Dynamics of Competition in the Hungarian Poultry Industry

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Abstract

This study examines the competitive nature of the Hungarian poultry sector between 2006 and 2016. The poultry population has stagnated over the period investigated, however the farm structure has changed significantly and the population of poultry held by individual farms has decreased. In this research, market competition was measured with the persistence of abnormal profits, while profit persistence was estimated using the Arellano-Bond GMM and Blundell-Bond dynamic panel regression. Based on the results, it can be said that the level of profit in the poultry sector is close to the equilibrium profit level. The farm size, technological development as well as the tax advantages of individual farms distort competition leading to higher profits. Taking long-term risk has a negative impact on abnormal profits. The results of the research suggests that the breakthrough points for the poultry sector are technological progress and population growth, as well as a reduction in labor intensity.

Keywords

Profit persistence, poultry, competition, agriculture.

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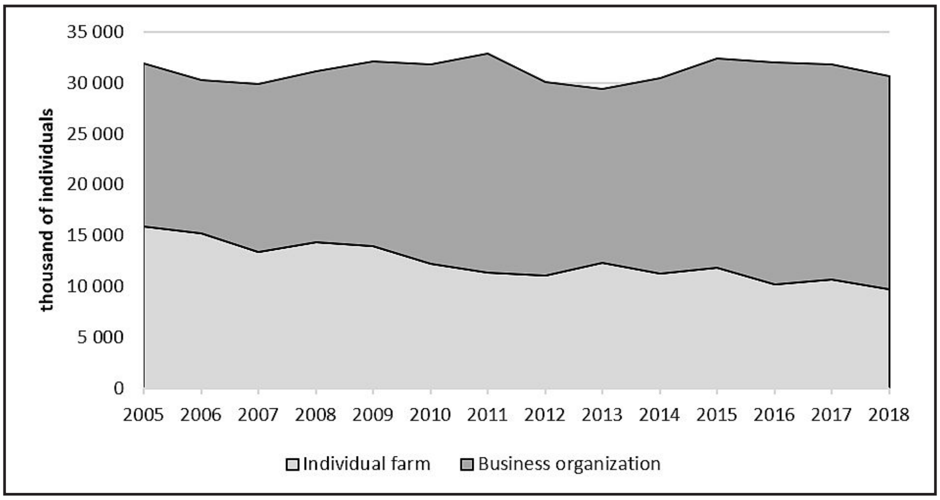
Introduction

Agricultural markets have undergone a significant transformation over the last 30-40 years and are very far from perfect competition. Usually, in agricultural sectors, due to corporate mergers and acquisitions, only a few agricultural players control 60-80% of the market leading to a high market concentration (Sexton, 2012). Horizontal integrations have a significant impact on the markets, and vertical integrations are also relevant actors in agri-food chains. In addition to vertical and horizontal concentration, the variety of products and quality differences all indicate that agricultural markets are not necessarily the best examples of perfect competition from a theoretical point of view (contrary to the foreign exchange markets, which are the closest to perfect competition due to the homogenous products, the high number of market players, and the immediate integration of information into prices).

Over the past 20 years the structure of the Hungarian poultry sector has been constantly changing, with a clear trend towards the decline of individual farms. There is a consensus in the Hungarian and international literature that the profitability, productivity and competitiveness of small-scale farms are very low, in general. The fragmented farm structure puts small-scale farms at a competitive disadvantage; the current structural transformation can therefore be seen as a natural market cleanup process.

The trend in the Hungarian poultry population is presented through the example of the most dominant poultry species (which is hen) in Figure 1. Domestic hen population has been fluctuating during the period investigated. Immediately after EU accession the total domestic population was close to 32 million heads. Following the accession, similarly to the majority of Hungarian animal husbandry sectors, the hen stock decreased. In the new EU-single market, the sector has recovered relatively quickly, with a ten percent increase between 2006 and 2016.

However, not the whole sector was affected by this expansion: the number of hens kept in individual farms continued to decrease during the whole period, the upward trend was limited to the corporate farms. The reason for this difference lies primarily in the differences in the size of farms and the size-related operational conditions. The average size difference between



Source: Own editing based on KSH (Hungarian Central Statistical Office) (2019) data

Figure 1: Development of the hen population in Hungary (2005-2018).

individual and corporate farms is well illustrated by the test farm data of the Research Institute of Agricultural Economics (hereinafter referred to as AKI - Agrárgazdasági Kutatóintézet) based on the standard production value per farm, the average farm size of corporate poultry farms in 2005 was about eighteen times higher than the average farm size of individual farms. The rate reached 20 in 2011, and was already well over 40 in 2015 (AKI, 2020). Popp (2014) emphasizes that modern technologies cannot be used economically in small-scale farms, while natural efficiency will be low in case of outdated farming technologies. Fragmented farm structure is also identified as a competitiveness problem by Varga et al. (2013), Nábrádi and Szőllősi (2008), and Udovecz et al. (2009).

As described above, it can be stated that after the initial downturn, a natural restructuring of the sector started in 2007, whereby the larger corporate farms using more advanced technology and being more competitive, were able to expand their production, at least until 2012.

Another reason for the sector problems lies in regulatory changes. In the European Union, burdens of market regulation have already led to significant competitive disadvantages vis-à-vis the competing countries in America and Asia in the early 2000s. During the second decade of the millennium, administrative, animal welfare and environmental standards for production and processing continued to tighten, for which poultry farms and slaughterhouses in less developed EU Member States were not fully prepared (Varga et al., 2013). One of the striking examples of tightening regulation is the 2012 regulation on expanding and replacing laying hens' cages. Increasing the minimum seating capacity and the obligatory number of sitting cows has not only increased production costs by 10-30 percent, but also raised the risk of injuries and mortality due to growing social stress and animal health problems (Aliczki, 2012).

The aim of the Paper is to examine the competitiveness and profitability of the Hungarian poultry sector through profit persistence. In addition to the examination of profit persistence, our further goal is to incorporate the factors influencing the profitability found in the literature into the competitive dynamics models and to estimate their impact on the abnormal profit level.

Our hypothesis is that a strong profit persistence exists in the Hungarian poultry sector and the poultry market is far from the perfect competition. The hypothesis is derived from the specific competitive characteristics of agricultural sectors and the structural transition of the Hungarian poultry farming mentioned above.

Research background – Profit persistence in agri-food sector

First, two similar studies, Hirsch and Gschwandtner (2013) and Gschwandtner and Hirsch (2013) dealing with profit persistence are presented here together. Both studies analyze the food industry in five European countries (Belgium, France, Germany, Italy and the United Kingdom) based on data from 1996 to 2008. What makes the two studies different is the methodology and the size of the sample. The study by Gschwandtner and Hirsch (2013) includes 4,676 companies, while

Hirsch and Gschwandtner (2013) includes 5,494.

In Gschwandtner and Hirsch (2013), short- and long-term profit persistence was estimated with AR1, and then the estimated coefficients were used as a dependent variable in an OLS model. Of the nine independent variables, five were company-related and four were industry-related indicators. Profit persistence and OLS models were estimated for each investigated country separately. According the results, the Belgian food industry market was the most competitive (profit persitence value is 0.06), while the United Kingdom (0.23) was the least competitive. However, the significant profit persistence values were between 38-42% for all countries, so less than a half of the companies deviates from the normal profit level. In the OLS model estimating short-term profit persistence, company size and growth were significant factors in four of five countries. In the long-term profit persistence model, there were also significant corporate effects (market share, company age, company growth), a single industry variable (number of companies operating in the industry) has become significant in at least three countries.

In Hirsch and Gschwandtner (2013) profit persistence was examined by dynamic panel GMM estimation. Similarly to the other study, Belgium had the lowest (0.11) and the United Kingdom had the highest (0.304) profit persistence. In the GMM model, short- and long-term profit persistence cannot be calculated as easily as in the case of autoregressive models. The authors solved this by relating the parameters of the independent variables to long-term profit persistence, and by relating the interaction between the dependent variable and its time lag to short-term profit persistence. Compared to their previous study, some new variables were included in the research, such as short-term risk and market concentration. For at least 3 countries, the following variables were significant for short-term profit persistence: firm size and growth, short-term risk and industry concentration (CR5). Three of this four effects were company-related effects, the result is very similar to the OLS estimation. Under the same criteria, short-term and long-term risk for long-term profit persistence was significant in at least three cases. Based on the results, high profit persistence was characteristic for young and large companies with a low risk rating. Another conclusion is that the food industry has lower profit persistence than the non-food sectors. In his doctoral dissertation, Hirsch (2014) reported only the results of the GMM estimation. In his meta-regression study, Hirsch (2018) highlights that many profit persistence research contains bias (citing some of his own studies as examples) because micro-sized firms are under-represented in the samples, which may result in profit persistence being overestimated. In the case of the two studies presented, a similar problem arises, so the real profit persistence values may be even lower.

The study by Tamirat et al. (2018) is most similar to our empirical research. The authors used the Dutch FADN database, the data were from 2001 to 2015 containing a total of 1796 companies. From the FADN database, dairy farms, field crop production, pig keepers and the category of mixed livestock farming were highlighted, with the largest number of pig keepers. To test the robustness of the results, two types of profit indicators (modified ROA and net profit margin) were also calculated. Three methodologies were used in the study, OLS, quantile OLS, and GMM. For the OLS and quantile OLS estimates, the authors do not incorporate the lagged profit rate into the model, so here will be presented only the results of the GMM models, focusing on the whole sample and the pig keepers. GMM models were filtered by year, region, and land type effect. Considering the modified ROA, the profit persistence was 0.075 for the total sample, and 0.071 for the pig keepers. These were very low values compared to the food industry (0.11-0.34). For both estimates (complete sample; pig keepers), long-term risk, firm age, size, and labor productivity were strong significant. In addition, working capital, capital intensity, and diversification were also significant variables in the overall sample. Considering the net profit margin, very similar results were obtained. Interestingly, the subsidy rate was not significant in either case, only for dairy farms.

Gschwandtner and Hirsch (2018) compared the profitability of the food processing industry in the European Union and the United States. Profit persistence analysis was performed with dynamic panel and GMM estimation, the comparability of samples was ensured by matching. In addition to the GMM estimation, the authors also performed a classical OLS estimation, with the aim of demonstrating the robustness of the estimation and quantifying the error of the OLS model (compared to GMM). The value of profit persistence became around 0.3 in both samples (GMM estimation), there were no significant differences between the EU and the US. This also means that profit persistence exists on both continents. The authors mentioned that a profit persistence of 0.3 is lower than those for other manufacturing industries. This finding was also made by Hirsch and Gschwandtner (2013), Hirsch and Hartmann (2014) and Goddard et al. (2005), among others, in their previous study. Among the company-related variables, the size of the company (logarithm of all assets), short-term risk (current liabilities / current assets) and long-term risk (long-term liabilities / equity) became significant. The size of the company and long-term risk show a positive relationship with the profit level, while short-term risk shows a negative relationship. Among the industry variables, a negative significant relationship was found for industry growth (industry revenue growth). In the EU sample, the coefficient was positive for the Herfindahl index. The authors tested the impact of the financial crisis in two ways: on the one hand, they marked the years of the crisis with dummy variables, and on the other hand, a second estimation was ran, excluding the years 2008 and 2009. In the case of the first method the crisis dummy variable did not become significant, in the case of the second method the profit persistence increased, however, the difference was not significant compared to the whole sample.

Figure 2 summarizes the significant variables found in the relevant profit persistence studies in the food industry. It can be seen that company-related factors are the most relevant.

Materials and methods

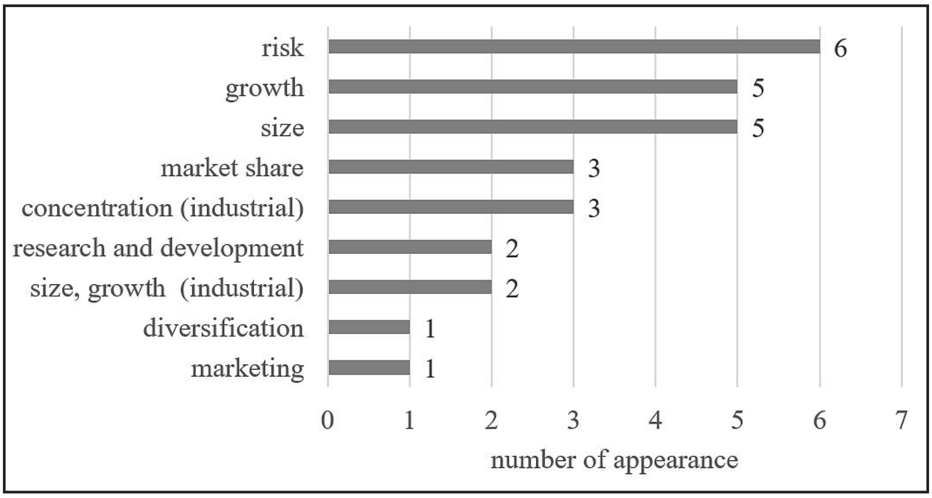
During the research, data were used from Farm Accountancy Data Network (FADN) provided by the National Agricultural Research and Innovation Centre (NAIK), Research Institute of Agricultural Economics (AKI). Every country in the European Union has the FADN system, which collects data about more than 80,000 farms. The EU-wide database represents a population of approximately 6.4 million farms (Keszthelyi, 2017). The database is representative of region, size and activity. Due to the form of data provision the data of individual and corporate farms becomes comparable. The Hungarian test farm system covers 2% of the Hungarian farm population; the monitored farms provide more than 5,000 data a year. The sample of this research includes data from 180 poultry farms between 2006 and 2016.

An abnormal profit test was used to examine the extent to which each company's annual ROA (profit before tax/total assets) deviates from the annual average industry profitability level. Thanks to normalization, the effects of macroeconomic cycles has been filtered out, and profit can be interpreted as a deviation from market norms (Maruyama and Odagiri, 2002; Gschwandtner, 2012).

$$\pi'_{i;t} = \frac{ROA_{i,t} - \underline{\underline{ROA_t}}}{\underline{ROA_t}} \qquad (1)$$

$\pi'_{i;t}$ denotes abnormal yield.

Initially, autoregressive processes were used to measure profit persistence, most often the AR (1) model. In number of lag 1 model, the profit rate at time t is explained by the profit rate one year earlier (t-1). In addition to autoregressive models, OLS models have appeared, most often using persistence values from AR (1) models as dependent variables.



Source: own editing based on related literature

Figure 2: Proxies for significant variables from the related literature.

The history of the measurement of profit persistence began with PCM models. Later, PCM method has been replaced by autoregressive models, primarily AR1. The next methodological development phase was to use the estimated AR1 parameter in an OLS model as a dependent variable and to use company-related and industry-related variables as independent variables. Roughly at the same time, fixed-effect (FE), pooled OLS, and in rare cases random effect (RE) models have been emerging. The primary use of panel OLS models was to estimate the AR1 parameter. After 2010 and nowadays, dynamic panel GMM models provide the most reliable estimate of profit persistence. GMM models usually deal with company-related, industry-related, and in some cases regional variables.

Hirsch and Gschwandtner (2013) found that due to the previously presented limitations of AR model estimation, the dynamic panel model with the Arellano-Bond Generalized Method of Moments (GMM) estimation is the most suitable for investigating profit persistence. According to Hirsch (2018), GMM is the proper technique for estimating profit persistence, OLS estimation biases upwards. The estimation can be applied well if there is a large number of observed companies (small T, large N type sample) for a short period of time.

$$\pi'_{i,t} = \sum_j \alpha_j (X_{j,i,t}) + \lambda \pi'_{i,t-1} + \varepsilon_{i,t} \qquad (2)$$

Where $\varepsilon_{i,t} = \eta_i + v_{i,t}$. The Arellano-Bond GMM estimate is based on the first differences in the equation, which eliminates time-invariant firm specific (η_i) effects (Hirsch and Gschwandtner, 2013; Kozlenko, 2015). Firm and industry-specific variables (X_j) that may explain the persistence of corporate profits may be included in the model. The GMM estimate is considered consistent if there is no second order autocorrelation in the error terms (the first order cannot be due to the delayed explanatory variable) and the instruments are adequate. Second-order autocorrelation is easy to test, and instruments can be tested by Hansen and Sargan test. The lagged depended variable is endogenous; everything else is exogenous variables in the model (Hirsch and Gschwandtner, 2013). The Hansen test is robust to heteroscedasticity.

The 1st and the 99th percentiles of the distribution were identified as outliers and trimmed for each variable. The database is certainly distorted by human errors, it takes several steps to populate the database with data, and problems may arise during queries. For this reason, a "cut off" of two percents of the data is justified. The treatment was performed for all variables.

During the literature review, it happened only a few times that a different dynamic panel estimation procedure appeared in addition to the GMM model. In order to test the robustness of the results, a profit persistence estimation was performed using the Blundell-Bond (1998) method. The Arellano-Bond GMM estimation procedure gives more reliable results than the panel OLS estimates, but does not perform perfectly. The Arellano-Bond GMM performs very poorly if the auto-regressive parameter (λ) is too large or the ratio of the variance of the panel effect and the variance of the individual error terms is too large (Blundell and Bond, 1998). The Blundell-Bond model was developed to remedy this problem.

The Blundell-Bond estimator assumes that there is no autocorrelation among the individual error terms, and the panel effect is independent of the first difference of initial levels of dependent variable. Just like the Arellano-Bond estimator, Blundell-Bond works well when we have a lot of observations, but the number of time periods is limited. For profit persistence estimation, the Arellano-Bond method is considered the standard in the case of agricultural and food markets. In my opinion the reason for this is that although the Blundell-Bond estimator gives a more reliable estimation when the autoregressive parameter is high, but profit persistence is typically low in agriculture and food industry. For this reason, the Arellano-Bond estimator was used as preliminary compass, and the Blundell-Bond estimator was applied to check the robustness of the results.

The Markov chain analysis applied in this research was based on the study of Stephan and Tsapin (2008). The process of the analysis can be summarized as follows.

Denote the rate of profit by y_s^t. The Markov chain working with discrete values requires the following relationship:

$$P\{y_s^t = i\} = p_{ij} \qquad (3)$$

It can be read from formula (3) that the profit rate in t+1 depends only on the state at time t. The transition between each group can be described as follows:

$$F_y^{t+1} = P * F_y^t \qquad (4)$$

F_y denotes the distribution of corporate profitability in t and $t+1$. These equations can be used to estimate the transition probability matrix. The estimated probabilities will be unbiased if two conditions are met: 1) the data generating process is constant over time, so its variance is constant; 2) the number of observations is sufficiently large.

The variables included in the research were defined based on the literature focusing on the economic analysis of the poultry sector. One of the main drivers of the restructuring of the poultry sector is economies of scale. Szőllősi and Nábrádi (2008) found that the average farm size in the poultry sector is below the optimal level. Szőllősi and Molnár (2018) reached a similar conclusion in relation to profitability and size. Sipiczki et al. (2019) found that the average farm size was the lowest in the pig and poultry sector among the Hungarian agricultural sector. Accordingly, farm size was expected to have a positive impact on the profitability of poultry farms. In this study, two logarithmized variables were used to express the farm size: the number of poultry kept by the farm (number of animals) and the balance sheet total. The first serves to express the natural size of the farm, while the latter serves to express the size of the farm. The relationship between profit persistence and farm size (balance sheet total) is unclear. In the case of large size, the principle of economies of scale may work, although several studies have been written about less efficient large companies. Company size plays a significant role in the food industry (Hirsch and Gschwandtner, 2013; Hirsch and Hartmann, 2014). Consequently, a positive relationship between size and (abnormal) profitability is expected in this research.

Another important factor is the mechanization of farms. In addition to the indicator $(\frac{value\ of\ farm\ machinery}{all\ equipment})$ generally used in the sector to measure mechanization, the machinery value per poultry was also measured as secondary indicator. To overcome the gap with advanced European competitors, the use of modern farm technology is required. Thanks to technological investments, natural efficiency indicators and thus profitability are significantly improved. One of the biggest problems of the poultry sector is the lack of technological development and innovation (Nábrádi and Szőllősi, 2008; Szőllősi, 2014; Szőllősi and Szűcs, 2014; Jankovics, 2017). In the Hungarian literature, technology is a recurring problem. Similar sentences can be found: "our professional knowledge is stagnant at the level of 1995-2000; our management knowledge is at the level of 15-20 years before" (Nábrádi and Szőllősi, 2008 cited by Bárány, 2007). According to the literature, the poultry sector is facing a major technology gap and there has been no significant progress at the sector level in the last 20 years. As a result, our poultry sector model includes two variables expressing the mechanization of the holdings.

In the lack of investment and innovation, the substitute for technology is farm labor, which, with few exceptions, is less efficient than machines. To express technological development, two mechanization index and one labor utilization index were included in the model. According to our preliminary expectations, mechanization may have a positive effect, while the latter may have a negative impact on profitability.

A long-standing dilemma for the Hungarian livestock industry is the question of whether to buy or grow feed. Furthermore, the optimal ratio of purchased feed is also a contentious issue. Jankovics (2017) states that cereal prices and broiler feed prices move closely together, but the actual problem is that the increase in grain prices is more pronounced increase costs by more than the increase in slaughter chicken prices. The most serious problem in the profitability of table egg producers besides size is the volatility of feed prices (Szőllősi and Molnár, 2018). According to Szőllősi's (2008) calculations, 60% of the costs of broiler chicken fattening is determined by the purchased feed. On this basis, profitability is very sensitive to changes in prices. The unfavorable development (opening) of the price scissors of industrial-agricultural products has a significant impact on the profitability of agricultural farms (Borszéki, 2003). Varga et al. (2017) found that price scissors have shown a favorable image in agriculture over the past 10 years, but the picture is improved by crop production and the situation for livestock farmers remains unfavorable. Taking all this into account, it should be assumed that the proportion of purchased feed within the total feed cost has a negative impact on profitability.

Realizing positive returns requires risk-taking, the risk is included in the definition of business. In line with profit persistence research, the concept of risk is approached from an accounting perspective, consequently, short-term and long-term risks are depending on the time horizon of indebtedness. High risk is expected to result in high expected returns (see CAPM model). Bowman (1980) found a negative correlation between risk and profit, which is supported by the practice of smoothing profits. Profit persistence research in the food industry has found a positive and negative relationship between risk and profitability. In most cases, long-term risk is positive or insignificant, and short-term risk has a negative impact on food companies. In his study, Borszéki (2008) estimated the cost of capital for the pig and poultry sectors. Based on his calculations, the optimal leverage ratio for both sectors is 35%, i.e. approximately two thirds of the liabilities side is equity and the remaining is debt. This is far below the optimal capital structure, one of the main reasons of which is the lack of own resources needed for foreign sources (Borszéki, 2003). The lack of technological development mentioned previously is rooted in the same place. This discrepancy and diversity characterizes well the relationship between risk and profitability, and consequently, we have no clear expectation of the relationship between any of the risk indicators. We measure long-term risk as the ratio of long-term liabilities to equity and short-term risk as the ratio of current assets to current liabilities.

The European Union and the prevailing domestic government policy have a special focus on agriculture. The level of subsidies in agriculture is outstanding compared to other industries (Sipiczki and Rajczi, 2018; Varga and Sipiczki, 2017a), and it is worth highlighting the favorable financing arrangements that are not effectively used by the farms. Subsidies received under the Common Agricultural Policy (CAP) also had a significant impact on the profitability of agricultural economies and the structure of production (Varga and Sipiczki, 2017b; Rajczi and Wickert, 2015). These factors mean a reduction in operational risks, so the subsidy ratio of total output were used as a control variable. Interestingly, except in one case, empirical studies processed in this paper do not include any form of support. The only exception is Tamirat et al. (2018), where the proportion of subsidies is not explanatory for the profitability of Dutch agriculture as a whole; the same is true for field crop production and pig holdings. There was a positive relationship only in dairy farms and a negative relationship in mixed livestock holdings between aid intensity and profitability. In our opinion, it is difficult to deny the subsidy dependence of the Hungarian agricultural economy although it is important to consider that the subsidy rate is much lower for livestock farmers than for crop producers. Moreover, according to Sipiczki et al. (2019), poultry and pig farming are the most profitable sectors within agriculture, but, if subsidies are taken into account, they become the least profitable. In the EU (and Hungary) there are only a few subsidies targeting the poultry sector. The most important year-to-year accessible subsidy is the so-called poultry animal welfare aid which partially compensates farmers for the increased production costs due to compliance with animal welfare rules. The other significant financial CAP-subsidy is the financial support for the modernization of poultry farms which provides a tender-based support for investments in production and manure management technology of farms. Several studies confirm that the profitability of poultry farms has deteriorated with the reduction of subsidies (Szőllősi and Nábrándi, 2008; Szőllősi, 2014). With these in mind, we expect the relationship between subsidy ratio and profitability to be positive or neutral. The subsidy ratio measured by the ratio $\left(\frac{subsidies\ without\ repayment\ obligations}{subsidies\ without\ repayment\ obligations + output}\right)$.

Non-repayable subsidies includes direct aid to producers, interest subsidies and aid for income compensation.

In case of the variable expressing the legal form of farming, it is assumed that the profitability of individual small-scale farmers and sole proprietors is higher than corporate farms and entrepreneur farmers. The reason for this is that the individual small-scale farmers' tax rules provide significant benefits and exemptions for families operating the farm. The poultry sector is characterized by a very small, sub-optimal (Szőllősi and Nábrádi, 2008) average farm size, which gives them tax advantages. As a result, the dummy variable for legal form (0 = individual farms, 1 = corporate farms) is assumed to have a negative relationship with profitability.

Variables	Expected impact	Mean	Median	Std. dev.
abnormal ROA.L1	0/low	0.096	-0.229	6.333
ln total assets	+	10.492	10.496	1.294
subsidy ratio	+/0	0.043	0.037	0.037
ln labor	-	0.713	0.647	0.820
purchased feed	-	4.064	3.283	2.920
ln number of poultry	+	8.848	8.985	1.412
long risk	+/-	0.444	0.000	1.288
short risk	+/-	5.577	1.634	14.435
mechanization _assets	+	0.048	0.008	0.087
mechanization_number	+	0.276	0.031	0.674
form of business	-	0.346	0.000	0.476

Source: own editing

Table 1: Expected impact and descriptive statistics of the variables used in the research.

Results and discussion

Table 2 shows the transition probabilities for the Hungarian poultry farms. While the ROA and aROA matrices are very similar for the poultry sector, the aROA probabilities are lower in most cases. So high ROA values do not automatically mean that abnormal profits are also high. The industry average profitability and the profitability of individual farms are rather likely to move together. The values in the diagonal are low. Values above 0.5 indicate strong profit persistence (Amidu and Harvey, 2016). Based on the values the competition is expected to be close to perfect competition.

Our results are in perfect agreement with the very similar study by Stabel et al. (2018) including 425 KFMA (Kansas Farm Management Associaton) farms: farm mobility between profit categories is generally high, but within this, the lowest and highest profit category farms are more likely to remain in their own quintiles. We agree with the findings of the cited authors that (i) this is most a problem for low-income farms, as they are less likely to be able to improve over time on their weaker profitability; (ii) for the highest-income farms, the same relative stability has a positive content, as it means more likely to maintain a favorable income position; (ii) the greater stability of the two extreme categories indicates the important role of farm management in profit stability.

The dynamic panel estimation will give a more accurate picture because 1) the conditions of the model are less strict (time invariance) than in the case of the Markov chain and 2) it provides an opportunity to control for different effects to get the most accurate value for the profit persistence coefficient. The Markov chain is appropriate as a starting point, and based on the results obtained, some expectations about the dynamics of competition can be derived.

The results of the Arellano-Bond dynamic panel estimation are shown in Table 3, Blundell-Bond results can be seen in Table 4. Hansen and Sargan test results are satisfactory. The profit persistence value is 0.108, but not significant. Considering the literature context, surprisingly rare is the study in which profit persistence is zero (e.g. Kozlenko (2015) for a few food sectors). On the other hand, on the basis of Hungarian literature, it has been emphasized on several occasions that the poultry farms are small, which is one of the barriers to profitability (Szőllősi and Nábrándi, 2008; Sipiczki et al., 2019).

In the case of farm size, the natural indicator (‘ln number of poultry’) is significant, so by increasing the average number of poultry per year the profitability of the farms also increases, this result supports the existence of economies of scale. There are examples in the international literature where the increase in size (from an accounting point of view) reduces profitability, but in the case of the Hungarian poultry sector this "critical size" seems to be far away. The results confirm the Hungarian and international theoretical and empirical research (Houedjofonon et al., 2020; Szőllősi et al., 2019; Khan and Afzal, 2018; Shorouei et al., 2017; Ymeri et al., 2017;

ROA	(1)	(2)	(3)	(4)	(5)	Pi
(1)	0.413	0.215	0.162	0.093	0.117	0.200
(2)	0.226	0.341	0.204	0.137	0.093	0.200
(3)	0.137	0.224	0.282	0.232	0.125	0.200
(4)	0.103	0.120	0.265	0.322	0.190	0.200
(5)	0.070	0.104	0.104	0.235	0.487	0.200
Pj	0.191	0.200	0.204	0.204	0.201	1.000

aROA	(1)	(2)	(3)	(4)	(5)	Pi
(1)	0.332	0.199	0.170	0.129	0.170	0.200
(2)	0.155	0.400	0.241	0.141	0.064	0.200
(3)	0.118	0.192	0.314	0.269	0.106	0.200
(4)	0.104	0.121	0.264	0.281	0.229	0.200
(5)	0.180	0.160	0.121	0.199	0.340	0.200
Pj	0.179	0.214	0.225	0.205	0.179	1.000

Source: own editing based on STATA output

Table 2: Transition Probability Matrices.

Arellano-Bond	Coefficient	Corrected Std. error	p-value
abnormal ROA.L1	0.108	0.109	0.325
ln total assets	-0.309	0.235	0.189
subsidy ratio	3.669	4.215	0.385
ln labor	-0.088	0.198	0.659
purchased feed	-0.022	0.064	0.737
ln number of poultry	0.478	0.277	0.087*
long risk	-0.424	0.136	0.002***
short risk	0.000	0.007	0.966
mechanization _assets	-6.475	3.190	0.044**
mechanization_number	0.574	0.323	0.077*
form of business	-0.822	0.436	0.061**
Tests			
AR(2)	z = -0.61		0.544
Sargan	Chi2(31) = 33.68		0.339
Hansen	Chi2(31) = 35.80		0.253

Note: ***, **, *Significant on 1, 5, 10 %
Source: own editing
Table 3: Results of dynamic panel estimation (Arellano-Bond).

		WC-Robost	
Arellano-Bond	Coefficient	Corrected Std. error	p-value
abnormal ROA.L1	0.001	0.021	0.955
ln total assets	-0.580	0.303	0.055**
subsidy ratio	1.705	7.673	0.824
ln labor	0.263	0.376	0.484
purchased feed	0.002	0.095	0.986
ln number of poultry	0.856	0.325	0.008***
long risk	-0.580	0.093	0.000***
short risk	0.002	0.013	0.882
mechanization _assets	-2.729	3.785	0.471
mechanization_number	1.101	0.436	0.012**
form of business	-1.860	0.947	0.049**
Test			
AR(2)	z = -0.89		0.375

Note: ***, **, *Significant on 1, 5, 10 %
Source: own editing
Table 4: Results of dynamic panel estimation (Blundell-Bond).

Szőllősi and Nábrádi, 2008) in the poultry sector.

Two variables were applied (‘mechanization_ assets’, ‘mechanization_number’) to get a more accurate picture of the depressing technological situation according to the literature. Both are significant, but with a different sign. In our opinion, the natural approach gives a more accurate picture, so with the growth of farm machinery per bird, efficiency increases and thus profitability. According to Szőllősi and Szűcs (2014), mechanisation is the only way to improve the profitability of the poultry sector; Jankovics (2017) also comes to a similar conclusion to escape forward. Recent international research (Rowe et al., 2019; Mancinelli et al., 2018; Hartung et al., 2017) also highlights the significant impact of mechanization. Based on these results, mechanization can be called one of the most important development areas of Hungarian poultry farming. In the case of mechanization ratio to the balance sheet total, accounting adjustments (the difference between real and calculated depreciation) and other items increasing or decreasing the balance sheet "move" this indicator. Although the logarithm of the balance sheet total is not significant, studies have treated declining farm size as a fact, so this effect also influences the mechanization index. A further reason for the negative impact is that investments are leveraged, as measured by long-term risk.

The variable for labor ('ln labor') has no explanatory power. The reason for this is on the one hand of technical origin, the effect of work intensity in the model is partly eliminated by the significant mechanization variable. On the other hand, it is a well-known fact that agricultural labor supply is declining in the region, as well as in the whole EU (Maucorps et al., 2019; Krajcsák and Kozár, 2018). According to the economic model of the labor market, insufficient labor supply moves wages upwards (Cassey et al., 2018; Zahniser et al., 2018). Thus, there were two contradictory effects during the period under review: firstly, the replacement of labor by mechanization had a reducing effect on costs (thereby improving profitability), and secondly, wage increases due to labor shortage had a reducing effect on profits. The two effects with opposite signs eventually extinguished each other.

Long-term risk (variable 'long risk') has a negative impact on profitability. The negative relationship is consistent with the findings of Lopez-Valeiras et al. (2016). Between 2006 and 2016 the average level of indebtedness fell by 80% on average (no significant difference by farm size), with the biggest drop after 2008, clearly a consequence of the global economic crisis. The debt has not recovered since the crisis, which also means that lack of investments. This is another sign of inefficiency and size problems. Improvements can be made primarily through the involvement of external capital, but with own funds, a farm is not indebted if the future expected profits yield the interest of the loan. On the other side, poultry farming, especially in the case of small-scale farms, is not an attractive target group for financial institutions providing loans. Because of high operational risks (e.g. animal epidemics, temporary restrictions on international trade, single costumer-dependence of farms), low transparency (unreliable accounting of individual small-scale farms), and the high volatility of input and output prices, loans to the poultry sector are risky, making them expensive and low in supply. In the current situation of the Hungarian poultry sector, this is a trap. In addition to low profitability, indebtedness in the short term is bound to worsen profitability, which owners are unlikely to undertake. Without improvements, profitability will also deteriorate, but in this case, it will be a slow process lasting several years, even decades, while in addition to indebtedness, there may be a sharp downturn and future returns are not guaranteed. In such a situation, it is difficult to choose the riskier way; especially if we consider the words of Bárány (2007) that management knowledge is 15-20 years behind.

The short-term risk is not significant according to the model. It is worth mentioning here the study of Borszéki (2008), who argues that the increase in trade payables does not mean an improvement in the market financing position, but rather the presence of the chains of debts, which is a sector problem.

Calling for grants and their rational use for development and risk reduction may be an appropriate "means". According to the model, the increase in the subsidy ratio within total output does not affect profitability. The reason for this is the low level of support compared to other agricultural sectors. According to Sipiczki et al. (2019), without subsidies, the poultry sector is one of the most profitable agricultural sectors. Considering the subsidies, the other sectors are improving to the extent that it becomes the least profitable. However, several studies (Szőllősi and Nábrádi, 2008; Borszéki, 2003) emphasize the minor and limited role of subsidies in the sector. For these reasons, the neutrality of the subsidies is not surprising.

The variable of purchased feeds is negative but not significant. In the model specification section has been mentioned the opening of the price scissors of industrial-agricultural products. Calculations have shown that the input price increase is higher than the output price increase, which clearly has a negative impact on profitability. The poultry sector has a high ratio of purchased feeds, as it is confirmed in Popp et al. (2018), according to which 50% of the nutrient mixes produced in Hungary in 2016 was poultry feeds, half of the feed mills produce poultry feeds. From this, two conclusions can be drawn: it is likely that poultry feed production is a profitable activity, and, on the other hand, poultry farms are not thinking about producing their own feed but buying. According to preliminary expectations, corporate farms will achieve lower abnormal profits and individual farms will be able to claim tax benefits.

Conclusion

The poultry sector has undergone a major transformation over the last two decades, and, according to a clear trend, most small-scale farms are unable to compete in the EU single market. Market competition was measured with abnormal profit (above-market-average portion of farm profit) persistence. The profit persistence of the poultry sector is not significant indicating, from a theoretical point of view, that the sector is close to perfect competition. Many small, sub-optimal farms justify the profit persistence value obtained.

In the case of the dynamic panel model, it can be stated that the increasing number of poultry (pcs) improves profitability and reduces competition, but the rate of financial (CAP-) supports does not affect the abnormal profit and thus has no distorting effect on the sector. Efficiency technology investments improves the abnormal profitability of farms, which is a breakout point for the poultry sector. Labor and purchased feed have no demonstrable effect on above-market yield. Among the risks, long-term indebtedness reduces abnormal profits, if the debt is invested in proper mechanization, companies can gain a competitive advantage in the long run. Individual farms have the potential to achieve higher returns in relative terms.

The results of the research, in comparison with the literature (theoretical and empirical), confirm the fact that the improvement of the international competitiveness of the sector within the Hungarian dual farm structure is clearly conceivable with large-scale, low-unit labor-intensive economies. Consequently, policy strategies and measures to maintain or possibly increase the Hungarian poultry population should be designed with this in mind, primarily focusing on the development of medium and large-scale livestock production.

The development of the competitiveness of individual and family farms can only be successful if future development programs and subsidies support the achievement of at least a medium-sized farm, the reduction of specific labor utilization, horizontal and vertical integration, and the provision of their own fodder base. An additional breakthrough point may be the expansion of one's own slaughtering and processing capacities, but this paper does not aim to support this statement.

Regarding the practical application of our results, authors consider the interaction between mechanization and indebtedness to be the most relevant. Mechanization as the most effective tool of increasing profits is of paramount importance for both producers and policy makers. If the technological heterogeneity of poultry farms will be not able to be reduced by the stakeholders, and the digitalization and precision technology transition does not take place in the next planning cycle, the Hungarian poultry sector will struggle with serious profitability and competitiveness problems. For successful technological developments and mechanization, however, it is essential to reduce the negative effects of long-term indebtedness. Therefore, we see the need to develop partially state-led loan schemes for the sector, enabling viable investments with a reduced / subsidized interest burden. With such schemes in place, farmers can start modernizing their farms with less risk and better profit prospects. We have not found any proposal in previous research to resolve the contradiction between the modernization constraint and the joint treatment of indebtedness as a hindering factor. In our opinion, the detailed elaboration of specific constructions and subsidies is another important area of future research.

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