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Price, Yield, and Revenue Risk in Wheat Production in Estonia

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Abstract. In recent years, price risk has been increasingly acute for Estonian cereal growers due to increased volatility of commodity prices in the world market. Price risk is especially important due to long production cycle of the cereals. Inputs for growing wheat are bought months before the harvest, but the producers are unable to affect the output price. Price volatility and yield uncertainty increase income uncertainty. In the paper we analyse wheat price and yield variability and respective impact of these on sales revenue of wheat in Estonian conditions. The results show that the variability of yields and producer price of wheat are similar, while the variance of sales revenue of wheat per hectare indicates that production and price risk cumulate.

Key words: farm revenues, price risk, yield risk

INTRODUCTION

Variability of crop revenues is a primary source of business risk for a farm, comprised of fluctuating components, the most important of which are yields and prices. The risks in these components arise from different sources: yields are dependent on weather and other external factors, and market prices are affected by supply and demand in world markets. Yield risk varies regionally and depends on soil type, climate, the use of irrigation, etc. In contrast, price risk for a given crop depends on such factors as stock levels, supply and export demand.

Weather is an important production factor in agriculture that can hardly be controlled; for example, drought or excess rain can cause poor harvests. Hence, weather risks are a major source of uncertainty in agriculture, exerting the most obvious impact on crop yields. The problem of production risk is becoming more relevant since price volatility has increased, in part due to recent CAP reforms in the EU. Due to the difficulties in making an accurate prediction of the future, agriculture is a risky business with unstable incomes. The problem of farm income instability, affected by different sources of risks, has been raised in different contexts, such as in policy documents, scientific and applied studies.

Yields and commodity prices are important factors that determine farmers' income. Yields depend on natural conditions, such as climate, rainfall, soils, etc., which vary regionally. Prices are (often assumed to be) the same for all farms, however

prices vary both within a single year, and across the years. Small countries like Estonia are unable to affect price formation in the world market.

Therefore, the aim of the paper is to analyse variability in yields and prices as a wheat producer's major revenue components. The main risk types in arable farming are reviewed, and the impact of yield and price variance on revenue variability of a wheat producer is analysed.

The paper is organized as follows: first, the definition of risk and uncertainty in cereal producing farming, and an overview of previous studies are provided. Then data and method are described, results are presented, and finally, conclusions are drawn.

Risk and uncertainty in cereal farming

Since the future cannot be predicted with complete accuracy, the results of economic decisions have consequences that lay in the future, therefore risks must be considered in decision-making processes in farming.

The concepts of 'risk' and 'uncertainty' are used to define the level of knowledge and information about an occurrence of a future event. Uncertainty is a situation when either all the possible outcomes or the probability of the outcomes are unknown, or both the outcomes and the probabilities are unknown. Risk is a situation characterized by a range of possible outcomes, where each outcome has some chance of occurring. Variability of an outcome, in contrast to a single, certain outcome, typifies risk (Hardaker et al., 2004).

Risk management involves choosing among alternatives to reduce the impact of various types of risk. It typically requires the evaluation of tradeoffs between changes in variability and changes in expected income (Harwood et al., 1999). Risks in agriculture can be divided into two types: business and financial. Business risk stems typically from production risk (unpredictable nature of the weather and risks in performance of crops and livestock) and from market risk (deviations in price and currency exchange rates, and market demand) (Barry et al., 2000). Financial risk depends on the chosen method of farm financing, e.g., credit constraints, leverages, leasing, and interest rate variability, as well as from insufficient liquidity and loss of equity (Hardaker et al., 2004).

Agricultural producers are subject to many uncertainties. Farmers have some risks in common with other business, others are unique to farming. The most important risks can be classified as follows: human or personal; asset; production or yield; price, and institutional risk. These risks can be often interrelated, so one event can create several impacts on other realities. All the categories of risk have an effect on the income of the stakeholder (Hardaker et al., 2004).

Various studies have analysed the reasons for farm revenue variability. Astover & Mõtte (2003) assessed changes in producer prices of main agricultural products as well as possibilities of diversification of price risks. The paper was conducted on the basis of the producer prices of food and fodder crops (barley, wheat, rye, oat), milk, pork and beef as well as the retail prices of potato and cabbage in 1995–2002. Meuwissen et al. (1999) showed, based on example of the Dutch livestock sector, that the price risk was identified as the highest source of risks, followed by institutional and personal risk. Purdy et al. (1997) explored how specialization, size and other farm characteristics were associated with level and variability of farm return on equity. Their findings indicated that the variance in the return on equity corresponded significantly to the

degree of enterprise diversification, farm size, and age of the operator. Mishra & Goodwin (1997) showed that an increase in farm income variability was associated with an increase in off-farm incomes. Barry et al. (2001) analysed the influence of farm size and other structural characteristics (relative prices and yields, farm type, farm location, farm life cycle and debt-to-asset ratio) on net farm income variability. The results of the study showed that larger farms tended to exhibit lower relative variability of net farm income and that higher level of enterprise diversification was associated with less income variability.

MATERIALS AND METHODS

The present study focuses on the measurement of farm revenue risk in wheat production in Estonia. Wheat is the most important crop in Estonian arable farms. For the analysis, time series (yearly) data on yield and prices pertaining to period 1996–2010, was used. The data was obtained from the database of Statistics Estonia. Revenue per ha is a function of wheat yield and its average selling price in respective years. In order to analyse wheat revenue variance, revenue components (wheat yields and prices) of historical data were de–trended, the coefficients of variation (CV) were calculated as an indicator of relative risks (variability) for yields and prices. The methods used for the analysis include descriptive statistics and statistical analysis of variance.

RESULTS AND DISCUSSION

The main threats facing the farmer are production and price risks (Kimura et al., 2010). Production or yield risk in wheat production is partly caused by weather conditions. The weather is responsible for yield risk, and that could be measured by yield variability. Yield variability of winter and spring wheat during the period of 1980–2010 is expressed in Fig. 1. The variability in yields is not only due to the impact of weather, i.e. random, conditions. Higher yields can be measured in the beginning and at the end of the observed period. The decline in the 1990s was because of reforms in agriculture, and by the post-communist transition period itself. Higher yields can be observed since 2004, after accessing EU.

In order to estimate the variation in yield caused by weather, the impact of trend was eliminated from the data. The impact of trend was eliminated by quadratic trend function. Trend function for spring wheat is expressed by the function:

$$y_1 = 2.54x^2 - 67.27x + 2{,}485.5 \quad (1)$$

where y_1 – yield of spring wheat (kg ha^{-1}), x – year number (1980 = 1), $R^2 = 0.2512$.

Trend function for winter wheat is expressed by the function:

$$y_2 = 3.69x^2 - 79.98x + 2{,}430.9 \quad (2)$$

where y_2 – yield of winter wheat (kg ha^{-1}), x – year number (1980 = 1), $R^2 = 0.4636$.

Comparing the variability in yields of winter and spring wheat, one can say that the yield variability of winter wheat is slightly higher than of spring wheat (Table1).

Price risk is the risk of price decrease or increase after a production modification has been made. In order to estimate the variation in price, the impact of trend was eliminated from the time series. Quadratic trend function was used to eliminate the

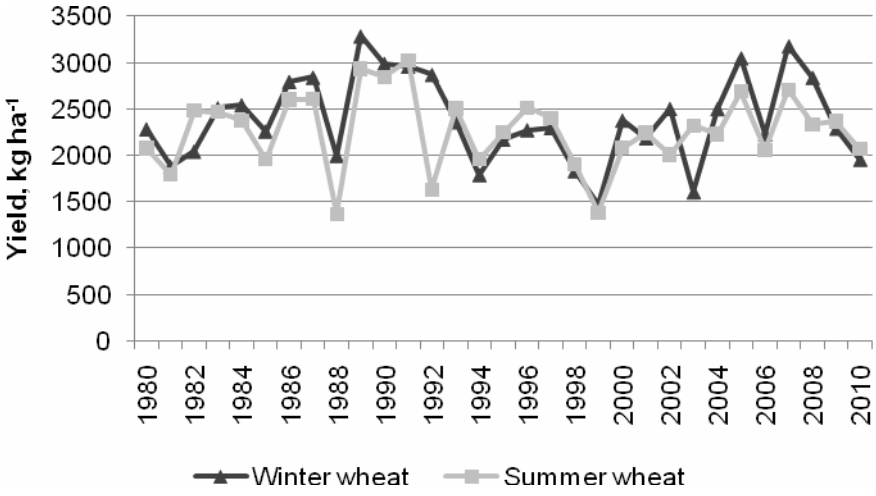

Figure 1. Yield of winter wheat and spring wheat in 1980–2010, kg ha^{-1}, de-trended

Table 1. Yield variation of spring and winter wheat in 1980–2010.

	Yield, spring wheat, kg ha^{-1}	Yield, winter wheat, kg ha^{-1}
Maximum	3,023	3,289
Minimum	1,367	1,467
Average	2,264	2,395
Range	1,655	1,821
Standard deviation	400.4	456.6
Average linear deviation	319.6	372.5
Number of observations (years)	31	31
Variation coefficient by range	73.1%	76.1%
Variation coefficient by standard deviation	17.7%	19.1%
Variation coefficient by average linear deviation	14.1%	15.6%

impact of trend. The trend of wheat producer prices (1996–2010) is expressed by the function:

$$y_3 = 0.62x^2 - 7.72x + 132.39 \quad (3)$$

where y_3 – yearly average price for wheat, € kg^{-1}, x – year number (1996 = 1), $R^2 = 0.3446$.

Respective linear trend function for wheat price (1996–2010) is expressed by the function:

$$y_4 = 2.26x + 104.11 \quad (4)$$

where y_3 – year average price for wheat, € kg^{-1}, x – year number (1996=1), R^2 = 0.1625

Price variability measurements of winter and spring wheat during the period of 1996–2010 are expressed in Table 2. However, we found the nature of linear trend function more suitable for characterizing general trend in producer prices.

Table 2. Producer price variability of wheat in 1996–2010.

	Purchase price for wheat (linear trend function), € ha^{-1}	Purchase price for wheat (quadratic trend function), € ha^{-1}
Maximum	170.3	207.5
Minimum	93.9	91.9
Average	122.3	123.9
Range	76.4	115.6
Standard deviation	21.4	36.6
Average linear deviation	18.0	29.1
Variation coefficient by range	62.5%	93.4%
Variation coefficient by standard deviation	17.5%	29.6%
Variation coefficient by average linear deviation	14.7%	23.5%

The results indicate that the variation in producer price and yield of wheat are similar in Estonian conditions. It is difficult to make a distinction between price and yield risk dominance.

Table 3. Variation coefficients of wheat yield, price and sales revenue in 1996–2010.

	Variation coefficient by range	Variation coefficient by standard deviation	Variation coefficient by average linear deviation
Yield, spring wheat, kg ha^{-1}	73.1%	17.7%	14.1%
Yield, winter wheat, kg ha^{-1},	76.1%	19.1%	15.6%
Purchase price for wheat, (linear function) € ha^{-1}	62.5%	17.5%	14.7%
Purchase price for wheat, (square function) € ha^{-1}	93.4%	29.6%	23.5%
Sales revenue for spring wheat	94.0%	27.7%	21.3%
Sales revenue for winter wheat	135.8%	31.9%	20.4%

Looking at sales revenue of a wheat producer per hectare in 1996–2010, one can see that production and price risks are cumulating, and variation coefficients are

higher. Table 3 summarises the variation coefficients for yield, price, and sales revenue. The results show that both yield and price risks separately are lower compared to sales revenue risk. This indicates that in Estonian conditions wheat prices are positively correlated to wheat yield, and historically low wheat prices have often been accompanied by poor yields. However, the causes of low prices and poor yields have different origins. Poor yields are usually the result of unfavourable weather conditions; low prices are caused by fluctuations in world markets. Estonia is known for a liberal economic policy with minimal tariff protection, therefore the internal supply shocks do not have significant impact on cereal prices.

CONCLUSIONS

The study focused on the measurement of farm revenue risk in the production of wheat in Estonia. The results of the study indicate that the yield variability of winter wheat is slightly higher than that of spring wheat, and the variation in producer price and yield of wheat are similar in Estonian conditions. According to the results, yield and price risk separately are lower compared to sales revenue risk for farmers.

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