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Examination of Cattle and Ovine Numbers in Turkey with Some Regression Models

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ABSTRACT *In this study, the analysis of cattle and ovine numbers in Turkey was made by using some regression models. Among all models belong to animal numbers; cubical regression model that has the highest R2 and Adj-R2 values was selected as the optimal model. Estimation of animal numbers was made for 2016-2020 period, based on cubical regression model. The number of animals is estimated to increase in upcoming years*

KEYWORDS : Regression analysis, coefficient of determination, number of animal

Introduction

Due to its strategic importance, stock farming is a sector that is supported in each country by a stock farming policy suitable for that country's own economic structure. The main objective of stock farming policy is the creation of an organized, highly competitive, sustainable stock farming sector. Stock farming is in an economically and socially strategic location both in Turkey and the European Union (EU) countries for such reasons as meeting the food needs of the countries, contribution to employment and having a significant share in foreign trade (Taş, 2010).

In Turkey, while 47.3% of animal protein per person is derived from milk, this value is 25.9%, 31.4% and 33.8% for the World, the USA and the EU respectively. Whereas in Turkey, while the contribution of meat to protein produced from animal food is 38.4%, this value is 44.8%, 55.2% and 46.0% for the World, the USA and the EU respectively (Akman et al., 2015).

Cattle, which can be farmed almost anywhere in the world except the Arctic, has products rather than meat and milk products and contributions to people in different ways depending on the properties of the farming area (Akman et al., 2008).

Today water buffalo is farmed widely in nearly 40 countries all over the world. (Nanda and Nakao, 2003). In Turkey, the aim of water buffalo farming is the production of milk (curl cream, yogurt, cheese, ice cream) and meat (sausages, salami, bacon) (Aral, 2000).

In Turkey, sheep farming is a sector of which meat, milk, wool, leather and fertilizer is benefited from and plays an important role in the national economy by generating income (Soysal and Soysal, 2004).

In addition, it has increased the importance of sheep that caring and feeding of them is easy, less labour and capital is needed. (Batu, 1962; Yalçın, 1988; Akçapınar, 2000).

Goat farming is a traditional animal production branch that is made often in least developed and developing countries. This activity constitutes an important source of livelihood and nutrition source of families with low in come in rural and forest areas (Kaymakçı and Aşkın, 1997). In Turkey, goat milk and meat is preferred as more local. The importance of goat milk has increased recently for Maraş ice cream to gain industrial size. (Boztepe et al., 2014).

According to 2013 statistics of FAO (The United Nations Food and Agriculture Organization), Turkey is located in the ranking of world countries as 21stin the number of cattle, 20th in the number of water buffalo, 9thin the number of sheep and 22nd in the number of goat. According to the records of TSI – Turkish Statistics Institute (2015), the number of cattle in Turkey is 13994071, of water buffalo is 133766, of sheep is 31507934 and of goats is 10416166.

The purpose of this study is the creation of the most appropriate regression model for Turkey's cattle and ovine numbers by using some regression models. It will be possible to make estimations of upcoming years based on the regression models created.

Material and Method

In this study, cow, buffalo, sheep and goat numbers were obtained through records of Turkey Statistics institution (TSI), (Food and Agriculture Organization of the United Nations, FAO).

In regression analysis, the relationship between dependent and independent variable may not always be linear but sometimes curved (Ohunbilge, 1996). Non-linear functions may be second (parabola), third (cubic) and of a higher degree. There are such other non-linear models as Exponential, Power, logarithmic and inverse.

Quadratic regression model

$$y = a + bx + cx^2 + \varepsilon$$

Cubic regression model

$$y = a + bx + cx^2 + dx^3 + \varepsilon$$

şeklindedir (Orhunbilge, 1996).

Exponential regression model

$$y = e^{\alpha+\beta x}\varepsilon$$

şeklindedir (Öztürkcan, 2009).

Logarithmic regression model,

$$y = a + bln(x) + \varepsilon$$

Inverse regression model,

$$y = a + b\left(\frac{1}{x}\right) + \varepsilon$$

Power regression model,

$$y = ax^b$$

it shaped (Kadilar, 2009).

Coefficient of determination (R^2)

$$R^2 = \frac{\sum_{i=1}^{n}(\hat{Y}_i - \bar{Y})^2}{\sum_{i=1}^{n}(Y_i - \bar{Y})^2}$$

Adjusted ,R^2

$$Adj.R^2 = R^2 - \frac{k-1}{n-k}(1 - R^2)$$

it shaped (Hamilton, 1992).

Results

The graph showing the trend in the number of cattle in Turkey between 1970 and 2015 is presented in Figure 1. As seen in Figure 1, the maximum number of cattle in this period is in 1981. Then the number of cattle has been in some decline until 1984, started to rise again from 1985 until 1989. A wavy trend is seen since 1990 and this situation continued until 2015.

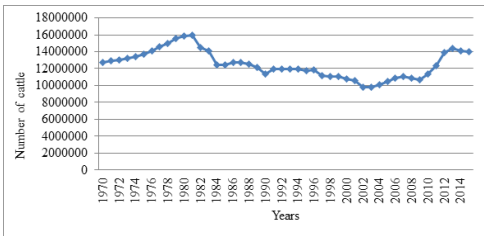

Figure 1. The number of cattle in Turkey between 1970 and 2015

Parameter estimations of the models quadratic, cubic, exponential, Power, logarithmic and inverse examined for the number of cattle is presented in Table 1. As seen in Table 1, the parameters estimation of all reviewed models were statistically significant (P<0.01).

Table 1. Parameter estimations of regression models (The number of cattle)

Model	Parametreler			
	Sabit	b	c	d
Quadratic	15303707.87	-236093.777**	3767.577**	
Cubic	12027538.22	557994.458**	-38020.301**	592.736**
Exponential	13873594.46	-0.005**		
Power	15069641.65	-0.068**		
Logarithmic	14885317.48	-825227.694**		
Inverse	12311736.38	1962689.036**		

*: (P<0.05), **: (P<0.01)

Goodness of fit criteria results (R^2, Adj- R^2 and Mean Square Error (MSE)) are shown in Table 2. The comparison of the models was made based on the goodness of fit criteria. Cubic regression model was considered the most appropriate model because it has the highest values of $R^2$and Adj-R^2. of cubic model, R^2=0.830, Adj- R^2=0.818 and MSE=482193493951.726.

Table 2. Test Results of Goodness of fit for the models (The number of cattle)

Model	R^2	Adj- R^2	MSE
Quadratic	0.373	0.344	1734326460692,180
Cubic	0.830	0.818	482193493951.726
Exponential	0.247	0.230	0.013
Power	0.213	0.196	0.013
Logarithmic	0.201	0.183	2161361049333.760
Inverse	0.039	0.017	2599970831294.310

Based on the obtained parameters cubic regression model is as follows.

The graph showing the trend in the number of water buffalos in Turkey between 1970 and 2015 is presented in Figure 2. According to Figure 2, the maximum number of water buffalos in this period is in 1970. The number of water buffalos has been in decline between 1970 and 1974. A wavy trend is seen in the number of water buffalos between 1975 and 1979. There has been a steady decline in the number of water buffalos between 1980 and 2004. There is a slight rise in the number of water buffalos in 2005, a decline between 2005 and 2010, and an increase between 2011 and 2015.

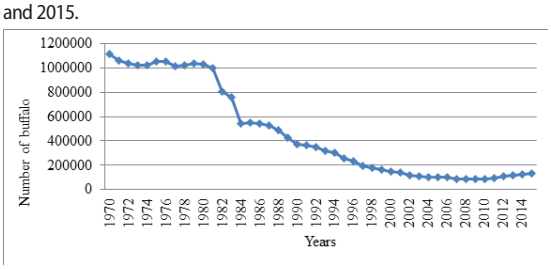

Figure 2. The number of water buffalos in Turkey between 1970 and 2015

Parameter estimations of the models quadratic, cubic, exponential, Power, logarithmic and inverse examined for the number of water buffalos is presented in Table 3. The parameters estimation of models were statistically significant (P<0.01).However parameter b in cubic regression model is removed from the model since it is insignificant. Cubic regression model was tested again for the remaining parameters and parameter estimations were considered to be significant (P<0.01) (Table 3).

Table 3. Parameters estimations of regression models (the number of water buffalos)

Model	Parametreler			
	Sabit	b	c	d
Quadratic	1335065.846	-56041.626**	619.782**	
Cubic	1164878.141	-14790.999	-1550.979**	30.791**
Cubic ¥	1093154.269		-2256.659**	40.169**
Exponential	1566060.677	-0.068**		
Power	4522208.599	-0.921**		
Logarithmic	1613071.748	-395627.850**		
Inverse	335017.403	1401674.653**		

*: (P<0.05), **: (P<0.01)

R^2, Adj- R^2andMean Square Error (MSE) are shown in Table 4. Cubic regression model was considered the most appropriate model because it has the highest values of R^2 and Adj- R^2. Of cubic model, R^2=0.968, Adj- R^2=0.966 and MSE=4980205528.

Table 4. Test Results of Goodness of fit for the models (the number of water buffalos)

Model	R^2	Adj- R^2	RMSE	MSE
Quadratic	0.948	0.946		8017067180
Cubic	0.970	0.968		4717629048
Cubic ¥	0.968	0.966		4980205528
Exponential	0.936	0.935		0.059
Power	0.740	0.734		0.238
Logarithmic	0.826	0.822		26307594441,237
Inverse	0.354	0.339		97697637347,105

Cubic regression model for the number of water buffalos is as follows.

The graph showing the trend in the number of sheep in Turkey between 1970 and 2015 is presented in Figure 3. The maximum number of sheep was reached in 1982. The number of sheep has been in decline between 1988 and 1998. The number of sheep has been in increase between 2010 and 2015.

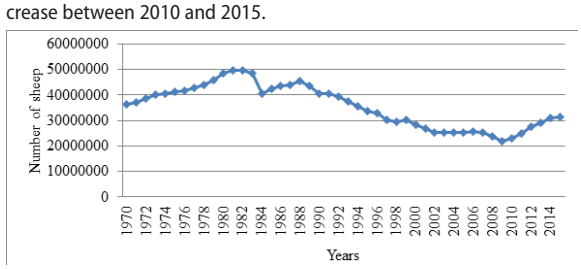

Figure 3. The number of sheep in Turkey between 1970 and 2015

Parameter estimations of the models examined for the number of sheep is presented in Table 5. The parameters estimation of models were statistically significant (P<0.01).

Table 5. Parameters estimations of regression models (the number of sheep)

Model	Parameters			
	Constant	b	c	d
Quadratic	43464368.91	-29134.953	-9911.489*	
Cubic	30344789.24	3150829.745**	-177253.067**	2373.639**

Exponential	48741723.60	-0.015**		
Power	55568774.82	-0.164**		
Logarithmic	51333394.29	-5457690.234**		
Inverse	34552946.03	10479947.35**		

*: (P<0.05), **: (P<0.01)

R^2, Adj- R^2 and Mean Square Error (MSE) are shown in Table 6. Cubic regression model was considered the most appropriate model because it has the highest values of R^2 and Adj- R^2. of cubic model, R^2=0.953, Adj- R^2=0.949 and MSE=3516616484692.120.

Table 6. Test Results of Goodness of fit for the models (the number of sheep)

Model	R^2	Adj- R^2	MSE
Quadratic	0.673	0.658	23694377906191.900
Cubic	0.953	0.949	3516616484692.120
Exponential	0.653	0.645	0.021
Power	0.357	0.343	0.039
Logarithmic	0.336	0.321	47071478657874.900
Inverse	0.042	0.020	67854866589488.100

Cubic regression model for the number of sheep is as follows.

The maximum number of goats was reached in 1980 between 1970 and 2015. The number of goats has been in decline between 1986 and 2000. The number of goats has been in increase between 2009 and 2015 (Table 4).

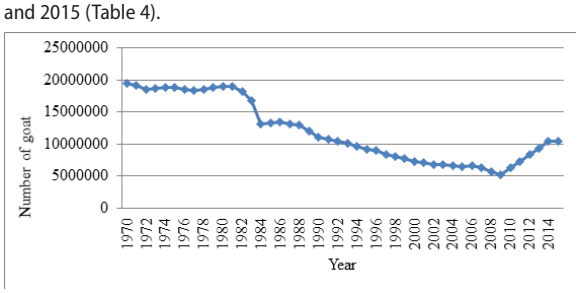

Figure 4. The number of goats in Turkey between 1970 and 2015

Parameter estimations of the models examined for the number of goats is presented in Table 7. The parameters estimation of models were statistically significant (P<0.01).

Table 7. Parameters estimations of regression models (the number of goats)

Model	Parameters			
	Constant	b	c	d
Quadratic	229512.68	-736475.235**	8624.111**	
Cubic	18803565.61	268857.691**	-44280.249**	750.416**
Exponential	21153867.04	-0.028**		
Power	34522182.84	-0.397**		
Logarithmic	25916618.79	-4840322.298**		
Inverse	10311771.06	16820226.99**		

*: (P<0.05), **: (P<0.01)

R^2, Adj- R^2andMean Square Error (MSE) are shown in Table 8. Cubic regression model was considered the most appropriate model because it has the highest values of R^2 and Adj- R^2. Of cubic model, R^2=0.973, Adj- R^2=0.971 and MSE=702284836644.351.

Table 8. Test Results of Goodness of fit for the models (the number of goats)

Model	R^2	Adj- R^2	MSE
Quadratic	0.893	0.888	2710858615265.270
Cubic	0.973	0.971	702284836644.351
Exponential	0.795	0.790	0.037
Power	0.692	0.685	0.056
Logarithmic	0.755	0.749	6081927597944.960
Inverse	0.311	0.296	702284836644.351

Cubic regression model for the number of goats is as follows.

Estimation of the number of cattle and ovine was made for between 2016 and 2020, which is generated by the cubic regression model and is given in Table 9.

Table 9. Estimation of the number of cattle and ovine between 2016 and 2020

Years	Number of cattle	Number of buffalos	Number of sheep	Number of goat
2016	15806047	240396	33320126	11535294
2017	16764342	286686	35699079	12677097
2018	17817304	338742	38407135	13946459
2019	18968490	396748	41458534	15347884
2020	20221456	460890	44867519	16885873

It is estimated that between 2016 and 2020, the number of cattle will be between 15806047 and 20221456, of water buffalos between 240396 and 460890, of sheep between 33320126 and 44867519 and of goats between 11535294 and 16885873.

Conclusion

In this study, regression models belonging to the number of cattle, water buffalos, sheep and goats were obtained. Cubic regression model was considered the most appropriate model for cattle and ovine because it has the highest values of R^2 and Adj- R^2.

A wavy trend is seen in the number of the cattle particularly between 1980 and 2004. There has been an increase in the number of cattle since 2011.The longest period that the number of water buffalos has decreased is between 1980 and 2004. The increases and decreases have been frequent other than this period. The number of sheep has decreased in 1988-1988 period and increased in 2010-2015 period. The number of goats has decreased in 1986-2000 period and increased in 2009-2015 period.

The numbers of cattle, water buffalo, sheep and goats have been estimated to increase in the next 5-year period covering the period 2016-2020. This is an important development for Turkey's stock farming and economy.

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