Producer price forecasting in beef cattle sector

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The goal of this paper is to introduce a model which creates a system by using a chain of simple statistical methods. This model is able to give an approaching estimation from the inputs' price changes to the prices of the output(s) (which of the inputs have the biggest effect on the output). By this way we are able to define the measure of the risk of the entrepreneurs, the companies or even the agricultural producers. The defined risk factors serve as a basis of the later analyses where the decision makers can classify these risk factors to choose out the best methods to risk management. The model is tested on beef cattle sector where the authors are making an experiment to explain the changes of the beef producer price with the price changes of the predefined key input factors.

Keywords: beef cattle sector, forecasting model, risk management, price forecasting

1. Introduction

Future and uncertainty: these two words are often used together in one sentence not only in Hungarian language. It is no accident because the **future** always contains a kind of **uncertainty** which is in fact a **risk factor** for the economic organizations. All the risk factors must be managed to avoid inadequate operation that may endanger the continuous course of business namely the **liquidity, good standing, and profitability**.

The mine of methods and procedures that could be effectively used during risk management is fairly large and well documented but many of these methods are based on multivariate statistical analysis. This means that the circle of people who are able to use these methods is limited partly because of the lack of knowledge partly because the statistical softwares are very expensive.

Our aim was to **create a model** that is **simple** and **easy to understand** and based on the calculations of descriptive statistics. With the chain of these simple statistical methods we could define the risk factors of the operation of a corporate and this way it will be possible to respond to the market changes before it would be

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realized. The model is tested on cattle beef sector where the factors of the producer price were examined.

2. Material and Methods

Three things what are usually examined by strategic planners before starting their job: (1) what happened in the past (2) what is the present situation like, and finally (3) what are the expectations like. The first two questions could be answered relative easily thus the stress is on the future namely the **expectations**. As it was mentioned in the introduction the future means uncertainty and risk that must be managed by the economic organizations.

Information about the figures of the past could be easily collected from the different **databases** (internal and/or external databases). All forecasting systems are based on these databases. The first question is: how long should be the time series namely how many figures do the calculations need. There is no unequivocal answer: it always depends on the nature of the examined occurrence but it could be said in general that **the longer time series are accessible for the calculations the more complex conclusions could be drawn**. It must be considered that the figures need (1) to refer to similar time, (2) to contain similar time intervals, and (3) to have similar content (Szűcs 2004).

The inputs of the model are the **prices of input factors** and the sum of the input usages in the final product. According to it the cost of production was calculated as it shown below (1).

$$\sum_{i=1}^{n} P_{x_i} * z_{x_i} \qquad (1)$$

where: x_i means: the inputs
$P_1, P_2, P_3... P_n$ mean: prices per input unit
$z_1, z_2, z_3... z_n$ mean: the sum of the input usages per final product

In order to the model could explain the price changes of the final product with the price changes of the inputs it is essential to determine that how an input price changing influence the final cost of production.

$$\gamma_i = \frac{\sum_{i=1}^{n} P_{x_i} * z_{x_i} + \Delta P_{x_i} * z_{x_i}}{\sum_{i=1}^{n} P_{x_i} * z_{x_i}} \qquad (2)$$

where: γ_i is the influence of the input price changing on the final cost of production (elasticity)

The new production cost will be equal to the product of former production cost and γ_i.

$$CoP_1 = \gamma_i * CoP_0 \quad (3)$$

where: CoP is Cost of Production

If more than one input price is changing and there is no any significant and professionally justified relation between them then **linear regression model** could be effectively used. This means that the original cost of production by influence of the price changes of the inputs are multiplied and this way the new production cost will be got.

The situation is a little different when there is relation between two independent variables (dependent variable is only the cost of production). In this case the formula number (3) must be corrected as it could be found in formula (4).

$$CoP_1 = \gamma_i * CoP_0 * (1 + r_{ij}) \quad (4)$$

where: r_{ij} is the correlation coefficient between two independent variables (only in the case of significant and professionally justified relations)

If more than one input price is changing than the changing of production cost will be equal to the sum of subtractions of the new calculated and original production cost (5).

$$\Delta CoP = \sum_{i=1}^{n} (\gamma_i * CoP_0 * (1 + r_{ij}) - CoP_0) \quad (5)$$

Risk factors:

- The larger the input usage ratio during production the smaller changes in input prices may cause significant changes in production cost
- Volatility of input prices

Input usage in a final product is signed by z. This data could be got from the calculation of the cost of production related to the basis period and the prices of the inputs and its changes could be extracted from the informatics systems containing figures from the past.

Every input factor's price is following a kind of **trend** that contains a lot of information. An average price value could be calculated for each period which of course have an own volatility too. If we fit a trend line to this average values a price changing tendency will be shown. The volatility shows how exact the trend line is (for instance: is there seasonality or not). Consider all have been mentioned before we could apply **interval estimation** to predict the **new production cost at a certain level of probability**.

Naturally not all of input factors' price should be predict this way only those that have significant influence on the final production price. (When relatively few independent variables are determining the dependent variable it is worth to do this estimation to every variable.)

Finally it is very important to take note of **seasonality**. If it appears to be it is needed to handle.

The steps of estimating production cost:

1st determination of inputs which influence the production cost and data collection
2nd check on multicollinearity
3rd determining of the values of γ_i
4th determining of the risk level of the input factors and select the most risky ones that should and could be managed.
5th calculating and representation of the periodic average input prices, fitting trends – volatility, seasonality
6th interval estimation
(7th changing the price of the final product to keep the contribution ratio)

3. Results

The model is tested on **beef cattle sector**. The examined period contains figures from 1 January 2004 to 31 August 2009. **The input factors and the bounds for the model are the followings**:

Identified input factors are (1) maize, (2) hay, (3) wage, and (4) other expenses.

The examination is based on the databases of **AKI[3] Pair** and a farm located in Hortobágy (Kovács Szabolcs "Zöldvonal" agricultural entrepreneur). The entrepreneur is breeding beef cattle. The territory of the farm is 160 hectare that is averagely 4-5 golden crown[4] per hectare is divided into two parts. Half of this is used as grazing ground the rest as meadow. The meadow is allowed to scythe once a year (early July) by Hortobágyi National Park. The cattle used to be kept in the grazing ground from May to end of August (the 80 ha is divided into 4 parts – each part contain 20 ha) then from September until November they are kept in meadow.

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[4] All land in Hungary has a golden crown value per hectare (originally per cadastral yoke) which is periodically related to the real unit of currency (HUF).

During winter period the cattle is kept in cowshed. Thus the summer grazing period last 215 days long, the winter one lasts 150 days long.

The cattle consume maize continuously. It's demand 0.2 tons/animal/year. As the consumption is continuous the purchase of maize is similar to it. Demand for hay is appearing only in the winter period: 12 bales/animal/year. The price of one bale is depending on the weather. In those years when it was no drought the price of a bale is about 3,000 HUF/bale. When it was drought the price is much higher namely 5,000 HUF/bale. The examination was supposed that the bales are purchased at the beginning of the winter period, the farmer breeding 80 cattle, and 2 member staff is needed to take care of the animals. The average monthly earnings in the sector of agriculture are low so the cost of one employee was calculated according to minimum wage. Because of the non-detailed data of other expenses (vet cost, public utilities cost, etc.) we used the data provided by an AKI study (Beládi–Kertész 2007) where other expenses are determined as animal/year.

After collecting the required information could the second step come namely the scope of **multicollinearity** problems. Here we examined that how the chosen variables (independent variables) – the input prices – influence on each other, and the dependent variable (the price of production or here: producer price). As a result of the data examination no multicollinearity was found the inputs influenced only the (final) producer price. (It was also checked by SPSS program.) Thus the producer price could be calculated according to the formula (6).

$$CoP_l = \sum_{i=1}^{n} \gamma_i * CoP_0 \qquad (6)$$

Determining the γ_i values is the third step namely how the final producer price was changed averagely when there had been one percent change in the price of the inputs.

Table 1. The γ_i values of the inputs

Input	γ_i
price of maize	0,0675%
price of hay[5]	0,6622%
wage cost	0,1771%
other expenses	0,3123%

Source: own creation

The most significant influence has the hay and the least significant influence has the maize price changing on the final producer price. From this

[5] only in winter period

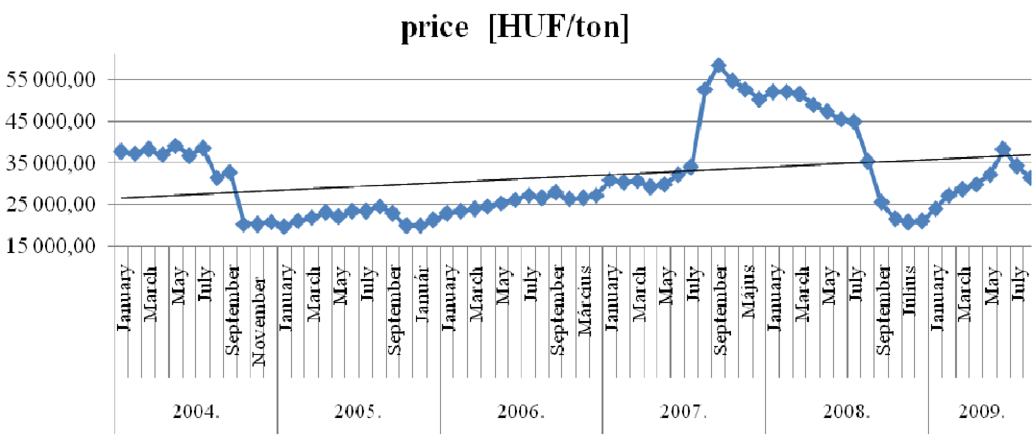
viewpoint the most risky input is the hay and especially the price of it should be followed during pricing then could come the other inputs as well.

The price of the hay depends on the weather mostly. The price of the bales is determined according to the yearly precipitation. As the hay purchasing used to be one time per year (before the winter period) then the cost of it is also appearing then. It comes from the previous that the producer knows how the producer cost will be change thus the producer is able to change the sale price to avoid the margin decreasing.

In this case the other expenses data are aggregated figures. The further breakdown of the numbers is indispensable in real situations. The wage cost is relatively inelastic because it changes only a few times per year thus the producers are able to manage the risk coming from the increasing of the wages easily in time. During the calculations the minimum wage was used which is changing only one time every year – determined by the government – so the producers have enough time build the grown cost into the cost structure.

Although the price changing of the maize had the least significant effect on the final producer price it is good to demonstrate the essence of the model. The **price of the maize had a big volatility in the examined period** (from January 2004 to August 2009) as it could be seen in the diagram below (Figure 1).

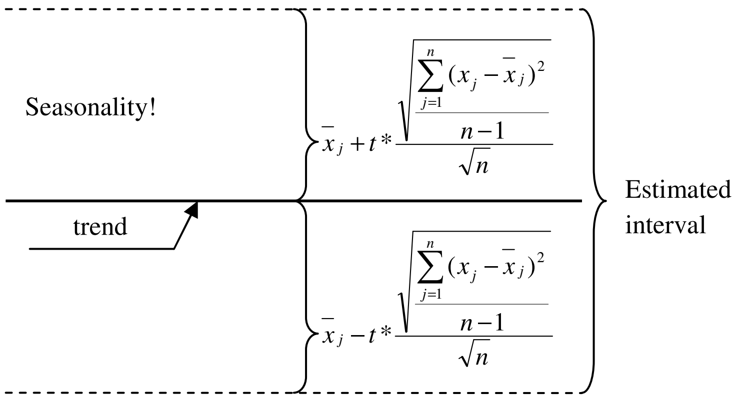
Figure 1. Variation in maize price (2004-2009)



Source: AKI

The diagram shows that the (linear) trend is slowly increasing but there were periods when there were bigger changes in the price. It seems at first sight that the maize price is changing only long term but the cause of it is that the price of the maize is higher when it was draught and lower when was not. It follows from this that these **different draught periods must be handled separately**. If we do not do this the estimated interval will be too wide and the analysis will be worthless.

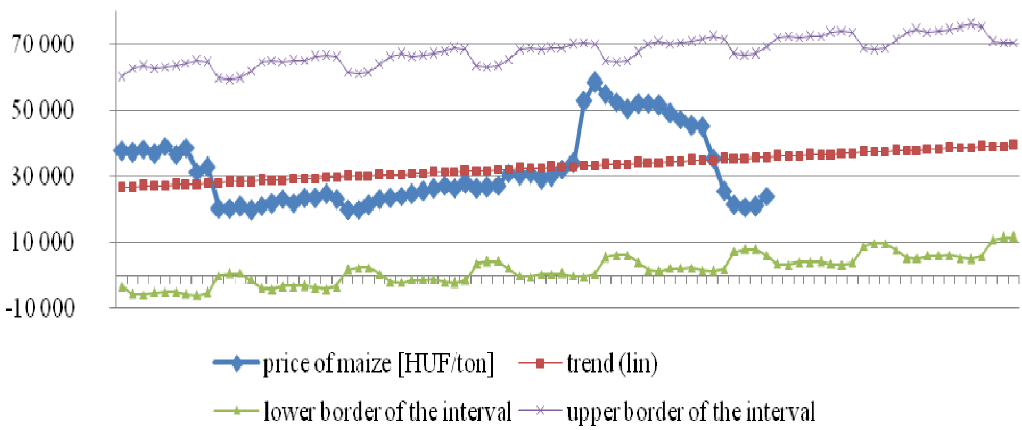
Figure 2. Calculation of estimated interval



Source: own creation

The width of the estimated interval is averagely 66,068 HUF if there is no separation between the periods (see Figure 2). This means an average 33,034 HUF difference from the trend both positive and negative direction. Considering that the price of one tone of maize is averagely 24,108 HUF in non-drought period it means that in extreme situation the price of the maize could increase by more than 100%.

Figure 3. Estimated interval without separation of the periods

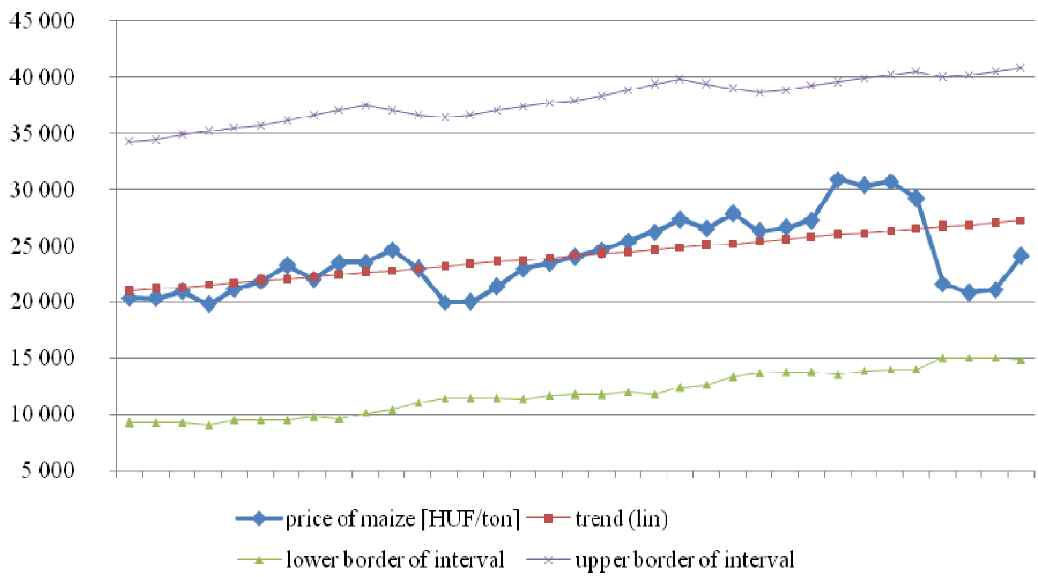


Source: AKI and own calculations

It could be seen from the interval borders that **the price of the maize is changing significantly one month to another – it refers to seasonality**.

When separated the non-drought and drought periods the values of the transition period were not considered because the data from these periods may cause distortions (wider intervals). Besides, the non-drought periods were examined together (Figure 4).

Figure 4. Estimated interval for non-drought period



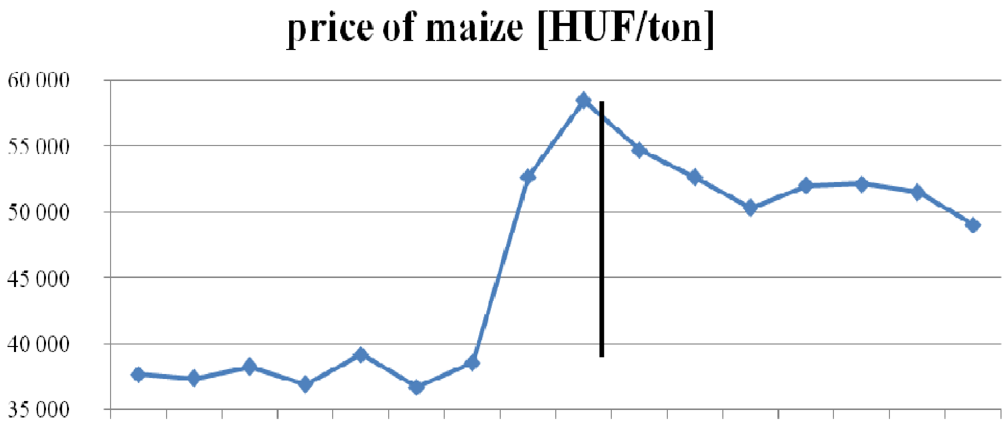
Source: AKI and own calculations

The average width of the interval now is only 26,147 HUF[6]. The interval is approximately 3 times narrower than it was before separation of the periods.

Unfortunately the data from the drought period were not enough to make such an analysis. The protocol is almost the same. The little different is that the gravity of the drought is not similar in every year so this must be examined separately as well. Figure 5 shows it us well.

[6] t value was 0.5. When it was 1.96 the width of the interval was 102,496 HUF.

Figure 5. Differences between drought periods



Source: AKI and own calculations

On the left side of the diagram (Figure 5) we could find **mild-drought period** while **hard-drought period** is on the other side. The same estimated interval was used for both two periods.

The following table contains the upper and lower interval borders fitted to the trend of non-drought period.

Table 2. Interval borders of non-drought period

Interval border of non-drought period		
	lower	**upper**
January	12,192	38,270
February	11,691	37,743
March	11,742	37,962
April	11,742	38,342
May	10,871	37,813
June	10,709	38,248
August	11,535	38,250
September	12,207	37,819
October	12,342	37,343
November	12,392	37,573
December	12,396	37,950

Source: own creation

The average price of the mild-drought period is 37,851 HUF while the hard-drought period has an average price of 52,628 HUF. The estimated interval (26,147

HUF) was fitted to them.[7] If the price of the maize in the basis period had been calculated according to non-draught period then the price of it could increase by 54% if there was hard-drought in the present period. If the basis was mild-drought-year then this number is 35%. If both two years have hard-drought then maximum 25% increasing is expected. It is true of course in the case of decreasing of the prices as well.

One percent change in maize price resulted 0.0675% change in producer cost. The following table (Table 3) contains the maximum effects of the maize price changing on producer cost.

Table 3. Maximum effect of the maize price changing on producer cost

If the former period was	
non-drought	3.6450%
mild-drought	2.3625%
hard-drought	1.6875%

Source: own creation

According to the table (Table 3) the most significant effect could be done if the former period was non-drought but it must be considered that all three periods have the same (non-drought) interval width. It means that **in worst case the price changing of the maize will result maximum 3.645% increase in the producer cost**.

4. Conclusions

The price of hay shows the largest γ_i value and the price of maize shows the lowest one. It means that the hay has the most significant effect on the producer price but it is always generated by the weather.

The average width of the interval is 66,068 HUF which means that the price could deviate from the trend with the half value of it in both sides. Considering that the average price of the maize in non-drought period was 24,108 HUF per ton this means that in extreme situation the price of the maize could be multiplied.

We made calculations: one to the drought and one to non-drought period. The width of this new interval is now only 26,147. In mild-drought period the average price was 37,851 in hard-drought it was 52,628.

One percent price change of the maize was made average 0.0675% effect on the producer price. This whole means that in worst case the producer price will be increased by 3.645%.

[7] At mild-drought period the interval fitting contains a period from January to July.

Finally, the study demonstrated that the price of the output had influenced considerably by changes in hay price while it could not been said about the price of maize.

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