Producer Valuation of Herd Bull Characteristics

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Selected Paper for presentation at the American Agricultural Economics Association Annual Meeting, Denver, Colorado, July 1-4, 2004

Abstract

This study evaluates the importance of certain bull characteristics (disposition, EPD's, conformation, etc.) on a cow-calf producer's herd bull purchase decision. Data were collected from the Auburn University Bull Test Sale from 1997 to 2004. A total of 260 buyers purchased a total of 370 bulls during this six-year period. These buyers will be surveyed to determine demographics, farm characteristics, and the importance of factors influencing their bull purchase decision. A hedonic pricing model will be utilized to determine the value that individual buyers place on various factors or bull characteristics when purchasing a bull.

Introduction

Beef cattle prices have fluctuated significantly on a monthly and annual basis for several decades. It is essential for cattle operations to have sound production and management practices to sustain these price fluctuations. Today cattle producers are becoming increasingly selective in the type of cattle that they raise and purchase in order to make their operations more profitable. Cow-calf producers are now more concerned with the physical and genetic attributes of cattle they are raising. They desire cows that will deliver high quality calves that possess the characteristics desirable in the market place. Cattle producers are aware that the cow and bull contribute equally to the attributes of offspring, so quality breeding stock is imperative.

Bull selection is one of the most critical decisions made in any cow/calf operation because it is the basis for building a profitable beef herd. Bulls have a major impact on economic returns for commercial beef cattle producers. A bull represents 50% of the genetic makeup of each year's calf crop. Additionally, a bull contributes 90% of a cowherd's genetic change for producers who retain their own heifers (Dhuyvetter). Consistently breeding calves with desirable performance traits can contribute to the productivity, efficiency, and profitability of beef production. The future of a cowherd depends upon using the best breeding stock selection tools available.

There are several factors that a producer considers when selecting a herd bull. These factors include price, pedigree, breed, physical traits, and expected progeny difference (EPD), accuracy levels, seller reputation, and disposition. Individual producers will be willing to pay more for various herd bull characteristics than other producers. This study will utilize the hedonic pricing method to evaluate the value buyers associate with various characteristics when purchasing a herd bull.

Background

Efficient reproduction is necessary for profitable beef cattle production. Management, environment, and genetics all significantly affect the productive performance for bulls and cows; however, genetics are the most influential for transferring traits to offspring. Traditionally, little emphasis was placed on reproductive traits or genetic herd improvement programs. However, technological advancements have caused a drastic change in the methods used for breeding and selecting cattle.

The first guidelines for the national sire evaluation were published in May of 1971. They were based on sound principles and the experience of the dairy cattle breeding industry, which promoted the use of mixed-model sire evaluation procedures. Historically, commercial cattle producers selected bulls predominately based on their visual appearance. More recently a transition from subjective evaluation to more objective assessment of breeding value in the beef industry has taken place with the aid of technology. The goal of the genetic improvement programs is to produce the best genetic predictions of breeding value on animals available as breeding stock for traits of economic importance in commercial beef production (BueLingo Beef

Cattle Society). These programs can increase help increase uniformity and performance of calves in a herd, which leads to higher returns.

Cattle producers can visually evaluate cattle with some accuracy for balance, structural soundness, correctness, temperament, and general eye appeal. However, visual selection does not necessarily indicate the genetic or performance potential of a bull's progeny. Visual selection must be combined with objective performance information to make accurate selection decisions in order for producers to obtain bulls and cows that accurately pass on desirable traits.

In today's market a bull should be evaluated based upon his ability to transfer performance and structural characteristics of economic value. This involves evaluating each individual for structural soundness, fertility, growth, calving ease, frame size, maternal performance, and carcass characteristics. A producer's preference for these characteristics may vary according to the genetic make up of his cattle herd, individual goals, and/or other characteristics of his operation.

Previous studies have assessed the value of objective characteristics such as EPDs and performance traits in the buyer's herd bull purchase decision. This study, however, evaluates the importance of both subjective and objective bull characteristics in the buyer's purchase decision. Visual characteristics EPDs, breed, price, seller reputation, physical and performance traits are accounted for in the analysis.

Sy, et al. evaluated producer preferences for different cattle characteristics using conjoint analysis. They noted that price was a composite for the bundle of genetic characteristics that defines the overall quality of beef animals. They measured the marginal contribution of specific beef cattle characteristics to quality in order to link economic decision criteria to improvement of genetic characteristics. A mail survey was used to determine purebred breeders and cow-calf producer's preferences for bulls and cattle feeder's preferences for steers. An ordered-probit model was used with separate models estimated for bulls and steers. The study found that different segments of the cattle sector do not value characteristics equally. Purebred breeders placed the highest value on weaning weight and milking ability, while cow-calf producers rated calving ease and temperament as most important. Cattle feeders rated slaughter weight and feed efficiency as the most important characteristics.

Several studies have assessed the value of EPDs by comparing the correlation between EPDs and actual traits passed onto progeny. A study conducted by Vieselmeyer, et al, used six Angus bulls with high (>.4) and six with low (<-.16) EPDs for marbling, to evaluate the impact of marbling on progeny production and carcass (USDA grade) traits. All bulls had at least a 0.42 accuracy rating for marbling and were selected from the 1989 American Angus Sire Summary. The 180 MARC II composite cows and heifers were randomly selected and artificially inseminated in two consecutive years. The first steers were slaughtered after 126 and 196 days of feeding and the second year's steers after 122 and 185 days of feeding. The first year's heifers were slaughtered after 85 and 148 days of feeding and the second year's after 84 and 147 days of feeding. The actual weaning weights of calves sired by the low marbling bulls were 24 pounds heavier for steers and 33 pounds heavier for heifers, than the weaning weights of calves sired by high marbling bulls. The final weights of the calves at slaughter were similar between treatment of both the low and high marbling EPD sires, contrary to the weight difference observed at weaning. However, the first year, 52 percent of the cattle from high marbling bulls graded USDA Choice compared to only 17 percent of the low marbling sire progeny. In the second year, over 70 percent of the progeny from high marbling group graded Choice as opposed to 47 percent of the low marbling group.

Another study conducted by D.H. Crews analyzed data from 273 progeny of 15 Charolais bulls in order to quantify the relationship between carcass EPDs of the bulls and the actual carcass performance of the progeny. The results indicated a strong relationship between the sire's EPD and the progeny data of hot carcass weight, fat thickness, marbling score, and percent lean yield. The sire's EPDs, were positively related to the progeny outcome at or near theoretical expectations (Crews).

Coatney et al. used hedonics in a study with the objective to statistically account for selected characteristic interdependencies that could be associated with the pricing decisions of feeder cattle buyers. The study assessed the magnitudes of the direct, total indirect and total price impacts of selected interrelated and independent factors on the overall price paid for a given lot of feeder cattle. Feeder cattle markets were analyzed at the micro level so that the model could account for interdependencies in order to determine the source(s) of indirect price impact(s) of changes in exogenous variables in price. The empirical model included physical characteristics, market factors, marketing techniques, seller-added characteristics, climate/environment influences, and seller characteristics, along with their possible interdependencies that are indicative of forward contract transactions, including video markets. The sales data on individual lots sold was gathered from the Superior Livestock Satellite Video Auction (SLA). Feeder cattle consisted of 2,441 sale lots and 790 no-sale lots, which represented the entire population of the SLA feeder cattle offered for sale in 1992. A three-stage least squares model was used in order to adjust for the possibility of equations being related through the nonzero covariance's associated with error terms across different equations and to account for structural simultaneity of equations. The results suggested that frame variance, cattle originating from hot regions relative to cold regions, proportion of polled animals related to nonpolled, cash price expectations, distance hauled, sex slide, and weight slide were all statistically significant at a low level. Overall, characteristics of feeder cattle categorized as physical characteristics and market factors exhibited the largest numbers of significant direct price determinants. Their results also suggested that average frame score, average weight, average flesh score, and pencil shrink each negatively impacted price. The most prominent estimated indirect price impacts for feeder cattle resulting from a change in exogenous variable were through direct impacts on frame score and weight.

Conceptual Model

In this hedonic analysis, the conceptual model specified below has a linear functional form.

P(b)=f(BREED, YEAR, EPD, PTRAIT, CONF, ULTSND)

In this model, P(b) is the dependent variable, which represents the actual price that buyers paid for a specific bull. The breed of the bulls, denoted by BREED, was included to represent the seven different breeds of bulls purchased during the years evaluated. The year (YEAR) was placed in the model in order to determine if any economic trends had an effect on the price buyers paid for bulls in a given year. The independent variable EPD represents the individual EPD characteristics that are evaluated in the model. The EPDs for birth weight, weaning weight, yearling, and milk are all variables considered for the empirical model. The PTRAIT variable represents the physical and performance characteristics recorded for each individual bull during the test. These variables include the bulls actually birth, weaning, and yearling weights; average daily gain during the test period; number of contemporaries; a feed efficiency ratio; 84-day scrotal circumference; the bull's height; and frame score. The conformation rating that buyers assigned to the bulls they purchased is specified by the independent variable CONF. Buyers were asked to rate the conformation of the bull(s) that purchased from the AU sale on a scale from negative five to a positive five, where negative five indicated a bull being very undesirable in conformation, zero being average conformation, and positive five denoting a very desirable conformation. This variable was expected to have a positive effect on price, because the better a bull's conformation, the more a buyer should be willing to pay at the auction. ULTSND represents ultrasound data recorded for each bull. Ultrasound data available was back fat thickness, ribeye area, and intramuscular fat. These variables were expected to have a positive relationship with price

Theory

Sherwin Rosen was one the first individuals to utilize the hedonic theory. He developed a model of product differentiation based on the hedonic hypothesis that goods are valued for their utility-bearing attributes or characteristics. The goal of his study was to exhibit a mechanism for the observations in the competitive case and to use that structure to clarify the meaning and interpretation of estimated implicit prices (Rosen).

The model for Rosen's study was basically a description of competitive equilibrium in a plane of several dimensions on which both buyers and sellers locate. Products in the class are completely described by numerical values of z and offer buyers distinct packages of characteristics, in which product differentiation implies that a wide variety of alternative packages are available. Once price differences among goods are recognized as equalizing differences for the alternative packages they embody, economic content of the relationship between observed prices and observed characteristics become evident. His model interposes a market between buyers and sellers. Producers tailor their goods to embody final characteristics desired by customers and receive returns for serving economic functions as intermediaries.

A price $p(z) = p(z_{1,} z_{2,} ..., z_n)$ is defined at each point on the plane and guides both consumer and product locational choices regarding packages of characteristics bought and sold. The function p(z) is identical with the set of hedonic prices - "equalizing differences" – as defined above, and is determined by some market clearing conditions. Market clearing prices are determined by the distributions of consumer tastes and producer costs.

The components of *z*, a class of commodities that are described by *n* attributes or characteristics $(z = z_{1,} z_{2,} \ldots, z_n)$, are objectively measured in the sense that all consumers' perceptions or readings of the amount of characteristics embodied in each good are identical, though of course consumers may differ in their subjective valuations of alternative packages. Each product has a quoted price and is also associated with a fixed value of the vector *z*, so that products markets implicitly reveal a function $p(z) = p\ (z_{1,} \ldots, z_n)$ relating prices and characteristics. This function is the buyers (and sellers) equivalent of a hedonic price regression, obtained from shopping around and comparing prices of brands with different characteristics.

Looking at the consumption decision, $U(y - 0, z_{1,} \ldots, z_n) = u$ is the expenditure a consumer is willing to pay for alternative values of $(z_{1,} \ldots, z_n)$ at a given utility index and income is represented by $0\ (z; u, y)$. It defines a family of indifference surfaces relating the z_i with "money", which has been widely used in urban economics. The amount the consumer is willing to pay for *z* at a fixed utility index and income is $0\ (z; u, y)$, while p(*z*) is the minimum price he must pay in the market. Therefore, utility is maximized when $0\ (z^*; u^*, y) = p(z^*)$ and $0_{zi}\ (z^*; u^*, y) = p_i\ (z^*)$, i = 1,…, *n*, where z^* and u^* are optimum quantities. In other words, optimum location on the *z*-plane occurs where the two surfaces *p(z)* and $0(z; u^*, y)$ are tangent to each other.

In this study, the purchase price (dependent variable) at the auction is represented by $0\ (z; u, y)$, where *z* is the combination of all the characteristics of the bulls, *u* is the utility received from bull, and *y* is the buyers income. The independent variables are represented by $z_1, \ldots, z_n$. There are a large number of differentiated products that are available so that choices among various combinations are continuous for all practical purposes. That is, there are many bulls possessing different characteristics and values among which choices can be made. The empirical model for this study is as follows:

$$P(b)= B_0+B_1 \text{ CONF} + B_2 \text{ BREED1} + B_3 \text{ BREED2}+ B_4 \text{ YEAR} + B_5 \text{ BW} + B_6 \text{ ADJ WW} + B_7 \text{ CONT} + B_8 \text{ DWeight} + B_9 \text{ DSC} + B_{10} \text{ BWE} + B_{11} \text{ MILKE} + B_{12} \text{ YWTE} + B_{13} \text{ DADG} + B_{14} \text{ DFE} + B_{15} \text{ AYW} + B_{16} \text{ BFIN} + B_{17} \text{ RBEYE} + B_{18} \text{ IMF} + E_i$$

Table 1 provides a detailed description of these variables and their expected signs.

Data and Methods

This study evaluates the value buyers place on different EPDs and other bull characteristics when selecting a herd bull. The primary data was attained from the Auburn University Bull Test Sales from 1997 and 2004. The data set from the sales contain the sires and dams of the bulls, their EPDs, birth weights, average daily gains, frame scores, height, and feed efficiency on bulls evaluated over an 84-day period. A total of 260 buyers representing 370 bulls were surveyed. The mail surveys contained questions regarding the importance of EPD statistics, the physical characteristics of the bull, producer demographics, characteristics of the operation, and occupational income. The survey also contained a contingent ranking question, which directly asked buyers to rank the bull's temperament, conformation, EPDs, breed, seller's reputation, price, and performance traits in the order of their importance. The survey was administered based upon the Dillman Tailored Design Method.

Since the surveys were linked directly to individual bulls, profiles of each bull were placed in the buyer's survey to aid them in recalling the correct bull(s). The profiles contained the name of the consignor, the bulls breed, his date of birth, sire and dams' names, ultrasound data, EPD values with their corresponding accuracy measurements, along with the bull's birth, weaning, and yearling weights. These profiles also contained the bull's performance test measurements: average daily gain, weight per day of age, feed efficiency, final weight, frame score, and final index. After the profiles of the bulls were placed in the survey, the surveys were reviewed, edited, and mailed to the proper buyers.

Individual farmers pay a fee to Auburn University for raising, testing, managing, and utilizing up-to-date technology on their bulls. The bulls are on test for 84 days before being sold at auction where buyers are able to view the bulls before and during the sale. All of the performance and physical traits of a bull are measured along with the EPD and ultrasound data. This information is available to buyers in order to aid them in their bull purchase decision, and buyers are able to view the bulls at anytime prior to the sale, from which they can individually evaluate subjective factors related to each bull.

Buyers were asked to rate the conformation of the bull(s) that they purchased on a scale from negative five to a positive five, where negative five indicated a bull with a very undesirable conformation, zero indicating an average conformation, and positive five suggesting very desirable conformation. Buyers who purchased more than three bulls in this time span were sent profiles of the last three they purchased, and were asked to rank the conformation of these bulls. This question allows for a subjective measurement of the buyer's decision-making process, which plays an important role in this study. Also, this question allows insight on the actual size and uniformity buyers look for in the bulls that they purchase. This aids in matching the bulls conformity to the different factors that buyers hold of high value.

Buyers were also asked to rank seven factors from one to seven in the order of their importance when selecting a herd bull, with one being the most important and seven being the least important. The factors that buyers had to choose from were temperament, conformation, EPDs (Expected Progeny Difference- birth weight, yearling weight, weaning weight, etc), breed, price, seller reputation, and physical and performance traits, such as average daily gain, scrotal size, etc. This question is used to determine the importance or value of different factors that influence an individual's bull purchase decision.

Personal interviews were conducted with nine buyers who were within a sixty-mile radius of Auburn. Individuals in this group of buyers had purchased as many as nine bulls, and a profile was taken of every bull they had purchased and given to the buyer in order to aid them in the rating of their bull's conformation. The buyers were asked to complete the survey if they had not already, and were also asked to rate the level of satisfaction they have received from the offspring that the bulls had produced. Once surveys were returned, the buyer's conformation ratings for each bull were placed in the hedonic model and matched with the objective characteristics from the bull test data set. The regression model was analyzed using Limdep.

<u>Descriptive Statistic Results</u>

There were more than 130 responses to the survey (50 percent response rate); however, only 108 were usable. The results of the survey showed that 84 percent of the respondent's farms are characterized as a sole proprietorship, or either family corporations. The average age of buyers was 60 years old and they had been raising cattle for and average of 32 years. The average age for Alabama farmers was 56.6 years old, and the national average was 57.6 years old, according tothe1997 Census of Agriculture. The average farm size was 744 acres and consisted of ten bulls and 182 cows and calving heifers on average. The Angus breed dominated all other breeds for both number of cows and bulls being utilized on buyer's farms.

Fifty-six percent of the buyers indicated they did not have any off-the farm employment, while 44 percent (44) did. Of the off-the farm employment, 63.64 percent (28) indicated they were full-time, with part-time and retired each accounting for 6.82 percent of the total. Over 42 percent of the buyers indicated that 81-100 percent of their gross farm income was produced through their cattle operation during 2003. About 31 percent of respondents claimed that agricultural sales accounted for $10,000 to $49,999 of the total income.

It was found that buyers rank the breed of a bull as the most important variable taken into consideration when purchasing a herd bull. The EPDs of a bull was ranked second and 30.84 percent of the buyers indicated they would pay an additional $500 or more to have EPDs and performance data available when purchasing a herd bull. The temperament of a bull and his physical and performance traits were ranked third and fourth, with conformation being ranked fifth and price and seller reputation sixth and seventh.

Empirical Results

An ordinary least squares (OLS) regression was run and a Breusch-Pagan test for heteroscedasticity was conducted. This test found that heteroscedasticity was present in the model. When heteroscedasticity is present in a model a definite pattern can be seen when plotting the residuals, however; when plotting them it is expected that they will be (roughly) normal and (approximately) independently distributed with a mean of 0 and some constant variance (Pindyck and Rubinfeld). Several variables displayed definite patterns when plotted, and weight was placed upon them to determine the variable causing the heteroscedasticity.

Each test performed showed comparable results, except when a regression was performed with CONT, the number of contemporaries, as the weighted variable. When this test was performed, nine different variables proved to be significant. The variables CONT, ADJWW, AYW, BREED2 (Simmental), and the EPD variables YWT and Milk all tested significant at the .01 level. DWEIGHT and DFE each tested significant at the .05 level, with BW being the only variable significant at the .10 level. All of the variables testing significant possessed the expected corresponding signs except for the MILK variable.

Heteroscedasticity was corrected for using the generalized least squares method (GLS). The regression R^2 and Adjusted R^2 values were 0.739492 and 0.68681 and the Durbin-Watson statistic was 2.20308. It also had a Breusch-Pagan chi squared value of 45.0708, with 18 degrees of freedom, so the null hypothesis of homoscedasticity was rejected in favor of heteroscedasticity.

Examining the coefficients of the variables testing significant at the .01 level, it was observed that the value for the variable CONT was 5.66081 and ADJWW was 2.80673. This meant that an increase in one contemporary or one pound for ADJWW would increase the price paid for a bull by $5.66 and $2.81. The EPD variables MILK and YWT had coefficient values of -42.16856 and 15.16971, which meant MILK was inversely related toward price and YWT had a positive relationship. Lastly, the AYW coefficient value was 2.72516 and BREED2 was -796.06330. Increasing the AYW by one pound would results in an increase of the price by $2.73 and BREED2 had an inverse relationship with price.

There were seven different breeds of bulls that were purchased from the Auburn University Bull Test Sales from 1997- 2004. The descriptive statistics indicated that the Angus breed was utilized on the majority of the respondents' farms. A numerical value was assigned to each breed and a program was written so that the level of significance of could be tested individually. Out of the 108 bulls represented in the data, Angus accounted for 51 percent and Simmental accounted for 22 percent. Since the Angus and Simmental breed represented such a large portion of the data they were tested individually as BREED 1 and BREED 2, respectively. Charolais, Gelbvieh, Limousin, Brangus, and Hereford accounted for the remaining 27 percent and were grouped together as BREED 3.

The Simmental breed (BREED 2) tested significant in the model at the .01 level and had a coefficient sign of -796.06330. This suggests that the price paid for Simmental bulls would be lower when compared to other breeds represented in the model. This finding is of *a priori* expectations, given the desirability of characteristics commonly produced by Simmental cattle.

Conclusions

Bull breeders should be able to utilize this information to produce bulls that are of high quality and in great demand. Cattle producers are now able to look at the different characteristics and attributes of bulls that are regarded highly by buyers. Bull producers can use this information to better understand of the important factors that affect the buyers purchase decision. Better bull quality increases uniformity and calf quality.

This information could instrumental in changing some of aspects of the breeding program for bull and commercial cattle producers. It offers insight into the demands and desires buyers have when purchasing a herd bull, which will enable producers to make the most effective decisions possible in their breeding programs. Producing bulls with superior traits that add value to progeny will benefit bull breeders, commercial cattle producers and the cattle industry as a whole. Producers will be raising the type of bulls that buyers desire, which could improve their cow-herd and prices at slaughter. The cattle industry could receive more revenue and benefits if buyers are earning higher profits on their cattle operations.

In the end, buyers are interested in bulls that are heavy in both weaning and yearling weights, and possess quality EPD measurements. They want a bull that has the genetics to produce offspring with low birth weights, high yearling weights, and heifers that can produce adequate amounts of milk. Buyers also desire for a bull to be of heavy weight on the 84^{th} day of test and at 205 and 365 days old. They desire for a bull to be efficient in feed conversion, which will aid in reducing cost, and have the most amounts of contemporaries possible.

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Table1: Description of Variables in the Model and Their Expected Signs.

Variables	Variables Definitions	Expected Signs for Variables
P(b)	Price paid for a given bull	
CONF	Conformation Rating of Bulls	+
YEAR	Year Bulls were Purchased	+, -
BIRTHW	Actual Birth Weight of Bulls	-
ADJWW	Adjusted 205 Day Weaning Weight	+
CONT	Number of Contemporaries	+
DWEIGHT	Weight of Bulls on 84^{th} Day of Test	+
DSC	Scrotal Circumference of the Bulls on their 84^{th} Day of Test	+
BW	EPD Birth Weight	-
MILK	EPD Milk	+
YWT	EPD Yearling Weight	+
DADG	84-Day Average Daily Gain	+
DFE	84-Day Feed Efficiency	-
AYW	Adjusted 365-DayYearling Weight	+
BFIN	Adjusted Ultrasound Backfat Thickness	-
RBEYE	Adjusted Ultrasound Ribeye Area	+
IMF	Adjusted Ultrasound Percent Intramuscular Fat	+
BREED1	Angus	+
BREED2	Simmental	+

Table 2: Descriptive Statistics of Variables Used in the Model with Correction For Heteroscedasticity and Using a Weighted Variable, CONT

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean
Constant	-2809.83495	1317.8505	-2.132	.0358	
CONF	-40.7978500	48.284177	-.845	.4004	4.1394680
BREED1	-38.5652512	166.26092	-.232	.8171	.45578720
BREED2	-796.063305	199.75165	-3.985	.0001 ***	.34507549
YEAR	-31.5965392	27.049757	-1.168	.2459	4.3386053
BIRTHW	-6.84555441	5.6207827	-1.218	.2265	81.954709
ADJWW	2.80673878	.95182901	2.949	.0041 ***	698.41553
CONT	5.66081491	1.3937543	4.062	.0001 ***	40.880661
DWEIGHT	1.08791872	.55219283	1.970	.0519 *	1312.0818
DSC	7.78345185	20.569183	.378	.7060	35.816319
BW	-71.5048610	41.488189	-1.723	.0883 *	3.1394680
MILK	-42.1685686	9.8430883	-4.284	.0000 ***	14.661395
YWT	15.1697199	4.4779188	3.388	.0011 ***	61.579295
DADG	-81.2274702	159.42025	-.510	.6117	4.2396986
DFE	-217.590911	99.610213	-2.184	.0316 **	7.0036069
AYW	2.72513363	.79066043	3.447	.0009 ***	1268.4050
BFIN	-609.807804	465.36408	-1.310	.1934	.33393961
RBEYE	47.0403109	32.786431	1.435	.1549	14.467829
IMF	-64.5271720	69.810725	-.924	.3578	3.1790671
R-squared		0.739492			
Adjusted R-squared		0.68681			
Durbin-Watson Statistic		2.203008			
Breusch - Pagan chi-squared		45.0708			