International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

Estimation of the Egg Albumen Weight in the Japanese Quails using Ridge Regression Method

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Abstract: ***In this work, Ridge regression method has been used firstly to determine albumen weight from some egg quality characteristic in the Japanese quails. In order to determine albumen weight, a regression equation was obtained using by egg weight (EW), shape index, (SI), albumen index (AI), yolk index(YI), yolk weight (YW), crust thickness (CT), crust weight (CW), albumen height (AH)and Haugh unit(HU). The goodness of fit of the model were determined as R^2=0.685 andAdj. R^2=0.670.It was that, given the high degree of multicolinearity of the predictor variables, Ridge regression techniques would provide less standard errors than would the Least Square (LS) technique in this research.***

Keywords: Ridge regression, Multicolinearity, egg quality, quails, albumen weight.

1. Introduction

Ridge regression analysis methods is statistical analysis technique that is used to analyze multiple regression data.When a high correlation present among the independent variables in regression model, a problem occurs called as multicollinearity. In case of multicollinearity, parameter estimations by least square method have large standard error and hypothesis tests result in contradictory. It was hypothesized that, given the high degree of multicolinearity of the predictor variables, Ridge regression technique would provide more stabilized coefficient and less standard errors than would the Least Square technique.

Least Squares and Ridge Regression algorithms, which allows the use of Kernel functions. Kernel functions represent dot products in a feature space, which allows the algorithms to be used in a feature space without having to carry out computations within that space. Kernel functions themselves can take many forms and particular attention is paid to a family of kernel functions which are constructed using ANOVA decomposition (Vapnik, 1998;Wahba,1990; Wahba, 1997). Least Squares and Ridge Regression have been widely used, and recently some papers such as Drucker et al. (1996) have used regression in conjunction with a high dimensional feature space. In a ridge regression an additional parameter, the ridge parameter (k) plays an important role to control the bias of the regression toward the mean of the response variable estimator (Stephen and Christopher, 2001). Ridge parameter 'k' proposed by Hoerl et al.(1975).

Recently, many researchers have suggested various methods for choosing ridge parameter in ridge regression. Kibria (2003), Pasha and Shah (2004), KhalaShukur (2005), Norliza et al. (2006), Alkhamisi and Shukur(2007), Mardikyan and Cetin (2008), Dorugade and Kashid (2010) and Al-Hassan (2010) were mentioned a few.

A Japanese quail, the smallest farmed avian species (Panda and Singh, 1990), is becoming popular in commercial poultry sector for meat and egg production.Egg quality is the more important price contributing factor in table and hatching eggs. Hence, the economic success of a laying flock solely depends on the total number of quality eggs produced (Monira et al., 2003).Japanese quail is current the smallest poultry species kept for eggs and meat on some farms(Minvielle, 1998).Significant differences were observed among the feather colors in terms of egg weight, specific gravity, and albumen index by nonparametric Kruskal-Wallis test (Inci et al., 2015a). Egg quality characteristics (Inci et al., 2015b), the fertility of the quail eggs should be considered in respect to different feather colors.

The albumen weight increased with the quails' age (Nazligul et al., 2001). Nagarajan et al. (1991)and Orhanet al. (2001)observed that the albumen index increased with the quails' age. The Haugh unit score is the accepted unit for measuring the albumen quality of eggs. Of all the egg quality traits, only the Haugh unit score is considered the best objective mathematical expression to measure egg quality (Kondaiah et al., 1983). The yolk weight in Japanese quail increased with their age (Nazligul et al., 2001).The yolk index increased with the quails' age (Nagarajan et al., 1991; Gonzalez, 1995). In contrast, Orhan et al. (2001) found that the yolk index decreased with the age. The target of this study is to investigate the effects of certain egg quality characteristics that affect the weight of quail eggs.

2. Material and Method

The resulting data from measurements of 200 Japanese quail eggs were used in the study. Variable structures used at this work were presented in Table 1.

Table 1: Variable structures used at this study were:

EW	Egg weight
AW	Albumen weight
YW	Yolk weight
AI	Albumen index
AH	Albumen height
YI	Yolk index
CW	Crust weight
CT	Crustthickness
HU	Haugh unit
SI	Shape index

In the work, in Model was used, EW, YW, AI, AH, YI, SHW, SHT, SHT, HU, and SI were involved as independent variables in the AW estimation.

The albumen index (AI) and yolk index (YI) were calculated the same as for laying hen eggs in accordance with en eggs in accordance with Heimanand Carver(1936) and Funk(1948), respectively. Shape index was calculated as egg width/egg length × 100 (Marks and Kiney, 1964; Erbaş and Olmuş, 2006). Haugh unit was calculated by measuring the yolk height with a three-legged micrometer, using the method proposed by Stadelman (1986).

Consider the model for multiple linear regression

$$Y = X\beta + \varepsilon \quad (1)$$

is shaped. here Y is an (n x 1) column vector of observations on the dependent variable, X is an (nxp) fixed matrix of observations on the variables and is of full rank p ($p \leq n$), β is a (px1) unknown column vector of regression coefficients, and ε is an n x1 vector of random errors; E(ε)= 0;E($\varepsilon\varepsilon'$)=$\sigma^2 I_n$, where I_n denotes the n x n identity matrix and the prime denotes the transpose of a matrix (Draper and Smith, 1998). The ordinary least squares (OLS) estimator, $\hat{\beta}$, of the parameters is obtained by equation 2 (Draper and Smith, 1998).

$$\hat{\beta} = (X'X)^{-1}(X'Y) \quad (2)$$

Ridge regression, aswell as many draw type of estimators (Scolve, 1968), is one example. This approach does not directly addressitself to the issue of multicollinearity, although multicollinearity is often the situation where the aforementioned estimators are used.Among these estimators, the ridge estimator points indirectlyto the issue of multicollinearity by constraining the length of the coefficient estimator (Hocking, 1976). The principal componentsregression, as well as the latent root regression is one such example. Hoerl and Kennard (1970) proposed the ridge estimatoras an alternative to the OLS estimator for use in the presence of multicollinearity. The ridge estimator is shown by(equation 3)

$$\hat{\beta}_R = (X'X + \mathrm{k}I)^{-1}(X'Y) \quad (3)$$

where I denotes an identity matrix and k is a positive number determined as ridge parameter. The corresponding mean squared error (MSE) is determined by equation 4.

$$MSE(\hat{\beta}_R) = \sigma^2 \sum_{i=1}^{p} \frac{\lambda_i}{(\lambda_i + k)} + k^2 \beta'(X'X + \mathrm{k}I)^{-2}\beta \quad (4)$$

3. Result

The descriptive statistics are shown for egg weight, shape index, specific weight, albumen index, yolk index, yolk weight, albumen weight, crust thickness, crust weight, albumen height and haugh unit values of Japanese quails in Table 2. Also, correlation coefficient between egg quality characteristics aregivenin Table 3.

Table 2: Descriptive Statistics

	Mean	Std. Deviation	N
AW	6.0327	0.81251	200
EW	11.9955	1.04617	200
SI	0.8836	0.02192	200
AI	0.3316	0.03189	200
YI	0.6728	0.03309	200
YW	4.1528	0.61537	200
CT	0.2485	0.01906	200
CW	0.8489	0.08950	200
AH	4.3318	0.74757	200
HU	88.1093	4.40524	200

EW: Egg weight, SI:Shape index, AI: Albumen index, YI: Yolk index, CT: Crust thickness, CW: Crust weight, AH: Albumen height, HU: Haugh unit, YW: Yolk weight, AW: Albumen weight.

Table 3: Correlation coefficients between independent variables and Variance Inflation Factor (VIF) values

	EW	SI	AI	YI	YW	CT	CW	AH	HU	VIF
EW	1	-0.136	-0.217	-0.294	0.779	0.073	0.396	0.098	-0.080	8.280
SI	-0.136	1	0.115	0.119	-0.076	-0.070	0.019	-0.041	-0.023	1.051
AI	-0.217	0.115	1	0.150	-0.285	-0.057	-0.091	-0.092	-0.058	1.110
YI	-0.294	0.119	0.150	1	-0.403	-0.258	-0.013	-0.111	-0.063	1.336
YW	0.779	-0.076	-0.285	-0.403	1	0.079	0.386	0.098	-0.045	3.009
CT	.073	-0.070	-0.057	-0.258	0.079	1	0.013	-0.009	-0.026	1.085
CW	.396	0.019	-0.091	-0.013	0.386	0.013	1	-0.087	-0.165	1.280
AH	0.098	-0.041	-0.092	-0.111	0.098	-0.009	-0.087	1	0.982	199.262
HU	-0.080	-0.023	-0.058	-0.063	-0.045	-0.026	-0.165	0.982	1	199.397

Multicollinearity problem is owing to some VIF values(such as 199.262and 199.397) (Table 3). To determine the total effect in AW, the collected egg data were analyzed using LS. The LS results are given in Table 4. Taking into account the positive coefficients, an increment in AW would be expected, as EW, SI, YI, CW and HU increased; but it is be expectedasAI,YW, CT and AHdecreased.

Table 4: The results obtained by least squares method

Parameters	Coefficients	Std. Error	t	Sig.
(Constant)	-14.194	7.93	-1.79	0.075
EW	0.86	0.09	9.59	0
SI	4.64	1.524	3.045	0.003
AI	-4.213	1.077	-3.91	0
YI	0.754	1.138	0.663	0.508
YW	-0.378	0.092	-4.12	0
CT	-3.567	1.781	-2	0.047
CW	0.61	0.412	1.481	0.14
AH	-0.77	0.615	-1.25	0.212
HU	0.136	0.104	1.302	0.194

Ridge regression for the collected data was executed for the prediction of total variability in AW, also preferred as an alternative method to LS. Results from the regression analysis suggested that there was an explanation of 68.50% and illustrated in Table 5. F value is 45.860 andsignificance (P<0.01) (Table 6).

Table 5: Ridge regression fit goodness and standard error valuescompliance with k=5% bias constant

Multiplyr	R Square	Adj. R Square	Standard error
0.828	0.685	0.670	0.467

Table 6: ANOVA results

Source	df	SS	MS	F value	Sig. F
Regression	9	89.963	9.996	45.860	0.001
Residual	190	41.413	0.218		

df: degrees freedom

As can be seen in Table 7, the regression model obtained for k = 0.05 bias constant is also given.In the case of k = 0.05 bias constant R^2=68.5%, however, more stable and reliable results are obtained since max VIF values are less than 10.

Table 7: Estimatedregression parameter values o Ridge regression result, standard error and VIF values

Parameters	Coefficients (B)	SE(B)	Beta	B/SE(B)	VIF
EW	0.659	0.043	0.849	15.469	1.019
SI	3.895	1.463	0.105	2.663	1.045
AI	3.961	1.030	-0.155	-3.846	1.095
YI	0.786	1.063	0.032	0.739	2.540
YW	-0.241	0 .076	-0.182	-3.159	1.005
CT	3.512	1.703	-0.082	-2.061	1.185
CW	0.615	0 .388	0.068	1.584	1.010
AH	0 .050	0 .037	0.046	1.351	1.006
HU	-0.003	0 .006	-0.018	-0.533	1.019
Constant	-3.102	1.784	0.000	-1.738	

SE: Standard error

4. Conclusion

In this study, the ridge parameter was estimatedin the presence of multicollinearity.In order to determine the weight of the albumen, the weight of the egg weight (EW), shape index, (SI), albumen index (AI), yolk index (YI), yolk weight (YW), crust thickness (CT), crust weight (CW), albumen height (AH) and Haugh unit (HU)

AW=-3.102+0.659EW+3.895SI+3.961AI + 0.786 YI - 0.241 YW + 3.512 CT + 0.615 CW + 0.05 AH - 0.003 HU equation was obtained.

Using the ridge regression technique, with an eggs albumen weight of 5% tolerance the linear relationship between quality attributes is 82.8%.68.5% of the change in egg albumen weight was explained by egg quality characteristics.

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