ON THE ESTIMATION OF THE SUPPLY FUNCTION OF THE HUNGARIAN PORK MARKET

A KÍNÁLATI FÜGGVÉNY BECSLÉSE A SERTÉSHÚS MAGYARORSZÁGI PIACÁN

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ABSTRACT

An uncertain situation can be observed in the Hungarian pork market in the last four years. The main reasons for that are the increasing quantities of pork import, the decrease of pig meat consumption, and the decreasing competitiveness of the Hungarian farms. Instead of well-defined control of the market ad hoc measurements have been taking place. The farmers found themselves in an uncertain position and they were unable to make appropriate decisions. The market price changed significantly several times within this period making the mathematical analysis of the supply function possible. In this paper the pork supply is estimated under various scenarios. The supply function is approximated by several regression equations. All of these give the same result in extreme market situations.

KEY WORDS: Hungarian Pig Production; Regression Equations; Supply Function

ÖSSZEFOGLALÁS

A magyar sertéshús piaca nagyon bizonytalan volt az utolsó négy évben. Ennek fő okai a növekvő import, a csökkenő belföldi fogyasztás és a magyar gazdaságok csökkenő versenyképessége. A piacon nincs egységes irányítás, hanem ad hoc beavatkozások történtek. Emiatt a felvásárlási ár többször jelentősen megváltozott, ami lehetőséget ad a kínálati függvény matematikai közelítésére. Mivel a rendelkezésre álló, egységes elvek szerint gyűjtött adatsorok a nemzetközi irodalom szerint is túl rövidek ahhoz, hogy valamely közgazdasági elméletre alapozva becsüljük a kínálati függvényt, ezért közvetlen regressziót alkalmaztunk. Több regressziós egyenletet is kidolgoztunk, amelyek azonban a piac szélsőséges helyzeteiben lényegében azonos eredményt adnak.

KULCSSZAVAK: magyar sertéshús termelés, regresszió, kínálati függvény

1. INTRODUCTION

In Hungary pork has one of the largest shares in the meat market. The consumption of beef is reduced because of BSE, although the disease has been observed in only one case. The share of poultry is still increasing and its consumption has exceeded the consumption of pork. The fish consumption is 2 kg per capita constantly. The market share of any other type of meat is far under 1%. In the Hungarian cuisine pork has traditionally an important role. Thus the pork market in Hungary can be investigated separately from the other part of the meat market.

Hungary is also a traditional pork producing country. In the 1980's 10,000,000 pigs were slaughtered in a year. In the recent years the pig population has been reported between 4,300,000 and 5,500,000. The organization of the producers used to determine a single value as the production cost. This is compared to the particular market price. Before Hungary joined to the European Union, i.e. before May 1, 2004, if this comparison showed that the producers suffered some losses, then some intervention was made. In year 2003, for example, the total number of interventions was 7.

In the recent years there have been many significant changes in the market price. It is also worth to note that the pig population and the pork production has not been reduced as radically as expected according to the reported losses experienced by producers.

Since the mid 1990's the Hungarian meat market has undergone some structural changes. The demand has been shifted towards white meat, i.e. chicken and turkey. At the same time as a side effect of the BSE crisis the beef market collapsed and beef has become a marginalized product. An important consequence of these trends is that it is not possible to determine reliable price elasticities on the meat market.

Very recently EU experts have been suggesting that the Hungarian pork production will not be successful within the frame of CAP. This statement can be either the wishful thinking of EU-15 or the reality.

The aim of this research is to explore the power of the Hungarian pork sector. The basis to this is that the available statistical observations about the quantity of the production belong to a wide range of market prices. This makes possible the estimation of the supply function in a wide range of market prices instead of determining a single cost value. It is a triviality of economics that different producers have different costs. As the Hungarian manpower is still relatively cheap compared to the EU-15 countries it is possible to execute some elements of the technology locally, e.g. instead of buying feed or services the pig farm itself can produce them for its own use.

2. OVERVIEW OF LITERATURE

Any theory of economics determining a supply function is based on some hypotheses like (i) the existence and presence of price elasticities, (ii) the behaviour of the producers is known, e.g. it can be described by adaptive price expectations by Nerlove [8].

Erjavec et al. [4] examined the agricultural production and price trends in Slovenia over the period between 1961 and 1995. Own and cross-price elasticities for six main agricultural products were established. The assessed products were ranked into three groups. High supply elasticities were pointed out approaching the value 1.0 for beef and maize. These farm products are not regulated by State, but depended on market trends. Both of these products were suspected to be weakly affected by the quasi-fixed factors of production. The second group was with low supply elasticities below 0.50 and lower (pig and potatoes). In the researched period pork production was under quasi market conditions, however the government highly intervened in the market. The third group of farm products was represented by wheat and milk. Elasticity coefficients were close to zero, with high degrees of State regulation in wheat and milk market organisations. Mishev et al. [7] examined the price elasticities of supply for the major Bulgarian agricultural commodities (in the crop sector) and estimated the elasticities of total supply and of marketed quantities. The authors concluded that the own price elasticity of products supplied to the market is higher than those in the developed countries. That high own price elasticity of supply is explained by the strong shortage of grain on the domestic market over the transition period. Mishev et al. [7] pointed out that changes in the price of the product substitutes had no significant impact on production. They detected a strong correlation between the purchased quantity of a product and the prices of the other products analysed. Hallam [5] analysed the agricultural supply in transition economies. The author found it ironic that while the economic transitions make the knowledge of agricultural supply response to prices important, the entailed structural breaks in fundamental economic behaviour make modelling problematic. The author used standard dynamic econometric models (Kalman filter). In [5] Hallam examined the supply function in Bulgaria, Romania and Slovenia finding that the agricultural market could be explored econometrically only in the case of Slovenia. The author mentioned that while such models have been widely applied, their applicability for the agricultural sectors in transition with structural breaks, and limited time series data, is uncertain.

Blangiewicz et al. [2] suggest that 'long enough time

series' must have at least 15 annual observations or 24 quarterly, but even this very restricted length is not available because of the transition. During periods of transition there are often changes in the way data are collected and processed – for example as a result of organisational changes or political considerations – thus the assembling of series containing homogeneous data and having adequate length is problematic. Hallam [5] states that due to the far-reaching implications of transition and the relatively short and often unstable post-transition period homogeneous post-transition series will not generally provide sufficient degrees of freedom for conventional econometric supply analyses. He also observed that farm-level panel data sets required to supply analysis based on the profit function, are not available. This is the case in Hungary, too, where the available data are not representing all of the farms of the country. Furthermore the post-reform period has been characterised by structural instability as the reform process implies the transition to private ownership of land, declining food demand, and the worsening terms of trade for agriculture as a result of partial liberalisation. It seems therefore that time series data sets confined to the post-reform period are inadequate for econometric analysis.

Charemza [3] argues that the estimation of a varying parameter model via an updating procedure such as the Kalman filter is appropriate only under the assumption that the parameters are changing continuously throughout the sample period while maintaining long-run equilibrium (cointegrating) relationships between the variables. Charemza states that the transition process in the CEEC's is of a different nature and is best described by a kind of continuous structural change with (different) constant long-run relationships operating for the pre- and post-transition periods.

There is no reliable investigation of producers' behaviour in the Hungarian meat market. There are indications that adaptive price expectation is present in Hungarian markets in general. On the other hand the parameter of this expectation behaviour is not unique and at the same time indications show the presence of other types of expectations, e.g. the extrapolative one, too [1].

3. BASIC ASSUMPTIONS

This research is based on the following assumptions.

It is assumed that if a producer suffers losses for a long time, then the production has no sense from the economic point of view and must be finished. The producer estimates the future profit from the present state of the market. In Hungary the animals are slaughtered in the age of 8 months. Thus, if the temporary prices are under the costs of the producer then this farm will not be on the market after 8 months. In other words it means that the size of the current pig population is determined by the input and output prices 8 months earlier. This assumption is also important from a technical point of view as there are available data on the pig population according to the methodology of EU in every fourth month (third of a year).

After the political turnover of 1990 a great structural change was experienced in Hungarian agriculture. In this research the time periods from the 1st third of 1996 to the 3rd third of 2003 has been investigated. In this period the pig population was approximately the half of the former peak. No drastic and sudden changes were observed. Therefore it was also assumed that the transient period was basically over and the pork market is on its new trajectory. An important feature of this period is that interventions by the state and/or by the organization of the producers were taking place very often. Therefore the pork market could not be considered as a part of the market economy.

Although the pig population and the meat production are highly correlated, of course, there is no one-to-one correspondence between them. It seems that there are channels of meat use, which do not appear in statistical data. They might have a specific importance if the market price is low.

4. EQUATIONS OBTAINED BY REGRESSION

As the applicability of the standard models of supply response has been questioned by previous authors and data collection shows the same problems in Hungary, the authors of the present paper decided to carry out a pure mathematical analysis of the available data.

In Hungary the main feed of pigs is maize. Thus the following four factors and their nonlinear functions were considered as independent variables in the regression analysis, which determine the pork production. These factors are: (i) the 8 months earlier corn price, (ii) the 8 months earlier market price, (iii) the 8 months earlier piglet price, and (iv) the current chicken price.

Chicken meat is the main concurrent product of pork in Hungary. If it has low price then one part of the demand of pork can be transferred to the poultry market and the alternative channels of using meat may start to work. This assertion is supported by a correlation analysis showing that the positively lagged chicken prices do not affect pork production. As a matter of fact even the correlation between pork production and the current chicken prices is not too high.

In the descriptions of the analysis the following notations are used:

t	the index of time unit (time is measured in thirds of a year)
Πt	the pork production in time period t
mt	the price of maize in time period t
pt	the market price of pig in time period t
lt	the price of piglet in time period t
ct	the price of chicken in time period t

The length of the time series is short as there are only 24 observations in it. This fact increases the uncertainty of the analysis. Therefore several equations have been elaborated for the pork production by regression analysis. Here only the four most promising ones are reported. The two criteria of selecting them have been R^2 (the higher the better), and the number of independent variables (the less the better). In all of the regression equations below the number of independent variables is at most six. Higher R^2 can be achieved if the number of independent variables is 9 to 11 taking into account some nonlinear effects, but it would be too high compared to the length of the time series.

All prices are corrected by the inflation and are on the level of the 1st third of 1996.

The first equation to be mentioned is of course the best linear regression using only the data of the pork market:

$$(1)\ \Pi_t = 189192 - 2842.26\ m_{t-2} + 269.82\ p_{t-2} - 9.83\ l_{t-2}.$$

The R^2 value of the equation representing the quality of the approximation is 0.5247. It is not high but still acceptable. The original and the estimated functions can be seen in Figure 1.

The signs of the market parameters in Equation (1) are correct in the sense that the high price of maize and/or piglet decreases the production while the high market price indicates higher expected profit in the future. The price of maize is especially important as the share of the feed from the total cost is approximately 60% according to the Hungarian Meat and Livestock Commission [10]. The regression can be improved if the external affect of the chicken price is taken into consideration. Then the signs of the coefficients are as they expected:

$$(2)\ \Pi_t = 179561 - 4723.68\ m_{t-2} + 93.26\ p_{t-2} - 6.23\ l_{t-2} + 467.08\ c_t.$$

The quality of (2) is even better than that of (1), i.e. $R^2 = 0.5630$. The signs of the coefficients are correct as the cost factors have negative ones. If the market price is high then higher profit can be achieved in the market. If the price of the product, which can substitute pork is high then more products can be sold. Thus the correct sign of the coefficients of both the market price and the chicken price is positive.

As the trajectory of the market is more complicated than the possible trajectories of linear systems, it is obvious to suppose the presence of nonlinearity. If powers of the four factors are considered independent variables, too, then the quality of the regression can be improved.

Using only the internal data of the market the equation

$$(3)\ \Pi_t = 260098 - 9164.88(m_{t-2})^{0.5} - 1092{,}85\ m_{t-2} + 8155.79(p_{t-2})^{0.5} - 2849.28(l_{t-2})^{0.5} + 3.086\times10^{-7}\ (l_{t-2})^3$$

can be obtained. The quality of (3) is better than that of (2) as R^2=0.5884. Despite of the not too high value of the determination coefficient obtained by the regression calculation, the values calculated based on the estimated output have a good fit on the original data (Figure 3).

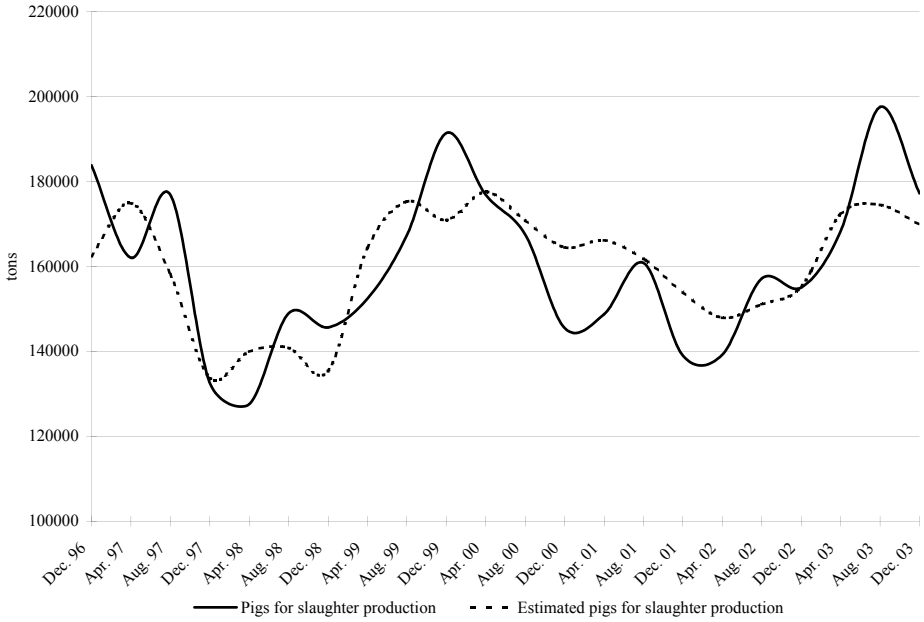
Using six independent variables $R^2 = 0.5936$ can be achieved by the equation

$$(4)\ \Pi_t = 257860 - 1110{,}59m_{t-2} - 15281{,}32(m_{t-2})^{0,5} - 2{,}485*10^{-7}(l_{t-2})^3 - 2310{,}02(l_{t-2})^{0.5} + 6021{,}6(p_{t-2})^{0,5} + 207{,}1c_{t-2}.$$

On the basis of the last two equations one may assume nonlinear correspondence between pork production and the price of maize, and piglet. The R^2 of (4) reached the highest value among the four equations. The original and the estimated functions can be seen in Figure 4. It is worth noting that this figure is very similar to Figure 3.

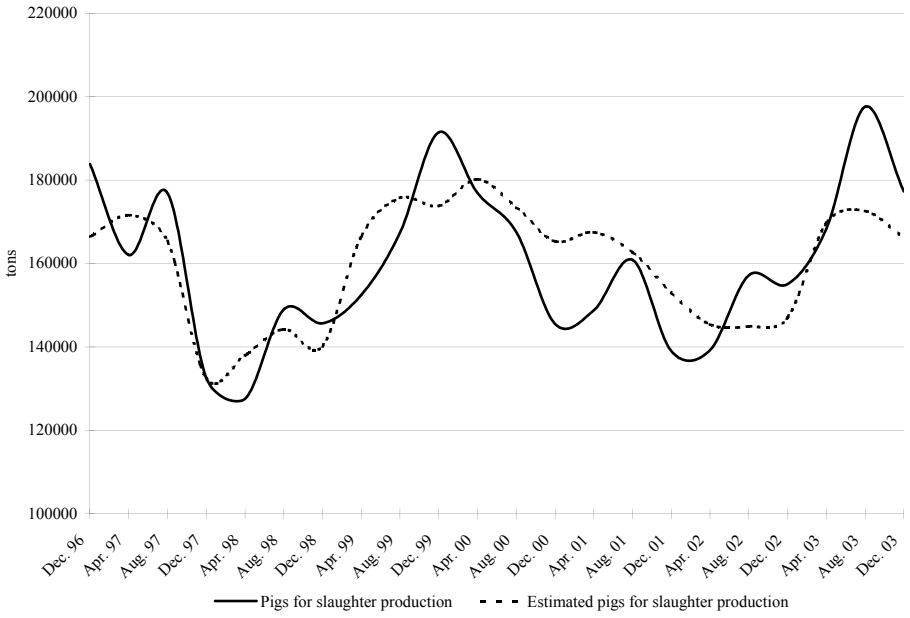
5. ESTIMATION OF THE SUPPLY FUNCTION

Prices are given in Hungarian Forint (HUF) of the year 1996. 210 HUF of 2004 equals to 100 HUF of 1996 (In 2004 1 € is approximately 252 HUF.). The supply function is considered in the range of the market price [90 HUF, 160 HUF] as the real market price was varying



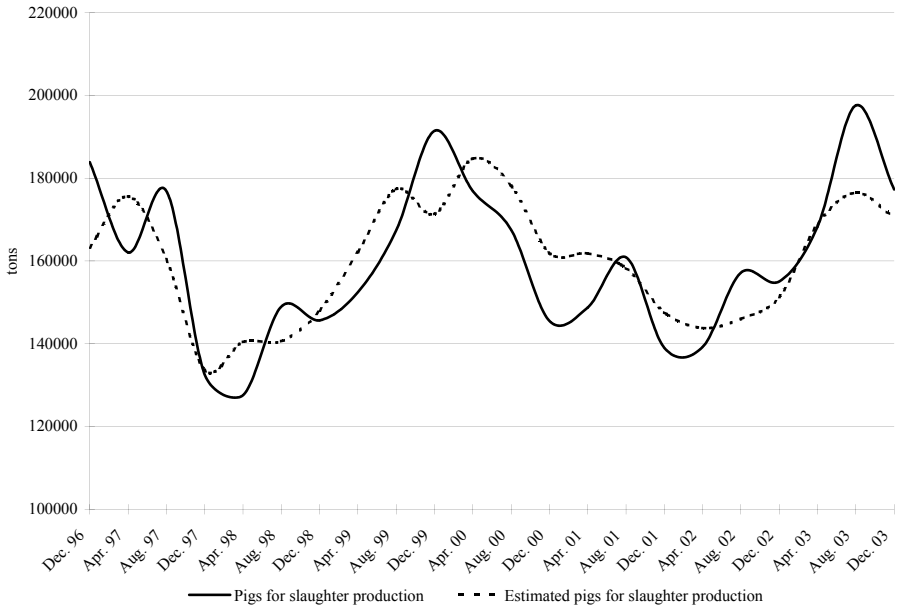
Source: Authors' own calculations based on HCSO statistics.

Figure 1 Linear Estimation of the Hungarian Pig production I.



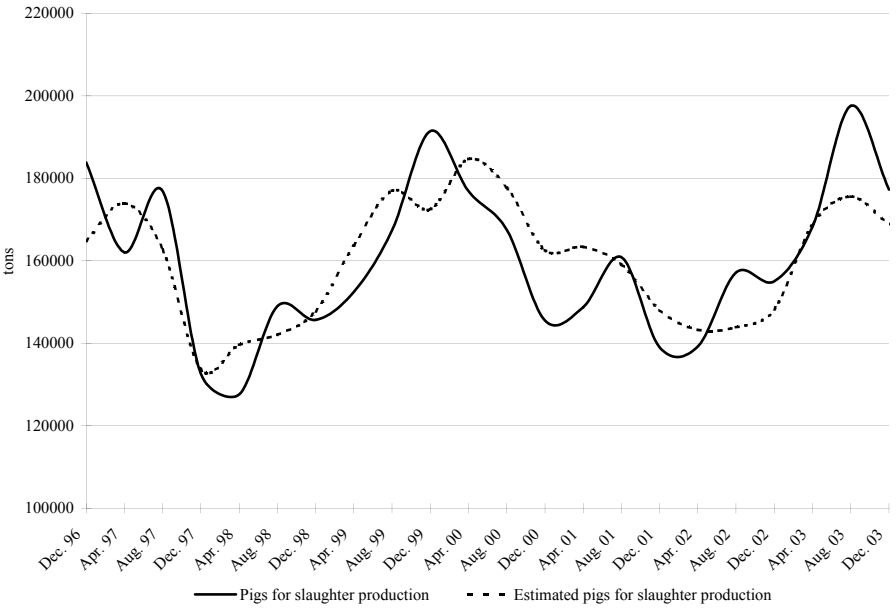
Source: Authors' own calculations based on HCSO statistics.

Figure 2 Linear Estimation of the Hungarian Pig production II.



Source: Authors' own calculations based on HCSO statistics.

Figure 3 Non-linear Estimation of the Hungarian Pig production I.



Source: Authors' own calculations based on HCSO statistics.

Figure 4 Non-linear Estimation of the Hungarian Pig production II.

in the same range. Three characteristic values of the piglet price are considered: 2400 HUF, 3400 HUF, and 4500 HUF. 104 HUF is considered to be the maximum, 76 HUF medium and 64 HUF for the lowest chicken real market price.

Each equation obtained from regression analysis automatically gives an estimation of the supply function. One obtains the estimated production from the equation if the values of the four factors are determined. The function is in the 5-dimensional space. The supply function can be plotted only if the values of some factors are fixed.

As the main part of the cost is determined by feed, it seems to be reasonable to investigate the supply function in two extreme cases. One is the situation of high maize yields resulting that the price of the maize equals to the intervention price of the EU. The other is the case of low yields implying a high maize price in the market..

The first extreme case represents the maximum potential of the Hungarian pork sector if at the same time the price of piglet is low. This situation may occur in a second consecutive year of high maize yields. In the first year there is a high demand for piglets and the price of piglets is high. The market reacts to that position by increasing the piglet production. In the second year the price of piglets goes down because the supply and demand of piglets becomes balanced.

Table 1 shows the numerical results of estimating the amount of pork produced by equations (1) to (4). The assumed prices are as follows: the real market price of pig is 125 HUF/kg, the deflated price of a piglet is 2400 HUF, the real price of 1 kg maize is 8,64 HUF.

Table 1. Maximum potential of the Hungarian pork sector according to the different regression equations.

Equation	Estimated Production, tons
(1)	174770
(2)	170953
(3)	179582
(4)	176677

The conclusion drawn from the numerical results is that the maximum potential of the Hungarian pork production is around 175,500 tons per one third of a year

Another extreme case is when the sector is in a very bad position as the costs are high and at the same time other agents of the global market are transporting cheap meat to the Hungarian market, i.e. in spite of the high costs the market price of pork is low. In this case the deflated market price is supposed to be 100 HUF. The piglet real price is 4500 HUF. As the yield was small, the real price of maize is assumed to be 11,84 HUF. Table 2 summarizes again the estimated results.

Table 2. The potential of the Hungarian pork sector according to the different regression equations in case of high costs and intensive competition.

Equation	Estimated Production
(1)	138287
(2)	140422
(3)	134164
(4)	135787

A part of the Hungarian pork sector is able to compete even under very difficult circumstances. The size of this part can be estimated as 137,200 tons per third of a year. If this part of the sector can develop then it can be a dangerous competitor on the market of other EU member states, too.

The estimated supply function, i.e. the quantity produced, can be plotted against price. Figures 5, and 6 show it for the three mentioned values of the piglet price. They represent the estimation given by Equations (2), and (4), respectively. The three different lines represent the three different piglet prices mentioned above.

6. CONCLUSIONS

An uncertain situation can be observed in the Hungarian pork market in the last four years. The main reasons for this are the increasing quantity of pork import, the decrease of pig meat consumption, and the decreasing competitiveness of the Hungarian farms. Instead of well-defined control of the market ad hoc measurements have taken place. The farmers had to face uncertain situations and were unable to make appropriate decisions. The market price changed significantly several times within this period, which has made possible the mathematical analysis of the supply function.

Several linear and non-linear regression equations have been developed for the supply function. All of them can lead to the same conclusions. In the case of good market position, i.e. when the input prices are low and pork market prices are high, the Hungarian pork sector can produce approximately 526 thousand metric tons of pigs for slaughter (in live weight). In the opposite case, when the input prices are high and pork market prices are low the production is still at a 411 thousand metric ton level. The future of the Hungarian pork sector depends on the speed of developing the producer segment in the market, which is able to make profits under disadvantageous circumstances.

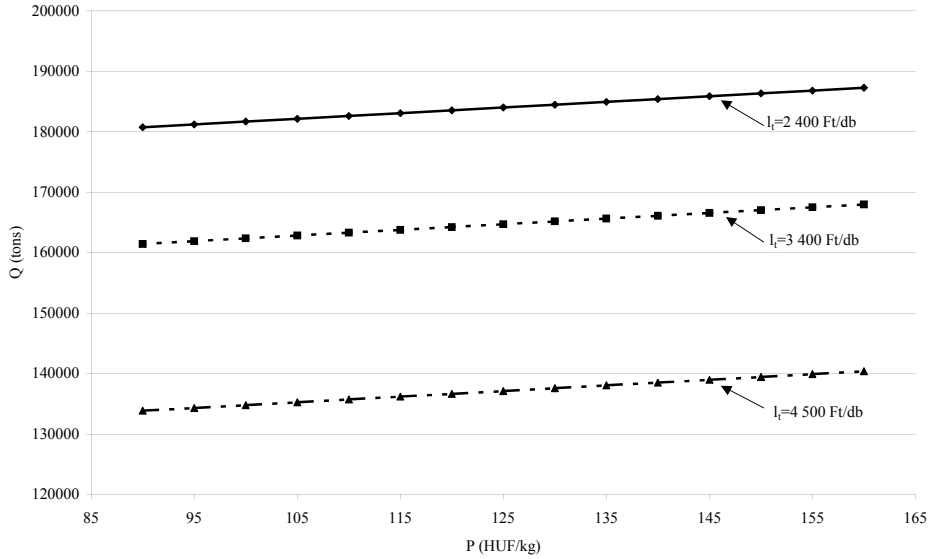


Figure 5. The supply function of the Hungarian pork market according to Equation (2) for high maize yields.

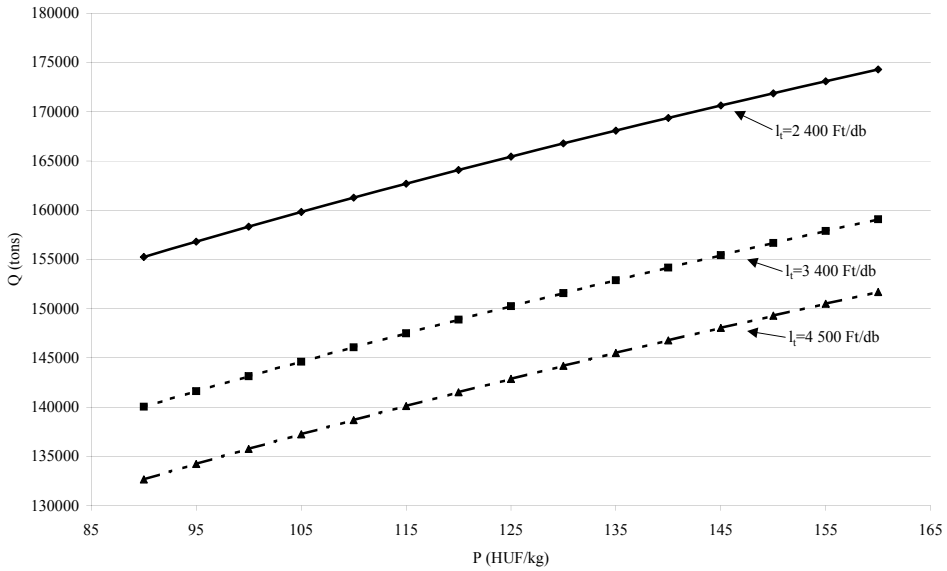


Figure 6. The supply function of the Hungarian pork market according to Equation (4) for high costs and intensive competition.

REFERENCES

1. Bacsi, Zs. et al. [2000]: Empirical Analysis of Producers' Price. Expectations. Central European Journal of Operations Research, 7 (2000). 327-336. pp.

2. Blangiewicz, M. et al. [1993]: Alternative data for the dynamic modelling of the East European transformation, Discussion Paper DP 17-93. Centre for Economic Forecasting. London Business School.

3. Charemza, W.W. [1993]: Economic transformation and long-run relationships: The case of Poland. Discussion Paper DP 16-93. Centre for Economic Forecasting. London Business School.

4. Erjavec, E. et al. [1998]: Supply Response aand Structural Breaks in Slovenian Agriculture. Options Méditerranéennes. Série B. Etudes et Recherches. No. 22. 132-144. pp.

5. Hallam, D. [1998]: Analysing Agricultural Supply Response in Economies in Transition. Options Méditerranéennes. Série B. Etudes et Recherches. No. 22. 123-131. pp.

6. J. P. LaSalle [1986]: The Stability and Control of Discrete Process. Springer-Verlag. New York.

7. Mishev P. et al. [1998]: Supply Response of Bulgarian Agriculture over the Transition Period. Options Méditerranéennes. Série B. Etudes et Recherches. No. 22. 147-154. pp.

8. Nerlove M. [1958]: Adaptive expectations and cobweb phenomena, Quarterly Journal of Economics. 72. 227-240.

9. HCSO : Monthly Bulletin of Statistics. Hungarian Central Statistical Office (HCSO). Budapest. 1996-2004.

10. Hungarian Meat and Livestock Commission [2004]: Statistics 2003 (in Hungarian).