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Profitability and risk of crop and livestock production in Slovak farms

Abstract: *The paper focuses on profitability and risk of crop and livestock production based on an analysis of farms operating in the Slovak Republic. Risk in agriculture has been a matter of worldwide concern since 1933, when the concept of risk analysis was introduced. Agriculture is a sector facing particularly large risks, resulting mainly from natural factors outside the control of farmers. The resulting variations in farm output, combined with a relatively low price responsiveness of supply and demand, also cause agricultural markets to be rather volatile. The sources of risks that are relevant in agriculture have different characteristics, and can be classified in very different ways. Sources of risk include biological nature of production, dependency on climatic conditions, seasonality, animal and plant health, prices instability, policy regulations, and a range of macroeconomic factors.*

Keywords: *profitability, risk, crop production, livestock production, portfolio.*

Introduction

Before 1989, Slovak farming consisted of cooperatives and large state farms but after 1989 the sector was transformed from a centrally planned economy to a market economy. The adoption of the Common Agricultural Policy (CAP) has led to a number of big changes in Slovakia that have ultimately impacted on economic development in the agricultural sector and the priorities of farmers.

In this paper we analyse the profitability of farms divided into groups based on the type of production into crop and livestock farms (according to the share in sales from crop or livestock production). Using descriptive statistics and Markowitz portfolio theory we simulate the total farm profitability and volatility of livestock and crop production in Slovakia. Farms focused on livestock production only are efficient and profitable, but the profitability is lower in comparison with crop farms. The results of livestock farms are less volatile than those of crop farms. Large farms tend to produce with lower value added and can generate enough profit for the owner. But production with lower value added has significantly less positive impact on rural development and job creation in rural areas. Therefore, policy measures at the farm level should be applied to motivate individual farmers with large UAA to increase the value added of their production.

The agricultural sector in general has faced tumultuous development in recent years. Price volatility has increased, with sharp swings in product and input prices. Markets have been affected by macro-economic disturbances, disease outbreaks and adverse weather events such as floods and droughts, as well as more frequent climate changes. With agricultural policies that are more decoupled from production and prices, farmers are now more exposed to market forces than in the past (Antón et al., 2011). Risk management in agriculture plays a key role nowadays, as an essential tool for farmers to anticipate, avoid and react to shocks, potential losses and increasing volatility of incomes (OECD, 2011).

As agricultural risk can be a difficult concept to recognise, there has not been universal agreement on how to define and measure risk (Hardaker et al, 2004; Tangermann, 2011). Generally, risk refers to deviation of the evaluated variable (income, price, production etc.), and its level depends on the volatility over a certain period. The smaller the deviation, the tighter the distribution and the lower the risk. In the risk assessment some authors focused on the stand-alone agricultural risk of individual farms, while others took into account the whole market level (Just and Pope, 2003; El Benni and Finger, 2013). One useful way of measuring risk in agriculture, counting with several individual farms of the agricultural sector at once, is the Markowitz portfolio theory approach. Portfolio theory significantly improved the ability to analyse and identify optimal choices under risk by extension of the analysis to include variability, as well as expected returns (Barkley and Peterson, 2008).

The application of Modern portfolio theory in the analysis of agricultural risk can be found in the work of many authors. Robinson and Brake (1979) con-

ducted a literature review about the application of portfolio theory in agriculture and agricultural finance, Barkley and Porter (1996) analysed Kansas wheat producer variety selection decisions, Peterson and Leuthold (1987) used the portfolio approach to examine the cattle feeding problem, Cox et al. (2004) used the portfolio theory to provide evidence that cultivar mixtures can increase yield and reduce yield variability, Turvey and Driver (1987) used principles of portfolio theory to study the systematic and non-systematic risk of Canadian agriculture. More recently, Nyikal and Kosura (2005) used quadratic programming (QP) to solve for the efficient mean-variance frontier to better understand farming decisions in Kenyan agriculture. In another application of portfolio theory, Figge (2002) summarised the literature on how portfolio theory has been applied to biodiversity, while Sanchirico et al. (2005) used portfolio theory to develop optimal management of fisheries. The research in risk in agriculture is supposed to begin with the identification of risk and its assessment (measurement). The ability to assess the risk and return of Slovak agricultural companies has been a focus of our research in recent years (Tóth et al., 2014). In this paper we examine the portfolio risk and return of Slovak agricultural companies, divided on the basis of their production orientation.

Methodology

The data used for the analysis are from the database of Ministry of Agriculture and Rural Development of the Slovak Republic (MoA), over the period 2004--2014. Data were selected according to the production orientation to the subset of crop farms and livestock farms. The selecting criterion was the share of livestock production based on sales. We created eight portfolios of farms: one for all farms and seven based on share of livestock production ranging from 0 to 100 per cent. For calculation of five-year moving averages were used for two periods: 2004-2008 and 2010-2014. From the dataset the following farms were excluded: farms that started or quitted during each observed five-year period and farms with negative equity (liabilities exceeding total assets) over the observed period.

The modified Markowitz portfolio theory approach was used to estimates the total risk of eight portfolios. Markowitz portfolio theory refers to the mean-variance analysis, with 'mean' used interchangeably with average or expected return, and 'variance' used to denote risk (Markowitz, 1952). The portfolio of stocks represents the equity securities. The measure of variability uses the deviation of the return on stock which reflects simply the return on equity invested into the business. Based on the principles and methods of risk estimation in Markowitz model the Simple index theory was created (Sharpe, 1963), which involves the accounting variables implication to the model. Because the majority of agricultural companies belong to the unlisted companies, the use of accounting fundamentals seems to be a necessity. The return on stock, from the original model, might be replaced with the return on equity of the farm, for the needs of estimating the portfolio risk and return of unlisted agricultural farms. Several different accounting variables have been used in other studies. Gempesaw et al. (1988) applied the SIM approach using the gross and net returns, Baginski

and Wahlen, (2003) measured farm volatility using the farm equity returns, and Fama and French (1995) opted for the book to market ratios. In our study we measured the market risk of unlisted farms using the return on equity ratio ROE.

We assumed that the return of the investor is based on the profit of the farm and the equity invested. Therefore, we considered return on equity ROEi (Equation 1) to be equivalent to the return on stocks, generally used in the case of quoted companies. Measuring volatility of return in the Markowitz portfolio theory is based on the average return over the observed period for each investment. We calculated the average return on equity EROEi (Equation 2) for each individual farm:

$$ROE_i = \frac{Earnings\ \ After\ \ Taxes}{Shareshold\ ers\ \ Equity} \tag{1}$$

$$EROE_i = \sum_{i=1}^{t} ROE_i \cdot d_i \tag{2}$$

where ROEi is return on equity of farm i, di is a weight of ROEi over the observed period (five years, $d_i = 0.20$), t is number of years in observed period. The individual risk of each farm σ_i is calculated using the standard deviation:

$$\sigma_i = \sqrt{\sum_{i=1}^{t} (ROE_i - EROE_i)^2 \cdot d_i} \tag{3}$$

where σ_i is standard deviation of the individual return on equity (individual farm risk), ROE_i is individual return on equity, $EROE_i$ is average individual return on equity.

The portfolio risk (σ_p is determined by three variables: weight of the individual investment in portfolio (wi), standard deviation of the individual investment – individual risk (σ_i), and covariance (σ_{ij}), relation between the ROE_i and ROE_j (return on equity of farm j). To take into account market portfolio of all agricultural farms, the weight w_i of each farm is determined by farm market share, which is the share of the farm's equity on the total equity of all farms. The covariance represents the relationship between returns on equity of farms (Equation 4) and Σ covariance matrix (Equation 5). The portfolio risk is then measured according to Equation 6:

$$\sigma_{ij} = \frac{1}{n} \sum_{i=1}^{n} (ROE_i - EROE_i)(ROE_j - EROE_j) \tag{4}$$

$$\Sigma = \begin{bmatrix} \sigma_{11}\ \sigma_{12} & \sigma_{13} & \cdots & \sigma_{1k} \\ \sigma_{21}\ \sigma_{22} & \sigma_{23} & \cdots & \sigma_{2k} \\ \sigma_{31}\ \sigma_{32} & \sigma_{33} & \cdots & \sigma_{3k} \\ & \cdots & & \\ \sigma_{k1}\ \sigma_{k2} & \sigma_{k3} & \cdots & \sigma_{kk} \end{bmatrix} \tag{5}$$

$$\sigma_p = \sqrt{\sum_{i=1}^{n} w_i^2 \cdot \sigma_i^2 + \sum_{i=1}^{n} \sum_{j=1}^{n} w_i \cdot w_j \cdot \sigma_{ij}} \tag{6}$$

where wi is an individual weight of i-farm (farm's equity) in a portfolio (total equity of all farms) and n is the number of farms.

The expected return on equity of portfolio is estimated by the multiplication of k x 1 vector of individual weights of portfolio (w) and k x 1 vector of corresponding individual expected returns on equity (the sum of multiplication of each farm´s expected ROE and its share in the market portfolio):

$$EROE_p = \sum_{i=1}^{n} EROE_i \cdot w_i \quad (7)$$

where $EROE_p$ is expected portfolio return on equity and EROEi is the average return on equity of an individual farm.

Results

Structure of Slovak agriculture

In 2014 there were 17,708 farms registered for subsidies in Slovakia, which together operated on 1,883,220 ha of utilised agricultural area (UAA). In terms of farm size (UAA), the farms structure in Slovakia is different from the European Union (EU) average. This results from the historical development of agriculture in the former Czechoslovakia before 1989. In 2014, 74.6 per cent of UAA was cultivated by farms with over 500 hectares (Table 1), while the average UAA per farm in the EU is much lower. Therefore, the measures implemented through the CAP also result different in Slovakia. As regards ownership of the land, 43.5 per cent is owned by individuals, 4.5 per cent own firms and 4.0 per cent are state-owned. Forty-eight per cent of UAA is owned by unknown owners and this UAA is temporally administrated by the Slovak Land Fund (SPF) and the users of the land have to pay a rent (data for 2014).

Table 1. Utilised agricultural area (ha) per farm as a percentage of total area

Year	0-5	5-10	10-50	50-100	100-250	250-500	over 500
2010	0.99	0.94	3.43	2.91	6.80	7.91	77.74
2011	0.99	0.95	3.75	2.95	6.42	8.20	76.75
2012	0.99	0.98	3.97	2.94	6.60	8.28	76.24
2013	1.01	1.04	4.23	2.97	7.04	8.21	75.49
2014	1.04	1.09	4.52	3.10	7.07	8.55	74,64

Data source: Agricultural Paying Agency of Slovakia, 2015.

As a result of privatisation, the number of independent farmers increased rapidly in the first years after 1989 and then stabilised. The share of cooperatives has decreased and the number of business companies has increased. In 2010 there were 1,419 private companies (consisting of 1,310 limited liability companies and 109 joint stock companies) and 579 cooperatives. From then until 2014 there was a 2.25 per cent decrease in the share of cooperatives, a 9.17 per cent increase in the share of joint stock companies and a 50.23 per cent

increase in the share of limited liability companies. A minority of farms (2,653 = 15.0 per cent) owned most (1.4 million hectares = 80.2 per cent) of the agricultural land in 2014. This distribution of the land, with a few large farms owning most of the UAA and many small farms sharing a low percentage of UAA, has a significant impact on the land and rent prices. Moreover, this phenomenon has not been changing in recent years. In 2010 12.5 per cent of farms owned 80.4 per cent of UAA, while in 2007 only 11.2 per cent of farms owned 81.0 per cent of UAA.

Table 2. Size structure of Slovak farms

	Number of farms		Index	UAA 2014		
Legal form	2010	2014	Change (%)	Land (ha)	Land per farm	Share on all farms (%)
Joint stock co.	109	119	9.17	13,272	1,113	0.67
Cooperative	579	566	-2.25	691,054	1,221	3.20
Small – family farm	9,020	9,785	8.48	53,291	5	55.26
Limited liability co.	1,310	1,968	50.23	687,429	349	11.11
Farmers	4,774	5,046	5.70	303,867	60	28.50
Other	146	160	9.59	12,383	n.a.	0.97
Total farms	15,938	17,708	11.11	1,883,220	n.a.	100

Data source: Agricultural Paying Agency of Slovakia, 2015.

Impact of integration and globalisation on farm performance

Under the CAP, Slovakia opted for single area payment scheme (SAPS). This form of support is in combination with large farms in Slovakia changing the performance of farms. Since 2004 Farmers have been continually decreasing their livestock production in favour of crop production. EU subsidies are decoupled from production which means that farmers are not motivated to produce and the intensity of support is increasing. Subsidies per hectare increased after adoption of the CAP (Tables 3 and 4). Large farms in combination with improved technology have resulted in a decrease in farm employment in Slovakia.

There are differences in the performance of farms based on the type of production. Generally, agriculture in Slovakia has very low profitability. On average this did not change when comparing the two periods 2004-2008 and 2010--2014. Also the risk measured as a farm portfolio ROE volatility is constant and changed from 1.00 per cent in 2004-2008 to 1.95 per cent in 2010-2014.

Profitability of farms differs based on the share of livestock production. In the period 2004-2008 the most profitable farms measured by ROE were those with 0-20 per cent share of livestock production and farms specialised in livestock production only were generating losses over 7 per cent. The situation did change in the period 2010-2014. The most profitable farms have no livestock production. Also the farms specialised in livestock production only are profi-

table now. Mixed farms with a share of livestock production from 60-80 per cent are generating losses. The integration and globalisation of Slovak agriculture is resulting in specialisation of farms and farms are reducing livestock production to limit their losses.

Table 3. Situation in Slovak agriculture in the period 2004-2008

	All farms	Share of livestock production in total production (%)						
		0	0-20	20-40	40-60	60-80	80-100	100
Average profitability (ROE) (%)	1.83	6.47	9.48	2.53	1.14	0.08	2.05	-7.18
Risk (%)	1.00	3.60	3.45	1.45	1.78	0.87	0.73	8.74
Share of number of farms	100.0	15.2	10.4	13.8	18.0	17.6	21.2	3.8
Number of farms	874	133	91	121	157	154	185	33
Subsidies per ha (EUR)	241	204	206	209	221	256	299	315
Hectares per employee	28.7	31.0	50.3	31.1	25.8	26.6	27.8	21.8
Income per hectare (EUR)	26.4	83.5	54.0	31.5	17.8	8.9	28.8	-86.1
Income per employee (EUR)	756	2,593	2,716	979	459	237	801	-1,877
Subsidies on total sales (%)	0.30	0.22	0.40	0.25	0.24	0.32	0.49	0.23
Sales per employee (EUR)	22,665	29,032	26,046	25,768	23,846	21,010	17,017	30,294

Data source: MoA

Table 4. Situation in Slovak agriculture in the period 2010-2014

	All farms	Share of livestock production in total production (%)						
		0	0-20	20-40	40-60	60-80	80-100	100
Average profitability (ROE) (%)	1.60	7.33	2.76	1.70	1.32	-1.14	-0.26	0.18
Risk (%)	1.95	4.92	5.31	2.81	4.34	1.58	0.97	1.77
Share of number of farms	100.0	21.0	16.7	14.1	13.5	11.7	16.5	6.5
Number of farms	922	194	154	130	124	108	152	60
Subsidies per ha (EUR)	289	220	247	270	293	324	365	371
Hectares per employee	39.8	58.7	55.3	39.1	33.4	35.2	34.3	31.8
Income per hectare (EUR)	26.2	120.5	40.2	33.6	-6.4	-10.7	5.1	10.4
Income per employee (EUR)	1,043	7,071	2,222	1,310	-213	-376	174	331
Subsidies on total sales (%)	0.34	0.22	0.35	0.29	0.32	0.42	0.50	0.46
Sales per employee (EUR)	33,309	59,526	38,560	36,307	30,267	27,150	24,995	25,414

Data source: MoA

Increased competition caused by globalisation and integration resulted in increased productivity. Sales per employee increased from EUR 22,665 per year in the first period to EUR 33,309 per year in the second period. Also the income (profit) per employee did increase from EUR 756 to EUR 1,043 per year (Tables 3 and 4).

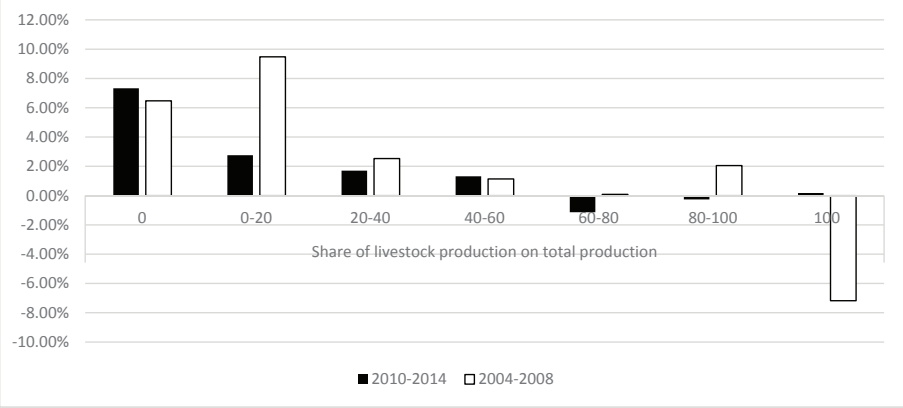

Figure 1. Average profitability of farms based on the share of livestock production in total production

Data source: Tables 3 and 4.

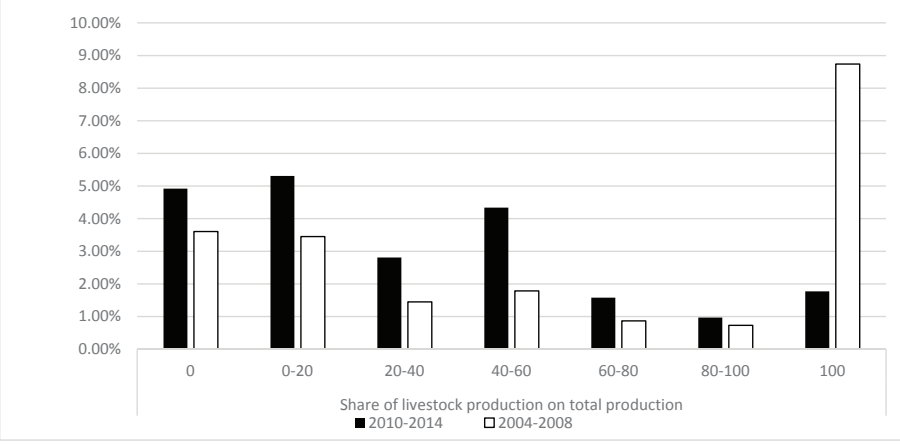

Figure 2: Risk of farms based on the share of livestock production in total production

Data source: Tables 3 and 4.

Livestock farms used to be risky and majority of the risk was systematic. The most profitable farms are the riskiest. Generally, livestock production be less risky than crop production. The situation in 2010-2014 in Slovakia is in line with this assumption (Figure 2).

The change to SAPS in 2004 is changing also the structure of farms. In the period 2004-2014 the share of livestock production decreased. In the first period farms with more than 50 per cent of livestock production were dominant. Now crop production is more profitable and therefore farms focus more and more on crop production. The share of specialised crop farms and farms with crop production less than 20 per cent increased by more than 5 per cent each.

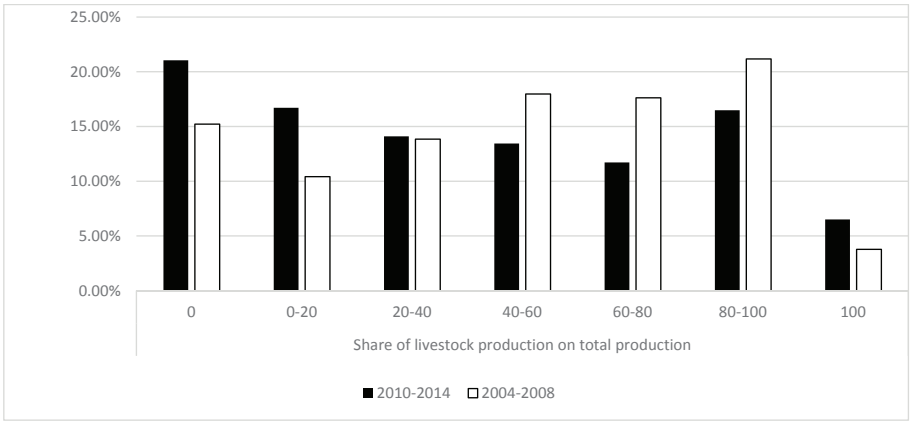

Figure 3. Share of farms based on the share of livestock production in total number of farms

Data source: Tables 3 and 4.

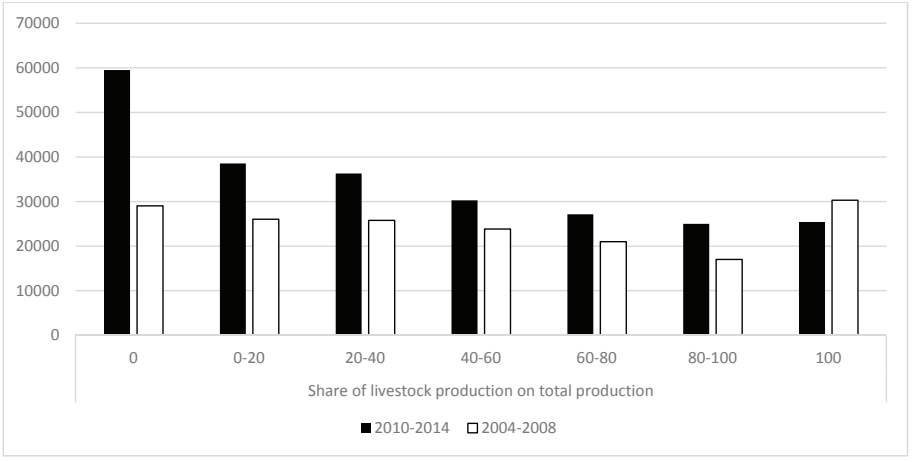

Figure 4: Sales per employee based on the share of livestock production on total production

Data source: Tables 3 and 4.

The productivity of farms did increase. Crop farms are more productive than livestock farms. Specialised crop farms did increase the productivity by

100 per cent. Other farms have lower productivity than specialised crop farms. The productivity of livestock farms is lower. The higher the share of livestock production on total farm production the lower the productivity. This is due to the fact that livestock production is more labour demanding.

Discussion

The paper shows how farms with large UAA contribute to different extents to rural development and employment based on the production focus. Livestock farms create value added and increase employment more than crop farms. In addition, the improvement in technology leads to a decrease in employment in big farms much more than on small farms. We conclude the productivity of farms increasd. Crop farms are more productive than livestock farms. Profitability of farms differs based on the share of livestock production. The most profitable farms have no livestock production. Mixed farms with share of livestock production from 60-80 per cent are generating losses. In the long run, crop farms are profitable and profit from crop production is used to cover the losses from livestock production in mixed farms. The most profitable farms are the riskiest. Generally, livestock production is less risky than crop production.

In conclusion, the integration and globalisation of Slovak agriculture is resulting in specialisation of farms and farms are reducing livestock production to limit the losses. Sustainable agriculture should always be a combination of livestock and crop production. These two types of production are complementary and important for rural development and environmentally-friendly agricultural production.

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