Poultry meat supply in the case of a Slovene enterprise

Geflügelfleischangebot am Beispiel eines slowenischen Betriebes

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Zusammenfassung

Die Modelle repräsentieren eine selektive Abstraktion der Realität. Die Analyse untersucht entscheidende Faktoren, die das Geflügelfleischangebot beeinflussen. Die Angebotsanalyse stützt sich auf eine Angebotsfunktion angewendet. Für die Bestimmung der Funktion (monatliche Observierungen, 36 Monate) wurden die technologischen und ökonomischen Daten eines realen Betriebes angewendet. Der Beitrag schätzt die Angebotsfunktion und ermittelt zugehörige Elastizitäten.
Schlagworte: Angebotsanalyse, Geflügelfleisch, Zeitreihen

Summary

All models are selective abstractions and simplifications of reality. With our model we have tried to estimate some key factors that influence the quantities of poultry meat supply. For the supply analysis we have used the data on quantities of meat sold, production, prices, stocks and some key production and technological parameters in the case of one of the major Slovene enterprises in the field of poultry meat production. The data gathered extends over period of three years and includes 36 observations with monthly frequency. The supply function was estimated and corresponding elasticities were obtained.
Keywords: supply function, poultry meat, time-series data

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1. Introduction

Quantities traded and prices realized in agricultural commodity markets reflect a complex of interrelationships between economic, technical, biological and institutional factors. Quantitative models of these markets, which represent one approach to dealing with this complexity, or information derived from them is now commonplace for many of those involved in analyzing current market developments, predicting future developments, devising policy interventions, and actually buying and selling (HALLAM, 1990).

In the paper we will present the use of econometric modeling in the case of supply function for poultry meat, since the production and consumption of poultry meat is constantly increasing. FAO projections until 2005 indicate the increase of production of poultry in EU for 2% per year, which represents the most significant rise in meat production. Major Slovene farms plan to enhance the poultry production from 1,5 to 5% per year until 2005 and 1 to 10% increase in production of turkey meat (ČEPIN et al., 2001).

Poultry production has developed the most among all branches in meat production in Slovenia after the war. Production is organized by some specialized enterprises, which cooperate with individual breeders on the base of contracts. In last few years also the processing of poultry meat into various products has increased. The biggest share in the production belongs to the breeding of broiler chickens (around 60%) and sitting hens (around 27%).

The supply chain is a very complex system and many variables affect its productivity and profitability. Decisions that need to be made are best made when the available information is taken into consideration. Supply chain decisions in the poultry meat supply chain tend to be much more difficult than those in fabrication supply chain because main building blocks are biological. In addition to market forces and physical laws, performance of the system depends on tremendously variable and often unpredictable processes such as growth and health. The rise of modern computer technology has enabled us to objectively analyze complex systems. Computer models allow decision makers to focus on the most important variables and thus to make better choices (ZUIDHOF, 2002).

2. Material and methods

For the supply analysis we have used the data on the quantities of meat sold, production, prices, stocks and some key production and technological parameters. The data gathered extend over the period of three years, with monthly frequency (36 observations). The relationships among prices, major technological factors and quantities supplied are examined in the paper with the dynamic model, which captures more than one time period.

We will emphasize some typical problems related to econometric modeling with time series data. The equations represented below explain a quantitative representation of the supplier's behavior through the time due to the data available.

2.1 Theoretical consideration - Models using time series data

Time series data is a set of observations drawn on the same observational unit at a number of (usually evenly spaced) points in time.

One objective of analyzing economic data is to predict or forecast future values of economic variables. One approach to do this is to build more or less structural economic model describing the relationship between the variable of interest with other economic quantities, to estimate this model using the sample of data, and to use it as a basis for forecasting and inference. For forecasting purposes, a simple model that describes the behavior of a variable (or a set of variables) in terms of past values, without the benefit of a well developed theory, may well prove quite satisfactory (univariate time series). In addition to producing forecasts, time series also produce the distribution of future values, conditional upon the past, and can thus be used to evaluate the likelihood of certain events (SCHAFGANS, 2003).

We have applied multiple regression analysis to time-series data, beginning with static models and then proceeding to dynamic models with lagged variables used as explanatory variables. Multicolinearity and autocorrelation are likely to be a problem when dealing with time series data. Non-stationarity is also an important issue here.

The term multicolinearity is used to denote the presence of linear relationships (or near linear relationships) among explanatory variables. If the explanatory variables are perfectly linearly correlated (the correlation coefficient for these variables is equal to unity) the parameters become indeterminate: it is impossible to obtain numerical values for each parameter separately and OLS method is no longer appropriate. On the other hand, if the correlation coefficient is equal to zero, the variables are called orthogonal[1] and there is no need to perform a multiple regression analysis – each parameter bi can be estimated by a simple regression of Y on the corresponding regressor: $Y = f(X_i)$ (KOUTSOYIANNIS, 1973). In practice neither of the above extreme cases is often met. In most cases there is some degree of intercorrelation among the explanatory variables, due to the interdependence of many economic magnitudes over time.

Uncorrelatedness across observations is labeled generically nonautocorrelation (GREENE, 2003). Autocorrelation is usually found in time-series data. Economic time series often display a "memory" in that variation around the regression function is not independent from one period to the next.

An important issue is whether a time series process is stationary, which implies that the distribution of the variable of interest does not depend upon time. Most economic variables that exhibit strong trends (e.g. consumption) are not stationary and there are fundamental questions as to whether general non-stationary processes can be analyzed by statistical methods at all. However there are two kinds of non-stationary series that can be obtained by simple transformation from stationary series. The first involves summation or integration. An alternative to that is detrending the time series (by two step regression).

2.2 Data variability & problems

The enterprise organizes its meat production by hiring individual breeders with corresponding capacities. Their mutual commitments are arranged by contracts. At the beginning of the production cycle the enterprise distributes one day old broilers/turkeys to the breeders and at the end of cycle they pick them up, slaughter, process the meat and purchase to the wholesalers (buyers).

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[1] Orthogonal variables are the variables whose covariance is zero: $\sum x_i x_j = 0$.

One of the main problems that we can stress is the length of the data set – we operate with 36 observations (three years with monthly frequency). We assume that better (more relevant) results would be obtained with the use of longer data set, but unfortunately this was not attainable. The other problem which is obvious while observing the data is its variability without some explicit trends as a rule.

We have gathered the data mainly for the chicken and turkey meat production. The data about broiler chicken meat production is more detailed and includes some technological parameters, which is not the case for turkey meat. We are dealing with the complex system of two production chains. In such systems there are often multiple managers who look after their own piece of the larger puzzle. This can lead to decisions that are based on a picture that is too small. Although the decision in the smaller context may be a logical choice, it may not be the best decision overall. Considering both types of production in quantitative analysis enables the recognition of the best solutions for solving the problems in the supply chain as a whole.

We have tried to answer the following questions:

- Which are the most important factors that influence the quantity of poultry meat supplied?
- Do chicken and turkey meat represent substitutes?

We have stated the following hypothesis:

- The most important factors that influence the supply of poultry meat are specified in the general model for supply consistent with economic theory.
- Chicken meat and turkey meat are substitutes.

With the supply function specified below we have tried to determine the influence of various factors on the supply with the general-to-simple modeling approach. We have made the dynamic model by including the time component. For the estimation we have used the OLS method in the EViews software package.

3. Results

3.1. General model for supply

Supply in generally depends on several factors:

$$S_t = f(P_t, A_t, F_t, H_t, W_t)$$

Where: S_t is supply of the commodity in period t, P_t is market price of the commodity in period t, A_t is market price of alternative commodities in period t (in our case turkey meat), F_t is price of factors of production in period t, H_t is production technology in period t and W_t is weather in period t. Of course there would obviously be far more influences on supply than are included in this model specification. We can capture their effects by adding a stochastic disturbance term. So we will use this general model with some necessary modifications to estimate the supply function.

Consistent with economic logic we foresee the estimated coefficients for the price of chicken meat will have a positive sign, which implies that any increase in the price of meat sold will enlarge the production of chicken meat. In the case of turkey meat as an alternative product, we expect the negative sign of the coefficient. If the price of turkey meat increases relative to that of chicken, it is inevitable that due to competition in the market, this will reduce the quantity of chicken meat supplied.

In the general model we have included all the variables that seemed to be relevant (see table 1). Parameter estimates are fitted by least squares. We assumed that most of variables influence the quantity of meat supplied, especially prices of factors of production, prices of meat and alternative commodities and production technology. But unfortunately, when including all the variables mentioned above (and using numerous functional forms), no significant statistical results appeared – in most cases t-tests were not significant (individual variable estimates were not significant). This leads us to the following conclusions: either the data set is not relevant (monthly frequency is not as significant as annual would be in longer data set), or the production is guided due to the capacity disposable, without some former analysis of demand and supply. We have also rejected the hypothesis that turkey meat is the substitute for chicken meat.

Table 1: General model for supply – linear form

Dependent Variable: SUPPLY_CH
Method: Least Squares
Sample: 2000:01 2002:12
Included observations: 36

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	680592.3	230170.5	2.956905	0.0062
Q_SOLD_CH_KG	0.097541	0.101977	0.956503	0.3470
CONSUMPTION	0.300429	0.026996	11.12881	0.0000
CONVERSION	-345233.2	101993.9	-3.384841	0.0021
COST_KG_CH	-1127.454	1651.244	-0.682791	0.5003
PCH_SITKG	187.4778	160.5622	1.167633	0.2528
PTU_SITKG	-57.16301	50.47749	-1.132446	0.2671
STOCK_CH	-0.035963	0.050371	-0.713963	0.4812

R-squared	0.932283	Mean dependent var	523615.8
Adjusted R-squared	0.915353	S.D. dependent var	77863.43
S.E. of regression	22653.68	Akaike info criterion	23.08716
Sum squared resid	1.44E+10	Schwarz criterion	23.43906
Log likelihood	-407.5689	F-statistic	55.06900
Durbin-Watson stat	2.292000	Prob(F-statistic)	0.000000

SUPPLY_CH= 680592.2+ 0.1*Q_SOLD_CH_KG + 0.3*CONSUMPTION - 345233.2*CONVERSION - 1127.5*COST_KG_CH + 187.5*PCH_SITKG - 57.2*PTU_SITKG - 0.04*STOCK_CH

Where: SUPPLY_CH is quantity of meat supplied (kg) in period t, Q_SOLD_CH_KG is the quantity of meat sold (kg) in period t, CONSUMPTION is total food consumption (kg) for all broilers in period t, CONVERSION is food consumption (kg) per kg of broiler meat in period t, COST_KG_CH is price of factors of production sit/kg) in period t, PCH_SITKG is market price (sit/kg) of broiler meat in period t, PTU_SITKG is market price (sit/kg) of turkey meat in period t and STOCK_CH is monthly stock of broiler meat (kg) in the same period.

3. 2. Simple model for supply

After excluding non-significant variables, the following simple equation satisfied basic criteria (DW, t tests, F, R^2):

$$Supply_{ch} = f\ (price_{ch},\ quantity\ sold_{\ ch},\ stock_{\ ch\ t-1},\ supply_{\ ch\ t-1})$$

Table 2: Simple model for supply – linear form

Dependent Variable: SUPPLY_CH
Method: Least Squares
Sample(adjusted): 2000:02 2002:12
Included observations: 35 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-558702.5	149473.6	-3.737801	0.0008
PCH_SITKG	909.6340	215.7151	4.216831	0.0002
Q_SOLD_CH_KG	0.919725	0.124800	7.369580	0.0000
STOCK_CH(-1)	-0.115455	0.064136	-1.800170	0.0819
SUPPLY_CH(-1)	0.417741	0.087209	4.790127	0.0000

R-squared	0.791417	Mean dependent var	526195.2
Adjusted R-squared	0.763606	S.D. dependent var	77423.84
S.E. of regression	37643.79	Akaike info criterion	24.04129
Sum squared resid	4.25E+10	Schwarz criterion	24.26348
Log likelihood	-415.7225	F-statistic	28.45686
Durbin-Watson stat	2.038935	Prob(F-statistic)	0.000000

SUPPLY_CH=-558702.5+909.6*PCH_SITKG+ 0.9*Q_SOLD_CH_KG - 0.1*STOCK_CH(-1) + 0.4*SUPPLY_CH(-1)

Where: SUPPLY_CH is quantity of meat supplied (kg) in period t, PCH_SITKG is market price (sit/kg) of broiler meat in period t, Q_SOLD_CH_KG is the quantity of meat sold (kg) in period t, STOCK_CH(-1) is monthly stock of broiler meat (kg) in period t-1 and SUPPLY_CH is quantity of meat supplied (kg) in period t-1.

The reason why we avoided lagging the variables for more than one period is the small size of the sample and by lagging the variables we are additionally loosing observations.

Elasticities are calculated as follows:

$$\text{If } y = a + bx + u_t, \text{ then } \varepsilon = b \cdot x_{avg} / y_{avg}$$

Table 3: Elasticities of supply function for chicken meat

Parameter	*ε*
Price of chicken meat	0.99
Quantity of meat sold	0.74
Stock of chicken meat(t-1)	-0.08
Production of chicken meat (t-1)	0.41

While testing different functional forms of equations and different variables, we did not manage to prove the connection between chicken and turkey meat supply (no significant results appeared). Perhaps we can conclude the chicken meat production is the primary choice of the enterprise, and turkey production is just a sort of additional activity, which runs independently of chicken production.

4. Discussion and conclusions

While observing the equations, we may conclude that we did not manage to prove economic theory model. We did not confirm that supply is dependent of production technology or the price of inputs, we have also rejected hypothesis about turkey meat as a substitute for chicken meat. We reject both initial hypotheses (see the chapter 2.1.1.). We believe we would not reject both hypotheses if we have had panel data set for all major Slovene producers during longer time period with yearly frequency. With latter data we could model a statistically significant supply function. But a lot of researchers avoid modeling supply functions and rather choose demand functions because usually more quality data is available on the demand side comparing to the supply.

Due to the elasticities calculated for chicken broiler meat we can say that supply is not explicitly elastic or inelastic (price elasticity almost 1). So 1% change in the price of meat will consequently rise supply for 0.99 %. One unit of meat sold rises production for another 0,74 unit. Also stock and the production in the previous time period have influenced the supply.

Taking into account the dynamic occurrences prevailing in a real world, it becomes obvious that any supply analysis has to consider those variables which reflect the dynamic comprehension of genuine conditions and which also reveal the decision-making process in production (Turk, 1995).

We are aware the results are not as reliable as they should be, but in practice you have always to deal with queer data and to try to make the best out of it. We assume the data was not representative (the data set is not long enough) and there would be less variability if we dealt with the data with annual frequency through the longer period of time.

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