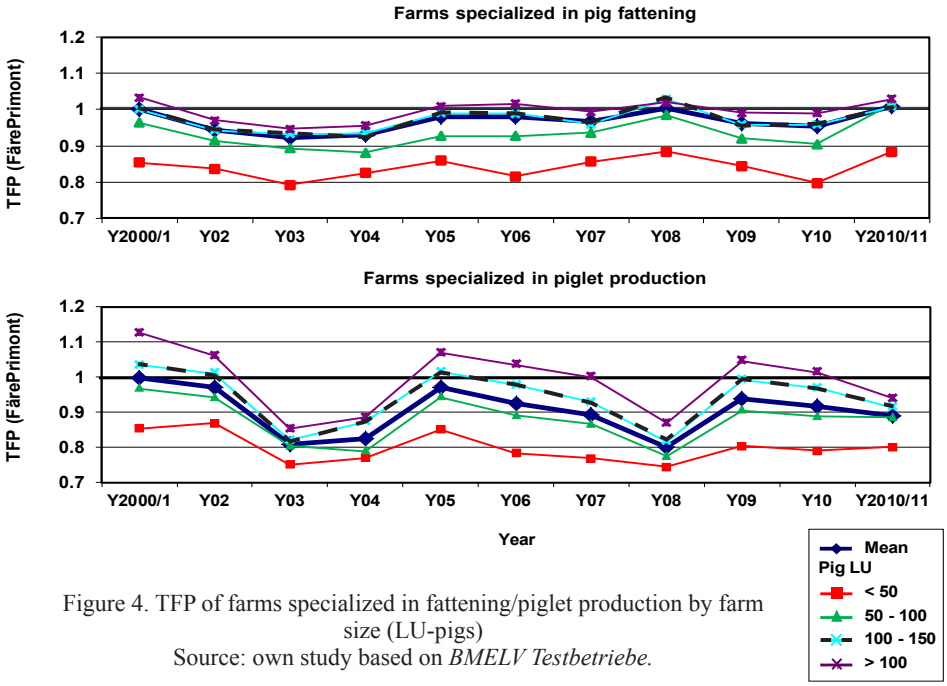

Figure 4. TFP of farms specialized in fattening/piglet production by farm size (LU-pigs)
Source: own study based on *BMELV Testbetriebe.*

COMPARING THE DEVELOPMENT OF TFP AND INCOME

In the following we compare the development of TFP with income. Family Farm Income (FFI) expressed in € per farm is used as the income indicator. Both indicators are expressed in relation to 2000_1 and no differentiation is made by farm size.

The development of average TFP for pig fattening farms (Fig. 5) looks rather stable; even under worse economic conditions the TFP index is only 5% lower. Variation of income is more pronounced; it was 45% less in 2002_3 and 25% less in 2009_10. The TFP of specialized piglet farms shows a higher periodic variation and a decreasing trend of TFP. Compared to this, the income variation is extremely high; it reached only 35% in 2003_4 and less than 20% in 2007_8 compared to the first year. After recovering in 2008_9 it halved again in 2010_11.

Based on these results it can be concluded that TFP estimates show much lower variation than the development of income. One reason is that TFP estimates are based on a rather aggregated set of output and input variables and not all variables influencing income are included in the TFP estimates.

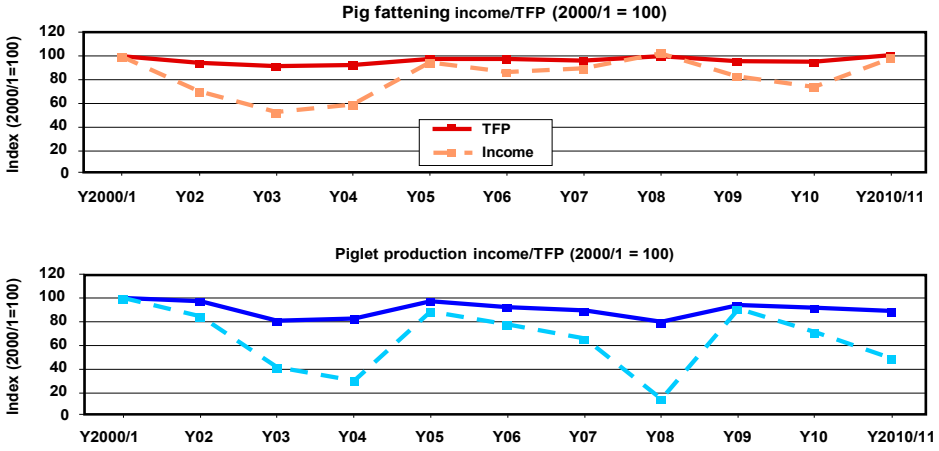

Figure 5. Comparing the development of TFP and income (FFI) of pig farms
Source: own study based on *BMELV Testbetriebe.*

CONCLUSIONS

This paper is a first attempt at analysing the development of TFP at the micro level. Balanced samples of farms specialized in pig fattening or piglet production drawn from the German Farm Accountancy Data Network were used. For the TFP calculations we used a free of charge program estimating the Färe-Primont index. It has the advantage that the prices of physical factors are internally derived from shadow prices of the Linear Programming model.

TFP is rather stable for farms specialized in pig fattening; it shows a higher variation and decrease of 1% per year in piglet production. The variation of income is much higher than of TFP. Under worst economic conditions it dropped by 40% below average in the year 2002-2003) in pig fattening. Income variation is extremely high in piglet production with around 80% lower incomes in two periods. In the year 2007_8 income fell by 80% while in pig fattening incomes increased slightly to the long term trend. This situation is influenced by changes in the market power of fattening farms against piglet producers: rising feed costs were entirely compensated by lower piglet prices. The work undertaken so far will be completed by estimates of the Fischer index.

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ROZWÓJ PRODUKCYJNOŚCI GOSPODARSTW TRZODOWYCH W NIEMCZECH

Streszczenie

W opracowaniu przedstawiono zmiany produkcyjności w gospodarstwach trzodowych w Niemczech. Zbilansowany panel gospodarstw wybrano z niemieckiego FADN. Do pomiaru produkcyjności użyto wskaźnika zaproponowanego przez O'Donnella (Färe-Primont Index). Wyniki badań wskazują na dość stabilny poziom produkcyjności gospodarstw z tuczem trzody chlewnej i malejący poziom wydajności gospodarstw, które specjalizowały się w produkcji prosiąt. Z powodu cykliczności zmian cen trzody chlewnej występowało dosyć wysokie zróżnicowanie produkcyjności. Najwyższe poziomy omawianego wskaźnika uzyskiwały gospodarstwa wielkoobszarowe, w których ujawniały się efekty skali. Zróżnicowanie dochodu w czasie było o wiele większe od produkcyjności, co może częściowo wynikać z dosyć dużego stopnia zagregowania danych użytych do kalkulacji.

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