INFLUENCE OF THE INTEGRATION OF AGROHOLIDNGS WITH RUSSIAN FARMS ON TOTAL FACTOR PRODUCTIVITY AND IST SUBCOMPONENTS

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INFLUENCE OF THE INTEGRATION OF AGROHOLDINGS WITH RUSSIAN FARMS ON TOTAL FACTOR PRODUCTIVITY AND ITS SUBCOMPONENTS

EINFLUSS DER ZUGEHÖRIGKEIT VON LANDWIRTSCHAFTLICHEN BETRIEBEN ZU AGROHOLDINGS AUF DIE TOTALE FAKTORPRODUKTIVITÄT UND DESSEN UNTERKOMPONENTEN

Zusammenfassung

Der Einfluss der Zugehörigkeit zu einer agroholding auf den Erfolg einzelner Unternehmen hinsichtlich deren Produktivität und Effizienz ist wissenschaftlich umstritten. Darüber hinaus gibt es nur wenige Artikel, die Effekte der Mitgliedschaft auf die Produktivität und Effizienz der landwirtschaftlichen Unternehmen in Russland auswerten. Zentrale Forschungsfrage dieses wissenschaftlichen Beitrags ist die Fragestellung, ob die Zugehörigkeit zu einer agroholding einen positiven Einfluss auf den Unternehmenserfolg hat. Wir berechnen anteilige Land- und Arbeitskraftproduktivität, Totalfaktor-Produktivität und technische Effizienz für zwei Kategorien der Betriebe: unabhängige Farmen und Mitglieder von agroholdings. In diesem Papier wird mit Hilfe des stochastic-frontier Ansatzes eine Produktionsfunktion geschätzt. Die Ergebnisse werden genutzt um die totale Faktorproduktivität in den technologischen Fortschritt, sowie die Änderung in der technischen Effizienz zu zerlegen. Die Ergebnisse zeigen einen divergenten Trend im Vergleich zu ähnlichen Untersuchungen. Das Wachstum der totalen Faktorproduktivität übersteigt bei Weitem das der unabhängigen Betriebe und das somit Gruppenzugehörigkeit einen positiven Einfluss auf das Leistungsvermögen der landwirtschaftlichen Betriebe hat.

Schlüsselbegriffe

Agroholding, Stochastic Frontier Analysis, Effizienz, Total Factor Productivity, Russland

Abstract

The impact of group affiliation to agroholdings on enterprise performance in terms of productivity and efficiency is controversially discussed in the literature. However, only few papers evaluate the effects of group membership on the productivity and efficiency of agricultural enterprises in Russia. The underlying research question of this paper is therefore whether farms that belong to agroholdings perform better than independent farms. We calculate partial land and labor productivity, total factor productivity (TFP) and technical efficiency scores for the two categories of independent farms and members of agroholdings. In this paper a production function approach is estimated in the framework of stochastic frontier analysis. The results are used to decompose TFP into a technological change effect and a technical efficiency effect. The results show a different trend than observed in previous studies. We show that the growth of agroholdings' TFP exceeds by far the development of the TFP of independent farms and that group affiliation has a positive impact on the performance of farms.

Key Words

Agroholding, Stochastic Frontier Analysis, Efficiency, Total Factor Productivity, Russia

1 Background and Motivation

The agricultural sector in Russia is still facing essential challenges due to the undercapitalization of agricultural enterprises. The vast potentials of Russia's agriculture are by far not reached. The appearance of agroholdings may help to bridge the liquidity constraints and thus might increase the productivity as well as the efficiency of agricultural enterprises. The impact of group affiliation to agroholdings on enterprise performance in terms of productivity and efficiency is controversially discussed in the literature. However, only few papers evaluate the effects of group membership on the productivity and the efficiency of agricultural enterprises in Russia. This gap can be explained by the fact that Russian agroholdings are a complex and new phenomenon as well as by the current lack of empirical time-series data.

In this paper we contribute to this discussion and analyze whether farms that belong to farms affiliated to agroholdings perform better than independent farms. We concentrate on performance indicators and examine how group affiliation affects the production possibilities of agricultural enterprises.

The next section provides an overview of the literature on the performance of members of agroholdings in comparison with independent farms in Russia. In Section 3 we describe the pivotal and controversial term 'affiliated to agroholding' and in what respect this 'label' has an influence on farms in terms of their development in size and management. In Section 4, a production function is estimated in the framework of stochastic frontier analysis. The results are used to decompose TFP into a technological change and a technical efficiency effect. These indicators are further examined towards the aim whether group affiliation has an effect on the initial levels of total factor productivity and their development. Conclusions are presented in Section 5.

2 Literature Review: Performance of farms with respect to group affiliation in Russia

Previous studies on the efficiency of agricultural enterprises in Russia have been conducted with the main focus on regional development over time, often with a special focus on the period of transition.[1] These studies estimate a production function for different production fields (crop, animal) and/or regions by using either stochastic frontier or data envelopment analysis. The findings of these papers usually proclaim significant technical and allocative inefficiency in agriculture.

Another group of empirical studies deals with differences in farm organization and its impact on production and productivity. Generally, vertical coordination in the agrifood supply chain is an important and growing phenomenon in the transition countries of Europe (SWINNEN ET AL. 2005). In contrast to works on efficiency of corporate farms versus family farms, however, compared to the number of papers on the efficiency of independent farms, only few papers concerning the efficiency of farms affiliated to agroholdings exist. One major reason for this could be a lack of information concerning the affiliation of farms to agroholdings. Therefore, the consequences of the appearance of agroholdings in the agrifood sector are still not well understood.

Vertical integration in the agricultural supply chain generally brings notable investments into the agricultural sector. The flow of capital allows modernization of primary agriculture and infrastructure of the supply chain. This capital dynamically leads farms to purchase modern

[1] For an overview see Liefert (2007).

machinery and allows them to introduce the most advanced technology (DRIES ET AL. 2009). RYLKO AND JOLLY (2005) showed that the affiliation to an agroholding increases the investments in assets such as machinery as well as the access to input markets and credits. In addition, vertical integration brings new management abilities to the farming sector. However, for the Oblast, Orel GATAULINA AND UZUN (2006) show that efficiency indicators as for example partial productivities and cost effectiveness indicate that agroholdings work less efficient than independent farms.

EBRD (2008) claims that members of agroholdings are more efficient than independent farms at present but uncertainties about the future development remain because agroholdings allegedly fail to integrate well in rural areas. Empirical works about the differences of members of agroholdings and independent farms, however, can rarely be found. For the Oblast Belgorod, HOCKMANN AND KOPSIDIS (2007) made an empirical analysis of members of agroholdings and farms independently operating. The authors conclude that many farms affiliated to agroholdings are less efficient than alternative organizational forms. As one of the reasons for this the authors name the insufficient recognition of economic forces that govern integration processes and the requirements for decision making. For the years from 2001 to 2003, efficiency scores of members of agroholdings calculated in a study by HOCKMANN ET AL. (2007) show that technological and managerial innovations introduced by agroholdings do not necessarily move agricultural production to an efficient trajectory.

In the above mentioned studies, a holistic approach to explaining why farms affiliated to agroholdings tend to have a different performance than independent farms is still not found. The reasons for the claimed hypothesis that agroholdings have better access to input markets and higher input quality but a worse performance than independent farms are not ascertained yet. It is questioned whether this issue is related to transaction costs or a needed challenge for Russian agriculture. This limited validity of former studies can be explained by the short periods of investigation.

3 Members of agroholdings and Independent farms in Belgorod – an experimental Characterization

We rely on the following sources of information: the First Independent Rating Agency (FIRA), the regional State Statistics Committee (SSC) of the oblast Belgorod and the Belgorod affiliate of the Allrusian Institute for Agricultural economy VNIIESCh. All of these agencies collect firm-level financial, ownership and operating data and maintain comprehensive databases: the former (FIRA) carries out this function for all entities that are either incorporated as open joint stock companies (OJSCs), or issue publicly traded securities; VNIIESCh collects data for all legally registered businesses in Russia. From FIRA we extracted farm level data for the oblast Belgorod and merged them with information from the SSC by unique firm identification codes. The data are supplemented with regional price indices from Goskomstat for price-deflation purposes. The key variable from the VNIIESCh data set is ownership structure: shares and owners are identified (name, firm identification code, country of origin, share).

In this section we are using an unbalanced panel of 725 farms located in the oblast Belgorod containing data for the years 2001, 2004, and 2007. The percentage of farms with affiliation to agroholdings increased from 33 % in 2001 up to 69 % in 2000. In the year 2001, 82 % of the arable land in Belgorod was controlled by these farms with a decreasing rate towards 2007 (67 % of arable land).

Towards the end of the 1990s, Western agricultural economists increasingly began to detect the existence of integrated business groups in the agro-food sector of Russia, which are usually termed 'agroholdings.' These agroholdings are collections of legally independent firms, which usually include agricultural, processing, and servicing enterprises, and in some cases also firms from totally unrelated industries, which in either case are bound together by formal ties. At the top of the group stands typically a mother company, the holding company that controls via equity ownership other firms, the subsidiaries or daughter firms. The agroholdings were usually created by operators from outside primary agriculture, mostly from food trading and processing, but also from the energy or metallurgy sector, through the acquisition of existing firms at the same stage and several subsequent stages of the value added chain (WANDEL 2000).

As mentioned above in this study we only focus on the farm level. In the case of agroholdings, a farm affiliated to an agroholding is either part of a multi farm operation with an individually assigned registration number, or numerous farms are horizontally aggregated to one unit with a unique registration number. Evidence for this can be obtained from table 1. The four largest members of agroholdings in terms of 'number of controlled farms' (RusAgro-Invest, Stojlenskaja Niva, BEZRK-Gelgrankorm and Belgorodsemena) control on average 8.5 thou. ha. Compared to the average agroholding farm (5.3 thou. ha), the sizes of the controlled farms are not exceptionally huge, even though farms like RusAgro-Invest is one of the biggest firms involved in the agricultural sector in Russia. The next three biggest members of agroholdings in farm numbers (Prodimeks – Cholding, Prioskolije and Razguljaj) enforce a higher horizontal integration of farms. The average farm size of 10.9 thou. ha per farm is double the size of a normal agroholding. An extreme can be found in Valujskij KRM, which has only one affiliated farm but controls 17 thou. ha.

Taking a look at the average agroholding we can see that the average size per enterprise affiliated to an agroholding increased from 4.4 in 2001 to 5.3 in 2007, indicating strong growth over the years compared to independent farms where average farm size almost remained constant. Concerning the average farm we can see that on average agroholdings employ more people than independent farms. This is not surprising considering the larger average farm size of members of agroholdings. The difference can in part be explained by the more labor intensive specialization (such as animal production) of farms affiliated to agroholdings but also by the fact that agroholdings recently bought insolvent or illiquid farms and in doing so also had to overtake an unreasonable huge number of the labor force (WANDEL 2011). In addition, table 1 shows that farms affiliated to agroholdings employ more workers per ha than independent farms, despite the tremendous reduction of about 45 % over the years. But also independent farms dismissed workers by 30 %.

Table 1: Farm characteristics in the Oblast Belgorod: Agroholdings and independent farms (No = Numbers of farms, ha = agricultural area under control, size = ha per farm, worker = workers employed in total)

	2001				2004				2007			
Name Agroholding	**No**	**ha**	**size**	**worker**	**No**	**ha**	**size**	**worker**	**No**	**ha**	**size**	**worker**
Shebekinskiy	11	49	4.5	2665	11	44	4.0	1640	UNK	UNK	UNK	UNK
OAO Belagrogas	9	56	6.2	2220	5	28	5.7	704	UNK	UNK	UNK	UNK
RusAgro-Invest	9	51	5.6	2037	21	157	7.5	4673	33	275	8.3	6554
Stojlenskaja Niva	31	108	3.5	4615	18	137	7.6	4491	16	126	7.9	3060
BEZRK-Belgrankorm	4	15	3.9	2020	5	32	6.4	2422	8	66	8.2	4453
Belgorodsemena	1	0	0.3	2	5	47	9.4	1209	6	57	9.4	1912
Prodimeks - Cholding	4	17	4.3	1390	7	41	5.8	988	4	48	11.9	844
Prioskolje	1	12	11.8	791	2	UNK	UNK	372	3	31	10.3	2681
Razguljaj	3	15	4.9	719	3	19	6.4	758	3	31	10.3	795
RIF	18	66	3.7	2929	11	41	3.7	1096	4	28	7.0	471
Gubkinagrocholding	UNK	UNK	UNK	UNK	4	15	3.9	692	6	28	4.6	993
Miratorg	UNK	UNK	UNK	UNK	3	5	1.8	200	7	24	3.4	767
Valujskij KRM	4	39	9.7	1893	1	21	21.0	695	1	17	17.0	526
Efirnoe	20	83	4.1	2931	21	89	4.2	1734	6	17	2.8	356
Belgorodskaja Zernovaja	UNK	UNK	UNK	UNK	4	18	4.5	820	6	16	2.7	492
Agrofirma Russ'	UNK	UNK	UNK	UNK	1	4	3.7	112	1	11	11.3	75
Plemreproduktor II	UNK	UNK	UNK	UNK	1	10	10.0	215	2	10	5.0	186
Slavjanka	1	3	2.7	168	1	3	3.0	152	2	9	4.3	311
Transjužstroj	UNK	UNK	UNK	UNK	2	10	5.0	475	2	8	3.8	317
Tomarovskij mjasokomb	1	7	7.4	527	1	7	6.9	493	1	7	6.9	414
Avida	5	14	2.8	536	5	14	2.9	422	2	5	2.7	198
Inteko	UNK	UNK	UNK	UNK	1	2	1.7	17	1	5	5.1	14
Agroekspert Servis	UNK	UNK	UNK	UNK	1	5	5.1	182	3	4	1.4	523
Belgorodskaja Niva	UNK	UNK	UNK	UNK	2	4	2.0	108	2	4	2.1	174
Alekseevskij mjassokomb.	1	3	3.1	76	1	3	3.2	116	1	3	3.1	108
Gubkinagrosnab	1	2	1.8	249	1	6	5.6	23	1	2	2.5	126
Todissa	1	2	2.5	156	1	2	2.4	146	1	2	2.4	113
Vega	UNK	UNK	UNK	UNK	1	8	7.8	189	1	2	2.4	19
Lesstrojtorg	UNK	UNK	UNK	UNK	1	2	2.2	72	1	2	2.2	50
Belaja Ptica	1	0	0.1	183	2	0	0.2	314	2	0	0.1	415
OAO BelAgroStan	3	18	5.9	923	1	0	0.0	62	1	0	UNK	64
Agrokompleks Belogorje	1	3	3.1	204	3	20	6.7	595	2	0	0.0	167
Belgorodskij	UNK	UNK	UNK	UNK	1	UNK	UNK	81	1	0	0.0	1
mean Agroholding:	**6**	**27**	**4.4**	**1297**	**4**	**26**	**5.2**	**796**	**4**	**27**	**5.3**	**877**
	workers per ha			**297**	**workers per ha**			**154**	**workers per ha**			**165**
mean Independent Farms:	**-**	**-**	**3.0**	**131**	**-**	**-**	**3.9**	**154**	**-**	**-**	**3.2**	**102**
	workers per ha			**44**	**workers per ha**			**39**	**workers per ha**			**32**

Source: own calculations

3 Performance of agroholding member farms

3.1 Data

The database described in chapter 3 is used again but we excluded farms for which there was just one observation. Further we eliminated farms with inconsistent data (i.e. production of wheat but no arable land). In addition we excluded farms that had implausible productivities such as yields being thrice as high as the average yield in the respective year. On average we had 173 farms per year with an increasing share of agroholdings (ranging from 58 % in 2001 up to 69 % in 2007). The farms included in this unbalanced panel, in 2004, controlled 60 % of arable land in Belgorod, while in 2001 and 2007 it was about 37 %.

3.2 Methodology

For the analysis of productivity, we estimated a production function and, controlling for agroholding membership, examined whether the productivity of firms owned by agroholdings is, *ceteris paribus*, higher than that of independent firms. Our methodology consisted of two steps: As basis for our analysis we estimated a production function for the farms explicitly controlling for ownership structure. In a second step we calculated total factor productivity as ratio of all input and all outputs. The TFP indicator is further decomposed into its subcomponents in order to understand the sources of TFP development.

Output was defined as the sum of crop and animal gross production. We calculated the index as follows: For the calculation of output values, farm specific producer prices for all production activities were calculated using the information on the value and amount of sold products. Second, gross production was weighted by the individual prices and summed up to the value of total gross production. This provided values in current prices. In the third step, the values of gross production values were deflated by a Torquist-Theil Index. The deflator was constructed using the price information obtained in step 1 and the shares of individual products in gross production. We used the procedure proposed by CAVES ET AL. (1982) to construct an index which allowed conducting multilaterally consistent comparisons. In addition this procedure allows constructing an output variable whose level and development are comparable among enterprises and over time.

As inputs we used labor (L), arable land (A) capital (C) and material inputs (M). For labor we considered the number of workers in agricultural production. Capital is represented by the costs of fixed assets, e.g., depreciation. Material inputs comprise available information on seeds, fertilizer, pesticides and other variable inputs. Capital and material inputs were only available in current prices. However, we applied the deflation procedure as described for output. The only difference is that we could not use firm but only regional level data for calculating the index. This procedure provides firm specific deflators; however, the differences reflect only the firm specific weight of the individual components in the aggregate and the firm specific prices.
For estimation purposes we normalized all variables by their arithmetic mean. This approach facilitated the interpretation of the estimation results very much as the first order terms represent the production elasticities at the sample mean. Taking into consideration that we just used depreciation as a proxy for the use of capital, there is a high probability that we underestimated the use of capital, especially with regard to members of agroholdings. This is due to the fact that the leasing of machinery is common state of the art in farms affiliated to agroholdings (RYLKO AND JOLLY 2005) which could not be calculated from the dataset.

A stochastic frontier analysis was conducted to estimate the farm production function. We consider a translog stochastic production frontier defined as follows:

$$\ln q_{it} = \beta_0 + \beta_t t + \frac{1}{2}\beta_{tt} t^2 + \sum_{n=1}^{N} \beta_n \ln x_{nit} + \sum_{n=1}^{N} \beta_{tn} t \ln x_{nit} + \frac{1}{2}\sum_{n=1}^{N}\sum_{j=1}^{N} \beta_{nj} \ln x_{nit} \ln x_{jit} + \beta_h h + \beta_{ht} th + \sum_{n=1}^{N} \beta_{tn} h \ln x_{nit} + v_{it} - u_{it} \quad (1)$$

Or

$$\ln q_{it} = f(\ln \mathbf{x}_{it}, h, t) + v_{it} - u_{it} \quad (1b)$$

where q_{it} is the output of the *i*th farm in the *t*th time period

x_{nit} are the *n*th input items of the *i*th farm in the *t*th time period

t is a time trend representing technical change

h is a dummy variable which is 1 for holding members and zero otherwise

β s are unknown parameters to be estimated

The v_{it} are random errors, assumed to be i.i.d. and have a $N(0,\sigma_v^2)$ distribution, The u_{it} represents the impact of technical inefficiency and is assumed to be log-normally distributed with $N^+(0,\sigma_u^2)$. Moreover, v_{it} and u_{it} are assumed to be statistically independent.

The specification in (1) allows for a rather detailed investigation of the impact of group affiliation on total agricultural production. First, agroholding membership may shift the production function. Second, the function accounts for effects on production elasticities, e.g., changes in partial productivities (ln_L*ln_H, ln_A*ln_H, ln_C*ln_H, ln_M*ln_H), and different effects of technical change on farms affiliated to agroholdings and independent farms.

As is commonly done we define TFP by the relation of the output index to the input index. Since we used a translog functional form representing production, we can apply the quadratic lemma (DIEWERT 1976) and calculate a Tornquist-Theil Index for inputs. Because this index gives intransitive results in multilateral comparisons, we used a modified version of the index. CAVES ET AL (1982) introduces the modified Tornquist-Theil Index which is exact for the translog function and in addition allows for consistent comparisons among individuals and over time. Considering economies of scale the index is given by OREA (2002):

$$\ln\left(I^{Input}\right) = \frac{1}{2}\sum_{j\neq 1}\left[\left(s_j + \bar{s}_j\right)\ln\frac{x_j}{\bar{x}_j} - \overline{s_j}\,\overline{\ln x_j} + \overline{s_j \ln x_j}\right], \text{ with } s_j = \frac{f(\ln \mathbf{x}, h, t)}{\partial \ln x_j}\left(\sum_j \frac{f(\ln \mathbf{x}, h, t)}{\partial \ln x_j}\right)^{-1} \quad (2)^2$$

The adjustment provides production elasticities as if the production function was characterized by constant returns to scale (OREA 2002). It is generally believed that agriculture possesses the nature of constant returns to Scale (Ellis 1993, Coelli and Rao 2003). This modification allows identifying the productivity effects of input changes, i.e. structural changes in agriculture. In addition, our input index includes also the effect of agroholding membership. We decided for this procedure in order to be able to consistently identify the effect of group affiliation on the various productivity components.

Applying the same procedure to the output index provides:

[2] Due to this transformation, every observation is assessed in relation to the average in the sample.

$$\ln\left(I^{Output}\right) = \ln\frac{y}{\bar{y}} \qquad \text{(B4)}$$

Correspondingly, TFP is defined as:

$$\ln(TFP) = \ln\left(I^{Ouput}\right) - \ln\left(I^{Input}\right)$$

This indicator represents all effect on production which result from the exploitation of technology (TC) and efficiency (TE), e.g. TFP = TC+TE.

3.3 Results

As can be seen from table 2 all first order terms are positive and statistically significant, except labor. The highest elasticity was estimated for material inputs. This is in conformity with the information in the data set, since this input amounts to 55 % of total production. The coefficient associated with land is second largest. The relatively low elasticity of labor (0.07) goes in line with results of studies by OSBORNE AND TRUEBOLD (2006) or BOKUSHEVA AND HOCKMANN (2006) who found relative low labour productivities. The sum of the four production elasticities (1.03) is higher than one, suggesting very mildly increasing returns to scale at the sample mean. We found the law of diminishing returns ($\alpha_{ii} + \alpha_i^2 - \alpha_i < 0$, for i = L, A, C) but ($\alpha_{ii} + \alpha_i^2 - \alpha_i > 0$, for i = M) for farms affiliated to agroholdings, and ($\alpha_{ii} + \alpha_i^2 - \alpha_i < 0$, for i = A, C) but ($\alpha_{ii} + \alpha_i^2 - \alpha_i > 0$, for i = L, M) for all independent farms at the sample mean.

Table 2: Parameter estimates

	Coef.		Std. Err.
Parameters Of Translog Function			
ln_L	0,07		0,07
ln_A	0,28	***	0,07
ln_C	0,13	***	0,02
ln_M	0,55	***	0,05
ln_L * ln_A	0,17	***	0,06
ln_L*ln_C	-0,02		0,03
ln_L*ln_M	-0,28	***	0,05
ln_A * ln_C	-0,01		0,02
ln_A * Ln_M	-0,10	***	0,03
ln_C * Ln_M	-0,03	*	0,02
0.5*ln_L^2	0,19	***	0,05
0.5*ln_A^2	0,00		0,04
0.5*ln_C^2	0,06	***	0,02
0.5*ln_M^2	0,35	***	0,06
Time Trend & Time Dependent Variables			
ln_t * ln_L	0,01		0,02
ln_t * ln_A	0,04	***	0,01
ln_t * ln_C	0,00		0,01
ln_t * ln_M	-0,03	***	0,01
ln_t	-0,01		0,01
0.5*ln_T^2	0,01		0,01
Effect Of Group Affiliation			
ln_H	-0,09	***	0,03
ln_t * ln_H	0,05	***	0,01
ln_L * ln_H	0,22	***	0,09
ln_A * ln_H	-0,25	***	0,08
ln_C * ln_H	-0,02		0,03
ln_M * ln_H	0,01		0,06
Intercept	0,29	***	0,04
sigma_v	0,17		
sigma_u	0,47		
Log-likelihood function	143,63		
LR Test of the one sided error	44,18	***	

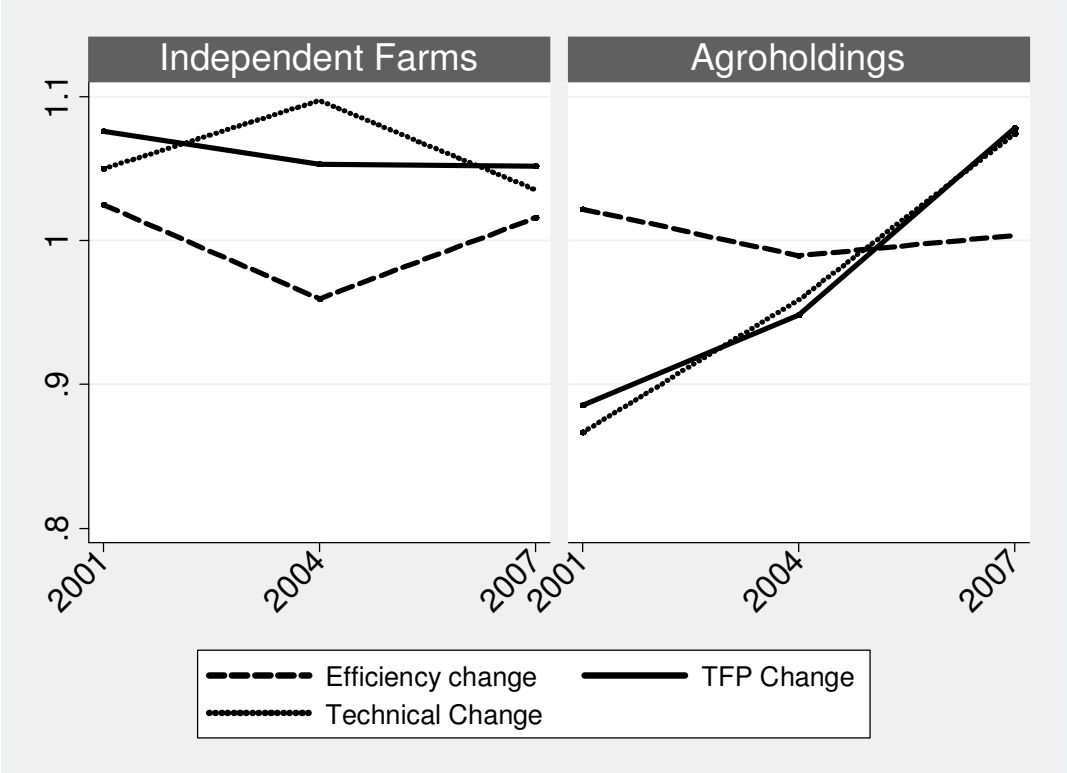
Source: own calculations

Group membership significantly affects the production structures. This holds not only for shifts in production but in addition also for the partial productivities and the effect of technical change. The coefficient of farms affiliated to agroholdings is to be calculated as follows: $ln_{iH} = (ln_i) + (ln_i * ln_H)$. The input labor of farms affiliated to agroholdings (0.22***) has a much higher contribution to the output than that of independent farms which means in other words that the average worker of an agroholding is responsible for 22 % of the output, implying that one worker of a farm affiliated to an agroholding could substitute three workers of an independent farm. If agroholdings increase their labor force by one percent, output grows by 22 %. This may be due to the fact that members of agroholdings use more skilled labor than independent farms. The much lower coefficient of land ($ln_A = 0.02$) can be interpreted to be the result of tremendous growth by

the size of land that members of agroholdings had during the period of observation. Due to the negative coefficient of the variable "member" (-0.09***), group affiliation initially negatively affected production. This corresponds to observations from the beginning of the period under investigation, many bankrupt, e.g., less productive enterprises were forced to join agroholdings by the regional government (WANDEL 2011). The parameters of members of agroholdings associated with capital and material are not statistically significant and as such cannot be interpreted appropriately. The perhaps most remarkable effect of group affiliation is its impact on technical change ($ln_t * ln_H$). The parameter (0.05***) suggests that the productive capacities of agroholding members improved much faster than that of independent farms. This result is in accordance with the observation that holding members experienced high investments with a corresponding improvement of production facilities. Moreover, the old management was often substituted by younger, well-educated decision makers (HOCKMANN ET AL. 2007).

Figure 2 shows the changes in TFP and its subcomponents over time. An increase in technical efficiency would imply that farms moved closer to the production frontier which represents the maximum output attainable from each input level. An upward shift of the maximum output level (production frontier) shows a technical change in the industry, or in other words each farm can technically produce more output for each level of input. Technical Efficiency and technical change add up to the TFP, which describes the ratio between all outputs and all factors of production.

Figure 1: Means of Economies of Technology Change, Technical Efficiency and TFP



Source: own calculations

Technical efficiency was estimated using the JONDOW ET AL. (1982) procedure and is almost stable in the period under investigation with exception of the year 2004 for independent farms. Since in unfavorable years the technical equipment is crucial in agriculture, we find first hints that independent farms are worse equipped than farms that are affiliated to agroholdings. The estimates provide further that in 2001 independent farms appeared to be better equipped with technology. They could hold their favorable position up until 2004. During the years from 2004 to 2007 independent farms could not keep their advantageous position. They suffered from a deterioration of technology. Holding members on the other hand, on average, were able to improve their technology over the whole period of investigation. Moreover, technical change was the driving force of TFP growth in agroholding members. These developments correspond to the parameter estimates of the production function. In the description of the results, the special role of technical change for farms affiliated to agroholdings was already highlighted. The conclusion can be drawn that holding members show a higher adoption of new technologies than independent farms. Furthermore, this provides that in recent years farms belonging to agroholdings are defining the regional production frontier. This conclusion, at first glance, is contradictory to HOCKMANN ET AL (2007) who found that members of agroholdings are lacking behind independent farms. However, their data set captures developments between 1999 and 2003.

4 Conclusions

In this paper we contribute to the issue of group affiliation and the intensity of factor use such as capital, land, labor and other production factors as well as the adjustment of new technologies. We were able to show that the 'phenomenon' of engagement of agroholdings at the level of farms is not an unclear und ominous development. Farms that belong to an agroholding are on average not outstanding in size. Though, if the entire land controlled by a respective agroholding is summed up, we find agroholdings with hundreds of thousands of hectares under control. But usually the farms are not treated as one big complex by the agroholding, but as semi-independent units with decentralized management and book-keeping. Generally it can be said that group affiliation has an influence on the structure and the performance of farms. Concerning the components of TFP, the findings of HOCKMANN ET AL. (2007) were confirmed. The result is twofold: On one hand, the conclusion that the technological and managerial innovations introduced by farms affiliated to agroholdings do not necessarily increase the efficiency of farms affiliated to agroholdings could be verified. On the other hand, we could show that farms affiliated to agroholdings are the driving force of the shift of the production frontier due to technical change. Farms that are affiliated to agroholdings were less productive than independent farms in the year 2001, but had almost the same TFP in the year 2007. This resulted in a strong positive performance. This is true for the average holding but we doubt that this holds true for all. Therefore, future research on the efficiency and productivity within the group of farms affiliated to agroholdings is needed. In addition, further research on the cause of a high technical change rate is necessary. A first assumption would be that more investments for farms that are affiliated to agroholdings are possible due to better access to credits by the mother holding. From this analysis it can only be said that a sophisticated labor force is the key factor for agroholdings that allows them to make better improvements than independent farms.

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