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Valuing Information: Evidence from Guitar Auctions on eBay

David H. Eaton*

Abstract

This paper uses auction data on Paul Reed Smith guitars to estimate the value placed on information signals in eBay auctions. Information signals in this market attempt to mitigate uncertainty based upon both the quality of the product being offered for sale, and the quality of the seller offering the goods. Information signals are of particular value to sellers with negative feedback ratings. Positive signals about the quality of the good, such as pictures, may increase the bid prices for auctioned items. Negative signals about the quality of the seller may decrease the bid prices for auctioned items.

I. Introduction

One assumption of perfect competition is the existence of complete information in the market. This paper examines the value of information signaling in markets where product and seller quality cannot be observed with certainty.

Akerlof (1970) and others have examined the impact of incomplete information on market outcomes. Akerlof posited that the "lemon problem" caused low prices to crowd out quality goods in a resale market. The basic result of Akerlof's work was that when quality cannot be observed with certainty, owners of high quality goods have no incentive to offer these goods for sale as buyers will not offer a sufficiently high price to induce quality goods on the market. Akerlof termed this the lemon problem.

This paper examines Internet-based auctions of high-end guitars. In this situation, buyers are not able to gather complete information about either the goods being offered for sale or the sellers offering the goods. Buyers in this market will have some knowledge of the item being offered based upon the reputation of the original product.

Internet-based resale of high-end guitars is an example of a case in which incomplete information may lead to lower prices in the secondary market. In this type of transaction, a seller has significantly more information on the quality of the instrument offered for sale than does the buyer. In addition, many of the information signals needed to value the guitar are highly subjective in nature. For instance, a guitar may be described as being in "mint" or "excellent" condition or as a "9.5 out of 10." All of these descriptors are subjective (though one could devise a set of guidelines in order to make such statements more objective). Other critical

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elements, namely sound and appearance, are highly subjective as well and it would be difficult to find criteria that would make statements, such as "looks great, sounds better," more objective. With the goods under examination in this paper there is knowledge concerning sound and appearance from the manufacturer's reputation, however information on the particular guitar being auctioned is incomplete on the buyer's side.

Dealing on eBay presents another dimension of information uncertainty as well. In addition to uncertainty over the quality of the product, there is uncertainty over the quality of both the seller and buyer in the market. It is understandable that buyers may be nervous about sending cashier's checks or money orders for large dollar amounts to complete strangers. It is also understandable why sellers are nervous about accepting personal checks from complete strangers, though sellers do have the advantage of holding the goods until they receive payment. Moreover, sellers can always offer the good for sale again if the original high bidder does not follow through.

In light of these difficulties, especially with high priced goods, it would make sense that a seller would want to offer some signal of the quality of the instrument and the quality of the seller. This paper will examine how valuable such information signals are in this particular market. The next section will briefly review the empirical literature on auctions involving adverse selection and Internet-based auctions. The paper will then present a simple theoretical model that will motivate the empirical research that follows.

II. Previous work on auctions and incomplete information

Related work has been undertaken in the car market by Genesove (1993) who examined adverse selection at used car auctions based on the seller of a car. Some of the factors considered included seller type, ownership history, mileage, and the reported condition of the car. Genesove found mixed evidence for adverse selection through price differences in the cars offered by new car dealers and the cars offered by used car dealers (who would have some incentive to keep good used cars for themselves).

Genesove (1993) lists four criteria a market must exhibit in order for adverse selection to lead to the lemon problem. First, at the time of the sale, one side of the market has more accurate information concerning the quality of the good. Second, both the buyer and seller must value quality. Third, the less informed party determines the price. Finally, extra-trading institutions must not fully eliminate uncertainty over quality.

These criteria are at least weakly met in the type of Internet auction under investigation here. Clearly the seller better knows the quality of the instrument being offered for sale. In an auction type of market, the buyer will determine the final sales price, subject to the highest bid meeting the reserve (or minimum acceptable) price. The concern over quality is met by the choice of the guitars to be studied, a high quality, high reputation, and relatively high priced brand. Finally, escrow services have developed which should reduce, but not eliminate, quality uncertainty.

There is a growing literature on Internet auctions. Lucking-Reiley et al. (2000), Melnik and Alm (2002), and Houser and Wooders (2000) have all examined the impact of reputation on final prices in eBay auctions. These papers typically found that reputation matters, but not a lot. For example, in a study of auctions of U.S. pennies, Lucking-Reiley et al. found that a one percent increase in a bidder's positive feedback leads to a 0.03% increase in the final bid price while a 1% increase in negative feedback leads to a 0.11% decrease in the final bid price. The mean book value of the items in this data was $278 with a mean bid price of $173.

Melnik and Alm studied auctions of 1999 $5 U.S. gold coins in mint condition. The average price of the coins in their auction was $32.73. They found that a doubling of feedback would lead to an increase of $0.18 in bid price. Similarly, a doubling of negative feedback would lower bid prices by $0.28. Houser and Wooders examined auctions of Intel Pentium III 500 Mhz processors during the fall of 1999. By selecting a reasonably homogeneous good, the authors hoped to more clearly isolate the impact of the seller's reputation on the bid. The mean price of the chips offered for auction was $220. The authors found that a 10 percent increase in negative feedback lowered the bid price by .24 percent. Although this finding was statistically significant, it was of very small magnitude.

Livingston (2002) examined the impact of reputation on the sales of Taylor Made drivers using ranges of feedback values. His results suggested that early positive reports increased the probabilities of bids and sales, as well as the sale price. In addition, very large amounts of feedback (above 675 positive comments) also increased the final sale price by 10% over those with no positive feedback.

Yin (2003) studied the impact of winner's curse on bids in a common value auction using eBay auctions of computers. Yin used both data from eBay auctions and survey data to estimate the value of information in common value auctions. Her results suggested that more experienced sellers, who provided more detailed information in the auction descriptions, promoted efficient trade by reducing the likelihood of overpaying for a common value auction.

Resnick et al. (2002) used a controlled experiment of selling vintage postcards using different eBay accounts, one with an extremely high reputation and the other with new sellers. The content and presentation of auction information was controlled so as to minimize its impact on the results. The authors found that the established account had selling prices 7.6% higher. Interestingly, they found that "one or two negative feedbacks for our new IDs had no price effects, even though these sellers had few positives." (p. 1)

Finally, Bajari and Hortacsu (2004) provided an outstanding summary of these, and other works, using Internet auctions.

This paper examines auctions of merchandise with much higher bid prices where reputation might be expected to be more important, given the large sums of money involved. In addition, the quality of goods examined in this paper is difficult to measure objectively and thus information signals should matter. As a result of the subjectivity inherent in the goods being auctioned, and the difficulty of quantifying the description of an auctioned item, one might expect weaker statistical results than found in studies of homogeneous goods. Finally, this paper adds to the literature by examining heterogeneous goods where information about the quality of the particular item is incomplete.

III. Theory

The Akerlof model is adapted to the guitar market in the following way.[1] Assume that when purchasing a guitar a consumer has the choice of buying in person or buying over the Internet. We will assume that the true value of a guitar purchased in person is known with certainty as the purchaser will have had the opportunity to examine the guitar.

The true quality of a guitar purchased over the Internet is not known with certainty. This is true of both new and used guitars. The uncertainty arises from both product characteristics and seller characteristics.

Suppose N^G is the value of a guitar examined and purchased in person by the buyer, U^G is the value of a "good" guitar purchased over the Internet that occurs with probability β, and U^B is the value of a "bad" guitar purchased over the Internet that occurs with probability $1-\beta$. The expected value of guitar purchased in person equals its value, $EN = N^G$. The expected value of a guitar purchased over the Internet is $EU = \beta(U^G) + (1-\beta)(U^B)$.

Good and bad may refer not only to the quality of the guitar, but also to the desirability of the guitar to the buyer. For simplicity, set $U^B=0$. Further let p^N and p^U represent the prices of guitars purchased in person and guitars purchased over the Internet, respectively. A risk-neutral buyer will be indifferent between purchasing a guitar in person and purchasing a guitar over the Internet provided that:

$$EU - p^U = EN - p^N.$$ [2]

Rearranging we have:

[1] This section is adapted from the lemons model presented in Shy (1995).

[2] Risk aversion could be added to the model by requiring the expected surplus from a guitar purchased online to exceed the expected surplus of a guitar purchased in person by some amount.

$$p^U = EU - (EN - p^N).$$

$$p^U = \beta(U^G) - (N^G - p^N).$$

This demonstrates that the price of a guitar purchased over the Internet will increase with β, the likelihood of a good Internet purchase. Thus, the more accurately a buyer is able to discern the quality of a guitar purchased over the Internet, the higher the price for that guitar should be. We can expect in an eBay auction that $\beta < 1$. In order to raise the price of the auctioned guitar sellers might be expected to take actions that increase the certainty of buyers regarding the quality of the guitar and thus the likelihood that they are purchasing a good guitar, β. In an auction or online setting uncertainty over the quality of the seller is expected to reduce β and thus the final auction price.

IV. Methodology

The products to be examined in this paper are electric guitars manufactured by Paul Reed Smith (PRS) guitars. PRS produces high-end guitars with list prices, and often resale prices, starting well over $1,000. PRS guitars have been in high demand over the last few years and have an active resale presence on eBay.

eBay offers several methods of reducing uncertainty in an auction transaction. The most notable is that of the feedback rating where the parties to the transaction may rate each other. The feedback rating is constructed by subtracting the number of unique negative feedback from the number of unique positive feedback. Neutral feedback is an option, but has no impact on the feedback rating. Some sellers refuse to accept bids from potential buyers with negative or zero feedback. One would also expect that sellers with negative feedback ratings, or a high percentage of negative feedback ratings, would have a harder time selling an instrument. Comments can be recorded along with the positive, neutral or negative rating, and those receiving negative feedback are able to post their response to the negative comments.

To reduce uncertainty concerning the condition of an instrument, a seller can post pictures of an item offered for sale. Auctions that provide pictures would be expected to attract more bidding action than auctions without pictures.[3]

A seller's willingness and ability to take credit cards is expected to reduce buyer uncertainty about the financial transaction, since the credit card company would provide an additional means of recourse against a poor quality seller. Finally, a number of e-escrow services have developed in which a third party collects money from the buyer prior to their receipt of the good and holds the money until the buyer indicates satisfaction with the

[3] This may be especially true for PRS guitars as they are prized for their appearance as well as their sound.

transaction. A lower risk of fraud in a transaction is expected to increase the number of bids as well as the selling price for an auctioned item. In addition this should reduce some product uncertainty as the buyer would be able to reject, within certain bounds, undesirable instruments after inspection.

The paper estimates an equation for the likelihood of an item selling using a logit model and an equation for the amount of the high bid regardless of whether a sale was made or not. These results will hopefully shed light on how valuable information signals are in this particular market.

V. Data

The data for this paper come from auctions completed on eBay between January and April of 2001. Data were collected by hand on several relevant variables including the model of the guitar, measures of information provided, whether a sale was made, the number of bids and the final bid price. This section will describe the data in more detail.

The first model is estimated using a binary variable as the dependent variable to indicate if a particular auction ended in a sale or not.[4] In order to be included, an auction must have received one bid. If no bids were received we assumed the minimum bid set by the seller exceeded the reservation price of all buyers and thus these auctions were excluded. A second model is estimated to explain the high bid at the end of an auction. This model includes auctions that registered at least one bid regardless of whether a sale occurred or not.

To control for the different models of guitars available for sale, dummy variables were used to indicate broad category classes. For PRS guitars, four model classes were used: McCarty, CE, Singlecut and Custom.[5] Lucking-Reiley et al. suggested that excluding the book value of a good causes omitted variables bias, and the inclusion of dummy variables should help avoid this issue by providing a control for different retail values for the guitars.

Guitars within each model category are not perfect substitutes as there are several options available on different model classes. The two most popular items are the “10” top, which has a more highly figured maple top, and bird inlays, which replace traditional fret markers. On new guitars the ten top option adds $550 to the list price of a guitar, while the addition of birds adds

[4] Whether an auction ends in a sale depends in large part on the reserve (or minimum sale) price set by the seller. Thus, it is possible that the high bid for an auction may closely reflect the market valuation of an instrument, but a higher reserve may prevent a sale. Many sellers begin the auction with a non-trivial opening bid, thus at least one bid must have been offered on the good in order for the final high bid to reflect auction activity.

[5] In order of list price (2000 catalog) the models are Singlecut ($3,000), McCarty ($2,840), Custom ($2,650), and CE ($2,300). Actual sales prices for new instruments will typically run between 62-75% of the list price.

$280. These options are not available on the CE model. The data used in this paper does not include measures of options included on the guitar offered for sale. Across the four categories, data from 324 auctions were used to estimate the empirical models.

Explanatory variables include measures of product information and seller reliability. To measure product information a series of variables were collected to indicate if pictures of the guitar were included in the posting of an item for sale. Picture posting is measured not only as a dummy variable, but also as the number of pictures. Because of the subjective nature of appearance, the expected probability of a satisfactory purchase should increase with some (albeit imperfect) visual information, and thus these variables should have a positive impact on the dependent variables.

A second issue regards assurance that the transaction will be completed once money is exchanged. Many sellers might be wary of accepting personal checks and require either a money order or cashier's check. Buyers might be hesitant to send a large sum of money to a complete stranger in advance of receiving merchandise. eBay offers a mechanism for previous traders to leave feedback on the quality of the seller (and the buyer). While not a perfect signal, it may be reasonable to assume that sellers with high numbers of feedback (and, in particular, high positive feedback) would be more likely to receive high bids on their products. This will be measured by the amount of feedback for a seller and the proportion of positive feedback. Measures of negative feedback will also be included, as will interaction terms to identify changes in slope and intercept terms for those sellers with negative feedback.

Some sellers accept credit cards for purchases that help buyers feel more secure since most credit cards offer fraud protection. In addition, acceptance of credit cards may reduce buyer uncertainty, since this suggests that the seller is a business and not an individual. A dummy variable was used to measure whether credit cards were accepted or not.

Finally, several escrow services are now available for eBay auctions. In this type of arrangement, payment is sent to a third party and is only released to the seller when the buyer has received a satisfactory product. A dummy variable was used to signal whether escrow services are available or not.

Several other factors in the market may also mitigate information problems. Primary to this paper is the quality of the product being offered. PRS guitars are built to very high quality specifications, and the instruments are very consistent in terms of quality. Buyers in the new guitar market commonly order these guitars from distant stores by phone or over the Internet. While reputable stores allow a buyer to return a guitar if they are unsatisfied, there is a shipping cost involved. The known quality of the new instrument may reduce the information asymmetry in the used market.

In addition, the nature of the eBay market may lead buyers who have limited information about the product or who are risk averse to avoid searching for an instrument on eBay. In this case the self-selection of eBay participants may reduce potential lemon problems. Resnick and Zeckhauser (2001) suggested that those who are likely to be poor sellers are similarly deterred from participating in the market.

Table 1 presents summary statistics for PRS guitars in three panels. Panel A provides descriptive statistics on the entire data set and shows that 17.9% of the guitars offered for sale were offered by those with at least one negative feedback. The average seller in the sample had .6 negative feedbacks and a total feedback rating of 109. Panel B, which divides the data by feedback rating, shows that the proportion of sellers with negative feedback increases with overall feedback levels. Panel C provides bid information by model category.

VI. Results

Table 2 reports the results of the logit model where the dependent variable takes a value of '1' if the auction for a PRS guitar ended with a sale. In each case the Singlecut model is used as the left-out, or base, case. Column 1 presents the results for a basic logit model. Negative feedback is measured using both an intercept dummy as well as slope interaction terms. The dummy variable for negative feedback has a negative sign and is statistically significant. While the dummy variable for the presence of a picture has a negative sign, for those with negative feedback, the presence of a picture increases the probability of an auction ending with a sale. The availability of escrow is statistically insignificant for those with no negative feedback, but the slope interaction term is positive and statistically significant.

As will be further discussed later in the paper, separate models may be appropriate for those with different amounts of feedback. Separate models were estimated for those with feedback ratings less than 20, shown in column 2, and those with feedback ratings of at least 20, shown in column 3.[6] The presence of negative feedback significantly reduces the likelihood of a sale for those with feedback ratings of at least 20 while the interaction terms for negative feedback with the presence of a picture and the availability of escrow services are positive and significant. For those with low feedback ratings, only the availability of an escrow service positively and significantly affects the probability of a sale.

While the negative sign on the picture dummy variable may at first seem odd, this is probably caused by the nature of the item being auctioned. As previously mentioned, PRS guitars are prized for their appearance as well as their sound. As a result, a seller may use pictures to attempt to induce buyers to meet a higher reserve price.

These results also suggest that information signals are valuable for sellers with negative feedback. Sellers with negative feedback increase their likelihood of sale by including pictures and escrow services. This is particularly true for high feedback sellers.

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[6] A feedback threshold of 20 was used as this provided stability to both parts of the separate model.

eBay records the high bid for each auction, as well as whether an auction ended in a sale. The next set of tables report the results of estimations for the final bid for an auction, regardless of whether the guitar was sold. Auctions with zero bids (where the high bid would be reported as the seller's starting bid) were not included in this estimation. These models were estimated using White's correction for heteroskedasticity. Since different guitar models have different suggested retail prices (see footnote five), the error variance may be related to the right hand variables for the different models.

Table 3 reports the results of the model to explain high bid prices using the number of pictures as an explanatory variable. These results suggest that for those with negative feedback increasing the number of pictures can further increase the high bid price.[7] The interaction terms between negative feedback and escrow and negative feedback and credit are negative but not statistically significant. Pictures do appear to offer valuable information, particularly for those with negative feedback.

These results make sense in the context of the model if the source of negative feedback, or the source of uncertainty, relates to the product as opposed to the seller. Additional pictures should increase the buyer's confidence in, and desire for, the item to be purchased. If the source of the negative feedback relates to the quality of the seller, additional pictures would not diminish the uncertainty in the transaction. Escrow services tend to relate more to the quality of the seller than the product and thus the negative sign does seem reasonable.

An additional concern related to the impact of negative feedback is the possibility that those with negative feedback also tend to be those with more eBay transactions and thus the negative feedback may simply be acting as a proxy for more experienced sellers.[8] To test this, a Chow Breakpoint test was used to discover statistically significant breaks in the data at feedback levels of 40 and 100.[9] Table 4 reports the results of estimations based on three sub-samples. Columns two, three, and four show results for feedback ratings of 40 or below, 40 to 100, and greater than 100, respectively.

For those with feedback ratings under 40, none of the information items, including the

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7 Specifications including the square of the number of pictures (to allow for diminishing returns to additional pictures) were estimated, but the square of the number of pictures was not significant and so these specifications are not reported.

8 Indeed a simple regression of negative feedback on number of feedback yields a statistically significant relationship that predicts a one-unit increase in negative feedback for each 60-unit increase in overall feedback.

9 The Chow breakpoint test is used to test the hypothesis that the regression coefficients between two (or more) subsets of the sample are the same as opposed to the alternative hypothesis that the coefficients are different across different subsets of the sample. See Greene (2000), pages 287-292.

number of pictures, are statistically significant. Additionally, none of the variables incorporating negative feedback are statistically significant. For those with feedback ratings between 40 and 100 the sign of the dummy variable for escrow is positive with a t-statistic of 1.48, just below conventional levels of significance. Of interest is the fact that the interaction variable is large, negative, and statistically significant between the presence of negative feedback and having an escrow service available. Again, there are indications that the escrow service may send a negative signal about the quality of the seller, particularly if the seller has negative feedback. The number of pictures is not statistically significant however the interaction term between negative feedback and the number of pictures is positive and statistically significant.

Column four reports results for auctions with feedback ratings of greater than 100. While none of the interaction terms are significant, the number of pictures does have the expected sign. For this group of sellers, just shy of 50 percent had at least one negative feedback, and while the dummy variable on negative feedback has a large value, it is statistically insignificant.

An examination of the descriptive statistics for the various groups in panel B of Table 1 also illustrates the differences among the different groups of sellers, particularly in regard to the information variables. While it is true that the proportion of sellers with negative feedback increases as we move through the three groups of sellers, it is also true that the percentage of negative feedback falls. For the group with feedback ratings of less than 40, 8 percent have at least one negative feedback, and on average 1.2 percent of the feedback received by this group is negative. In contrast, among sellers with a feedback rating of greater than 100, 52.2 percent have at least one negative feedback, but on average only .53 percent of feedback is negative. The proportion of goods sold is highest for the group with feedback ratings of less than 40, which may also lend credence to the suggestion that very experienced sellers hold out for higher reserve prices.

The results in Table 4 replace the number of pictures with a dummy variable for including a picture. In column two, the interaction term between negative feedback and the dummy for pictures has a large and statistically significant positive coefficient. In addition, for the low feedback group in column two, the dummy variable for negative feedback is negative and significant.

In column three the dummy for pictures is statistically significant with a large coefficient and the interaction term between negative feedback and accepting credit cards is negative and significant, again with a large coefficient.

VII. Conclusion

This paper estimated the impact of various information signals on the probability of sale and the high bid price for Paul Reed Smith guitars on eBay. This paper is distinct from others that have examined eBay auctions due to the use of high-ticket items that encompass both visual and aural subjectivity to increase the value of information-related items.

The results indicate that some information items, such as pictures, do, in fact, convey valuable information. More importantly, this paper finds that the presence of negative feedback has a large impact on final bid prices, but not in ways that were expected ex ante. This paper has also found that the use of escrow services may actually send a negative signal to prospective buyers. This is particularly true if a seller has negative feedback.

One can think of reasons why negative feedback in this market may not have the expected negative impact on high bid, while having a negative impact on the likelihood of a sale. There are at least two possible explanations for this seemingly contradictory result. The first is the possibility that negative feedback is more likely to occur for those who are active traders on eBay, and thus the presence of negative feedback may not be an immediate cause for alarm. The use of the Chow Breakpoint test seemed to suggest that this was the case. In addition, negative feedback was common for those who were active traders. The decreased likelihood of a sale may reflect more on higher reserve prices for eBay "pros" than a lack of trust in the seller. If this is the case it may be that negative feedback is acting as a proxy for eBay selling experience.

The second possibility is that the decision to bid and the decision on how much to bid are separate. If this is the case, once a bidder has decided to enter an auction they believe that the seller is trustworthy and bid according to that belief (see, for instance, Sweeney et al. (2000)). The fact that negative feedback impacts the likelihood of a sale, but not necessarily the high bid, would support this. Rabin and Schrag (1999) provide evidence of confirmatory bias, which suggests that bidders respond positively to any signal the auction provides about the trustworthiness of the seller.

The market examined may also mitigate the information problem. As previously mentioned, PRS guitars are known for high quality and consistent tonal properties. As a result, the amount of incomplete information in the market may be small, and thus the marginal impact of the information variables may not be large.

There is much room for further work on information signals and auction behavior. Of particular interest in the area of on-line auctions is the extent to which negative feedback related to seller characteristics affects auction outcomes differently than negative feedback related to product characteristics. Additionally, there are functional form issues in the estimation of auction prices that may warrant further study. Finally, issues related to the impact of reputation on the separate decisions to enter an auction and the amount to bid need further study.

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Table 1. Summary Statistics, PRS guitars.

A. General Descriptive Statistics, n = 360.

	High Bid	Credit Card (dummy)	Escrow (dummy)	Feedback (number)	Negative Feedback (dummy)	Negative Feedback (number)	Number of bids	Picture (dummy)
Mean	$1,636.04	0.4753	0.429	108.86	0.179	0.5772	11.3	0.9074
St. Dev.	$699.75	0.5001	0.4957	260.12	0.384	1.73	7.42	0.2903
Median	$1,525.00	0	0	35.00	0	0	10.00	1.0000
Maximum	$7,110.00			2,030.00		16.00	36.00	
Minimum	$555.00			0		0	1.00	

Table 1 (continued)

B. Descriptive Statistics by Feedback Level.
Includes 324 observations used in the estimation of the high bid.

	Feedback<=40			40<Feedback<=100			Feedback>=100		
	Feedback	Negative Feedback	Percentage Negative Feedback	Feedback	Negative Feedback	Percentage Negative Feedback	Feedback	Negative Feedback	Percentage Negative Feedback
Mean	12.38	0.139	7.50%	58.35	0.16	10.80%	410.12	2.18	52.20%
Median	9.00	0.00		55.00	0.00		216.00	1.00	
Maximum	40.00	3.00		97.00	3.00		2,030.00	16.00	
Minimum	0.00	0.00		42.00	0.00		102.00	0.00	
n	172			83			69		

Table 1 (continued).

C. Descriptive Statistics by Model Category

	CE	Custom	McCarty	Single Cut
Mean	$1,047.88	$1,724.58	$1,682.94	$2,243.92
Median	$1,026.00	$1,615.28	$1,512.00	$2,176.00
Maximum	$1,650.00	$6,600.00	$7,110.00	$4,159.00
Minimum	$710.00	$555.00	$900.00	$960.00
Proportion Sold	43.60%	39.63%	26.83%	13.04%
n	55	164	82	23

Table 2: Results on Logit Model for "Good Sold", PRS guitars. (t-statistics in parentheses.)

Variable	Equation 1	Equation 2	Equation 3
Picture (dummy)	-0.3039***	-0.2307	-0.3804***
	(-2.80)	(-1.19)	(-3.28)
Credit Card (dummy)	-0.0854	-0.0784	-0.0082
	(-1.34)	(-0.78)	(-0.10)
Escrow (dummy)	0.0411	0.3556***	-0.0780
	(0.64)	(3.16)	(-0.96)
Feedback	-0.0002*	-0.0066	-0.0001
	(1.90)	(-1.02)	(-0.91)
Negative	-0.4007**	-0.2854	-0.4274*
	(-2.15)	(-0.88)	(-1.92)
CE	0.2487**	0.3162*	0.1000
	(2.09)	(1.68)	(0.64)
Custom	0.2024*	0.3970**	0.1103
	(1.91)	(1.96)	(0.86)
McCarty	0.0759	0.0943	0.0767
	(0.68)	(0.52)	(0.55)
Negative*Picture	0.4154**	0.3568	0.4701**
	(1.99)	(0.77)	(1.98)
Negative*Escrow	0.2926*	0.3961	0.3421*
	(1.77)	(0.68)	(1.92)
Negative*Credit	-0.0714	-0.0293	-0.1386
	(-0.41)	(-0.05)	(-0.74)
Constant	0.5024***	0.3994*	0.5884***
	(3.47)	(1.71)	(3.28)
Mean of Dependent Variable	0.3518	0.4418	0.2923
Log-likelihood	-205.458-74.811	-114.411	
N	324	129	195

*,**, and *** represent significance at the 10, 5 and 1 percent levels, respectively.

Table 3: Results for High Bid for PRS Guitars. Includes measures of negative feedback and pictures measured by number of pictures. (t-statistics in parentheses.)

	Equation			
Variable	1	2	3	4
Constant	1,888.26***	1,913.02***	1,682.54***	1,512.75***
	(12.76)	(9.82)	(6.41)	(4.73)
Credit (dummy)	-2.94	85.96	-16.36	-501.86
	(-0.04)	(0.98)	(-0.16)	(-1.16)
Escrow	9.65	-20.80	166.21	-102.74
	(0.17)	(-0.28)	(1.48)	(-0.59)
Feedback	0.092	2.96	3.50	0.47
	(0.45)	(0.86)	(0.99)	(1.49)
Number of Pictures	41.24**	10.94	20.46	119.99***
	(2.26)	(0.67)	(1.50)	(3.03)
CE	-1,077.16***	- 967.74***	-1,203.84***	-996.60***
	(-8.56)	(-4.66)	(-7.14)	(-4.60)
Custom	-449.80***	-318.12	-557.94***	-98.15
	(-3.51)	(-1.52)	(-4.10)	(-0.38)
McCarty	-461.07***	-389.22*	-589.83***	-190.25
	(-3.32)	(-1.76)	(-3.10)	(-0.62)
Negative (dummy)	187.61	-69.86	349.45	612.33
	(0.90)	(-0.26)	(1.16)	(0.88)
Negative * Credit	-339.31	708.30	-239.60	-577.38
	(-0.89)	(1.22)	(-1.13)	(-0.72)
Negative * Escrow	-366.84	-120.44	-696.21***	-329.55
	(-1.26)	(-0.36)	(-2.56)	(-0.69)
Negative * Number of Pictures	139.53**	33.81	194.47***	76.66
	(2.11)	(0.42)	(5.29)	(0.96)
adj. R-squared	0.3392	0.2706	0.6218	0.3822

*,**, and *** represent significance at the 10, 5 and 1 percent levels, respectively.

Table 4: Results for High Bid for PRS Guitars. Includes measures of negative feedback and pictures measured as dummy variable. (t-statistics in parentheses.)

Variable	Equation 1	2	3	4
Constant	2,137.99***	2,036.28***	1,565.15***	2,091.45***
	(14.36)	(10.33)	(6.31)	(3.84)
Credit (dummy)	77.57	115.25	14.44	-390.55
	(1.22)	(1.61)	(0.15)	(-0.61)
Escrow	-32.77	-28.59	129.49	-125.90
	(-0.53)	(-0.38)	(1.14)	(-0.58)
Feedback	0.135	1.06	2.59	0.55
	(0.66)	(0.32)	(0.75)	(1.39)
Pictures (dummy)	2.45	-82.98	267.53**	517.43
	(0.02)	(-0.74)	(2.38)	(0.90)
CE	-1,244.84***	-968.12***	-1,108.53***	-1,599.89***
	(-9.46)	(-4.76)	(-7.19)	(-5.23)
Custom	-494.79***	-301.12	-530.83***	-295.28
	(-3.71)	(-1.47)	(-3.75)	(-0.85)
McCarty	-563.92***	-366.76*	-600.35***	-103.66**
	(-3.99)	(-1.70)	(-3.25)	(-2.03)
Negative (dummy)	-77.70	-509.22***	213.16	110.81
	(-0.42)	(-3.43)	(1.35)	(0.16)
Negative * Credit	-473.49	621.57	-687.90***	-1,197.80
	(-1.16)	(1.05)	(-5.41)	(-1.08)
Negative * Escrow	-280.23	-240.32	-1,585.81***	-4.62
	(-0.95)	(-0.78)	(-5.41)	(-0.01)
Negative *Picture (Dummy)	1,065.74***	752.90**	1,992.21***	1,139.78
	(2.56)	(2.45)	(6.40)	(1.24)
adj. R-squared	0.2630	0.2870	0.6517	0.2181

*,**, and *** represent significance at the 10, 5 and 1 percent levels, respectively.

Undergraduate Economics Degrees: Trends and Determinants

Thomas G. Watkins*

Abstract

This paper examined the number of undergraduate degrees awarded in economics and business economics between 1989 and 1999 using data from the National Center for Education Statistics. The results showed that the total number of undergraduate degrees in economics and business economics decreased by about 30 percent between 1990 and 1996 before increasing during the latter half of the 1990s. Furthermore, this decrease occurred at both public and private institutions. The paper also employed ordinary least squares to identify factors explaining the variation in the number of economics degrees in 1999 at research, doctoral, master's, selective baccalaureate, and other baccalaureate institutions.

I. Introduction

Throughout much of the 1990s the number of undergraduate degrees in economics decreased sharply and at the same time so did the number of undergraduate degrees in business. Siegfried and Scott (1994), using data from two surveys of colleges and universities, reported that the number of undergraduate degrees in economics increased from 1977-78 to 1987-88, but then decreased in 1992-93. Using a larger sample of public and private colleges and universities, Siegfried (2003) later reported that the number of baccalaureate degrees in economics decreased from a peak of 13,298 in 1991-92 to 9,275 in 1995-96 and then increased to 12,380 in 2001-02 at the sample institutions.

The sharp and prolonged decline in the number of undergraduate degrees in economics concerns economics faculties for at least two reasons. A permanent decrease in the demand for economics courses eventually forces many institutions to reallocate resources, both faculty and otherwise, away from economics departments. Also, as the number of majors decreases, departments are usually forced to make a number of changes in course scheduling, faculty workloads, and the curriculum. In extreme cases the undergraduate degree program may be eliminated.

As a result, several studies have examined the factors explaining the decrease in student interest in the undergraduate economics degree during the early 1990s. Using a cross section sample of public and private institutions, Willis and Pieper (1996) studied the determinants of the number of economics majors in order to test five different hypotheses about the decline in student interest. Their results suggested that the number of economics majors increased with school size, the institution's selectivity in admissions, and the presence

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of a doctoral program in economics, but decreased with the presence of business programs and degrees in business economics. Also, there were significant differences in the number of majors in certain regions.

Using survey results from 200 institutions, Brasfield, Harrison, McCoy, and Milkman (1996) compared the characteristics of 137 institutions experiencing decreasing numbers of degrees to those of the 51 institutions experiencing increasing numbers of degrees between 1989-90 and 1993-94. Their results suggested that the economics degree was a substitute for the business degree when the department did not compete with business programs. Other results showed that private institutions were more likely to lose majors, that larger economics programs were more likely to lose majors, and that programs allowing more electives were more likely to gain majors.

Salemi and Eubanks (1996) used the number of economics degrees awarded at the University of North Carolina-Chapel Hill to study the discouraged-business-major hypothesis. Business programs at many institutions significantly increased admissions requirements when business enrollment boomed in the early 1980s, and the discouraged-business-major hypothesis suggested that discouraged business students turned to the economics major instead. As business enrollments increased, the number of economics degrees increased, and as business enrollments decreased, the number of economics degrees decreased. Their results supported this hypothesis.

Skoorka and Condon (2003) studied the number of economics degrees awarded at 20 New Jersey institutions between 1979 and 2000. The number of undergraduate degrees in economics was related to business conditions and was pro-cyclical. They also found that the number of degrees was positively related to the number of students taking the Graduate Management Admissions Test and the total number of degrees awarded by an institution. The number of degrees was also generally higher at private institutions and at liberal arts institutions.

This paper extends prior study of the number of undergraduate degrees in economics in two ways. First, this paper summarizes the number of undergraduate degrees in economics awarded by most public and private institutions between 1989-90 and 1999-00 using data from the National Center for Education Statistics. The paper therefore provides a more complete analysis of the trends in economics degrees over the period. Second, the paper examines the factors explaining the variation in the number of economics degrees at public and private institutions in 1999 by institutional category.

The remainder of this paper is presented in four sections. In the next section the sample of institutions is described, and the number of economics degrees at different types of institutions over the period is presented in the following section. The statistical model and results are then discussed, and some conclusions are offered in the last section.

II. Sample

Much of the data used in this study was collected from the annual *Completions Survey* that is conducted by the National Center for Education Statistics as part of the Integrated Postsecondary Education Data System. This annual survey asks colleges and universities to report the number of degrees awarded in each major by level and gender. Institutions report only the first major of each student, so the number of reported degrees for any major may be smaller than was true.

Data on the number of economics degrees were collected from the surveys that are available for 1989-90 through 1997-98 and 1999-00. The survey for 1998-99 was not available, and the survey for 1999-00 was the most recent year available. The number of baccalaureate degrees awarded in economics is reported under two codes. One refers to the liberal arts degree (hereafter, economics degree), while the other refers to the business-oriented degree (hereafter, business economics). From these annual surveys data were collected on the institution's characteristics, the institution's number of degrees in each economics code, the institution's total number of degrees in business, and the institution's total number of degrees.

During the period 932 four-year institutions awarded at least one baccalaureate degree in economics. However, 27 of these institutions failed to report degrees in one or more years and were excluded so that the analysis could track the degrees awarded by a consistent group of institutions. The degrees awarded by the remaining 905 institutions represented in excess of 99 percent of the degrees awarded by the population each year. To detect differences due to differences in institutional mission, the Carnegie classification system (1994) in place during most of the period was employed. The sample included the degrees awarded by 121 research institutions, 93 doctoral institutions, 377 master's institutions, 145 selective liberal arts institutions, and 169 other baccalaureate institutions. Of the 905 institutions in the sample, 399 were public institutions.

III. Trends in Undergraduate Degrees

This section examines the number of economics degrees and business economics degrees awarded between 1989-90 and 1999-00 at both public and private institutions in each Carnegie classification, the percentage of total baccalaureate degrees awarded in economics and business economics, and other summary statistics. The discussion and tables will hereafter use the initial year of the academic year to describe the year.

Table 1 summarizes the total number of degrees, the percentages of total degrees awarded in economics and business economics, and the percentage of the total degrees awarded to females by the 905 institutions in the sample. The total number of degrees increased from 26,540 in 1989 to a peak of 26,748 in 1991, decreased to 18,830 in 1996, and then increased to 21,009 in 1999. From peak to trough the number of baccalaureate degrees decreased by nearly 30 percent, while over the period as a whole the number of baccalaureate degrees decreased by slightly more 20 percent. The percentage of degrees awarded to females decreased from 32.2 percent in 1989 to 30.3 percent in 1993, and then increased to 34.1 percent in 1999.

Table 1 also shows the number of degrees in economics and business economics. In 1989 23,096 economics degrees were awarded, representing 87 percent of the total baccalaureate degrees. This percentage fell to 84.9 percent in 1993 and then increased to 86 percent in 1999. While the business economics degree was certainty less popular over the period, its popularity increased slightly. Business economics as a percentage of total degrees increased from 13 percent in 1989 to 15.1% in 1993 and then decreased to 14.1 percent in 1999.

The annual number of degrees awarded at public institutions and the percentage of total degrees awarded at public institutions are shown by Carnegie classification in Table 2. The average full-time equivalent (FTE) enrollment for all years except 1999[1] and the average annual growth rate of each degree over the period are also reported for each type of institution.[2] The 84 research institutions, which had the highest average FTE enrollment, awarded the majority of economics degrees at public institutions over the period. These institutions produced 64 percent of degrees awarded in 1989 and 65.5 percent of the degrees in 1999. Doctoral institutions, which had the second highest average FTE enrollment, awarded far fewer degrees than research institutions. They produced 11.8 percent of the total degrees awarded in 1989 and 10.3 percent in 1999. The 222 master's institutions, which on average had the third highest average FTE enrollment, were the second most important source of economics degrees over the period, producing 22.5 percent of the total degrees in 1989 and 21.9 percent in 1999. The six selective liberal arts institutions, which had the lowest average FTE enrollment, produced only 1.2 percent of the total degrees in 1989 and only 1.4 percent in 1999, while other baccalaureate institutions awarded less one percent of the degrees in 1989 and in 1999.

For each category of public institution, the annual number of economics degrees far exceeded the annual number of business economics degrees. Over the entire period, the number of economics degrees decreased sharply at research, doctoral, and master's institutions, increased slightly at selective liberal arts institutions, and remained the same at other baccalaureate institutions. On the other hand, the number of business economics degrees awarded in 1999 was greater than the number awarded in 1989 at research, doctoral, and other baccalaureate institutions, but was less than the number awarded in 1989 at master's and selective liberal arts institutions.

Table 2 also shows the average number of degrees per public institution. The highest average number of degrees occurred at research institutions and the lowest occurred at other

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[1] Enrollment data were not available for the 1999 – 2000 academic year.

[2] The average annual growth rate in the number of degrees was estimated for each institutional category by regressing the natural logarithm of the number of degrees on time. If the coefficient was not significantly different from zero, the reported growth rate is zero.

baccalaureate institutions. Also, the average number per institution at doctoral, master's, and selective liberal arts institutions were sharply below those of research institutions.

Similar information is shown for private institutions in each Carnegie classification in Table 3. If the total numbers of degrees in economics at public and private institutions are compared in each year, then public institutions awarded more degrees than private institutions. However, while public institutions awarded about 62.5 percent of the total degrees awarded at all institutions in 1989, they awarded only 56.7 percent of the total in 1999. The decline in student interest in economics was more pronounced over the period at public institutions than at private institutions.

Among private institutions, research institutions, which had the highest average FTE enrollment, awarded 33.4 percent of the degrees awarded in 1989 and 39.6 percent in 1999. Doctoral institutions, which had the second highest average FTE enrollment, awarded far fewer degrees than the research institutions, awarding 10.6 percent in 1989 and just 8.6 percent in 1999. The 155 master's institutions, which had the third highest average FTE enrollment, awarded 15.4 percent of the degrees at private institutions in 1989, but only 9.3 percent in 1999. Selective liberal arts institutions, which had the second lowest FTE enrollment, awarded 35.5 percent of the degrees in 1989 and 35.9 percent in 1999. Other baccalaureate institutions produced relatively few degrees over the period. They produced about 5 percent of the degrees in 1989 and 6.7 percent in 1999.

For all private institutions except other baccalaureate institutions the economics degree was significantly more popular than the business economics degree. The number of economics degrees awarded in 1999 was less than the number awarded in 1989 for each category of private institutions except research institutions. After a sharp decline in the number of economics degrees between 1989 and 1994, research institutions produced more economics degrees in 1999 than in 1989. The number of business economics degrees awarded in 1999 was less than the number awarded in 1989 for each category of private institutions except other baccalaureate institutions. Other baccalaureate institutions produced about twice as many business economics degrees in 1999 than they did in 1989.

Like public institutions, private research institutions awarded significantly more degrees per institution than the other private institutions. Doctoral and selective liberal arts institutions awarded significantly more degrees per institution than master's and other baccalaureate institutions.

IV. Statistical Model and Results

This section discusses the model that was estimated to explain the variation in the number of economics degrees awarded in 1999 at research, doctoral, master's, selective baccalaureate, and other baccalaureate institutions. As the last section illustrated, the economics degree was more popular than the business economics degree at both public and private institutions. The extent of substitutability between the two degrees can be estimated by using the number of economics degrees as the dependent variable, so this variable, rather than total degrees, was used.

Prior research suggests that a number of independent variables explain the variation in the number of economics degrees. Since prior research found a positive relationship between the number of undergraduate degrees and the size of the institution, the size of the institution was measured using the annual total number of baccalaureate degrees awarded in all fields. The annual percentage of total baccalaureate degrees awarded in business areas other than economics was included, since prior studies suggested the two degrees are substitutes. The annual number of business economics degrees was included to measure the relationship between the two undergraduate degrees in economics. The percentage of statewide employment in the finance, real estate, and insurance industries was included, since prior research found a positive relationship between this variable and the number of economics degrees. This variable is intended to measure student expectations regarding employment opportunities in occupations closely related to economics. The number of doctoral degrees awarded in economics by the institution each year was included in the models for research and doctoral institutions, since prior research found that institutions with doctoral programs generally have more economics majors. For a similar reason the number of master’s degrees awarded in economics by the institution each year was also included.

Several dummy variables were also defined to distinguish institutional characteristics or location. Control assumed a value of one if the institution was private and a value of zero if the institution was public. Regional dummies for the eight Bureau of Economic Analysis regions were also defined, but they failed to detect significant differences.

Economic theory also suggests that the expected wage paid in occupations closely related to the economics degree relative to the wages in other occupations is an important factor in the choice of major. Unfortunately, data to measure relative wages are not available. Walstad (1996) also recommends variables that reflect how students choose a major should be defined and measured, but data have not yet been collected to measure these variables.

Using ordinary least squares, separate models were estimated for research, doctoral, master’s, selective baccalaureate, and other baccalaureate institutions using the number of economics degrees awarded in 1999, since the descriptive statistics presented in the last section suggested that the different categories of institutions were different populations. Also, a Chow test was conducted to test the hypothesis that the different institutional categories were part of the same population, and this hypothesis was rejected at the 1 percent level. Outliers in each model were identified and excluded and the Huber/White consistent estimator of variance was estimated and used for statistical inference.

Table 4 shows the estimated coefficients and Huber/White consistent standard errors directly below the coefficients for each institutional category. For research institutions the coefficient on the total number of degrees was positive and significant at the 1 percent level, suggesting that the number of economics degrees increased with the size of the research institution. The percentage of total degrees awarded in business areas other than economics was negative and significant at the 5 percent level. The elasticity between the number of economics degrees and the percentage of total degrees in business, evaluated at the mean values of the two variables, was - .67, which suggests that the two degrees were substitutes at research institutions. The number of business economics degrees was negative and significant at the 5 percent level. The elasticity between the two economics degrees programs, evaluated at the means, was - .03, suggesting that the two economics degrees were weak substitutes. The number of doctoral degrees was positive and significant, while the coefficients on the percentage of statewide employment in finance, real estate, and insurance and the control dummy variable were not significant at research institutions.

For doctoral institutions the total number of degrees was positive and significant at the 10 percent level, the number of business economics degrees was negative and significant at the 5 percent level, and the number of doctoral degrees was positive and significant at the 10 percent level. At the mean values of the variables the elasticity between the number of economics degrees and the number of business economics degrees was - .15. The percentage of total degrees in business areas other than economics was negative at doctoral institution, but not significant. The percentage of statewide employment in finance, real estate, and insurance was positive and insignificant, while the control dummy variable was positive and insignificant.

At master's institutions the total number of degrees was positive and significant at the 1 percent level, while the percentage of total degrees in business other than economics was negative and significant at the 5 percent level. The elasticity of demand between the number of economics degrees and the percentage of total baccalaureate degrees awarded in business areas other than economics, computed at the mean values of the two variables, was -.3. Also, the number of economics degrees was negatively and significantly related to the number of business economics degrees. The estimated elasticity at the mean values of these two variables was only -.06. The percentage of statewide employment in the finance, insurance, and real estate industries was positive and significant at the 1 percent level. For master's institutions the number of master's degrees replaced the number of doctoral degrees, and this variable was positive but insignificant. The control dummy variable was also insignificant at master's institutions.

After a few outliers were excluded from the sample of selective baccalaureate institutions, none of the remaining institutions awarded business economics degrees or master's degrees in 1999. The estimated model for these institutions therefore had only four explanatory variables. Once again, the total number of degrees was positive and significant at the 1 percent level and the percentage of total degrees in business areas other than economics was negative and significant. The estimated elasticity between the number of economics degrees and the percentage of total degrees in business was - .44. The percentage of statewide employment in finance, real estate, and insurance and the control dummy variable were not significant.

Like selective baccalaureate institutions, none of the other baccalaureate institutions in the sample awarded business economics degrees or master's degrees in 1999. The total number of degrees was positive and significant at the 1 percent level and the percentage of total degrees in business was negative and significant at the 5 percent level. The elasticity between the number of economics degrees and the percentage of total degrees in business was - .58. The remaining two variables were not significantly different from zero.

V. Conclusion

During the 1990s student interest in the undergraduate economics degrees decreased significantly. While the number of undergraduate degrees decreased at both public and private institutions across all Carnegie classifications, the decrease was more significant at public institutions. This was especially true at the public research institutions, which awarded more undergraduate degrees in economics than any other institutional category between 1989 and 1999.

The economics degree was more popular than the business economics degree during the 1990s for most institutions, but both degrees decreased during the early 1990s. The average annual rate of growth between 1989 and 1999 was significantly negative for the economics degree at all institutions, except public selective liberal arts institutions, public other baccalaureate institutions, and private research institutions. On the other hand, the average annual rate of growth over the same time period was significantly negative for the business economics degree for all institutional categories, except public research institutions, public doctoral institutions, public other baccalaureate institutions, and private other baccalaureate institutions.

Since the number of economics degrees is very different across institutional categories, ordinary least squares was employed to explain the variation in the number of economics degrees in 1999 for each institutional category. The results suggested that the number of economics degrees was positively related to the size of the institution for all institutional categories. The number of economics degrees was also positively related to the number of doctoral degrees awarded by research and doctoral institutions. The number of economics degrees was also positively related to the percentage of statewide employment in finance, real estate, and insurance for all institutional categories, but was only significant for master's institutions. The number of economics degrees was negatively related to the percentage of total degrees awarded in business areas other than economics and significant for all institutional categories except doctoral institutions. The number of economics degrees was negatively related to the number of degrees awarded in business economics and significant at research, doctoral, and master's institutions.

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Table 1. Total Baccalaureate Degrees in Economics

		1989	1990	1991	1992	1993	1994	1995	1996	1997	1999
Economics	Number	23,096	23,275	23,047	20,939	19,044	17,306	16,289	16,181	16,671	18,075
	% of Total	87.0%	87.0%	86.2%	85.2%	84.9%	85.6%	85.9%	85.9%	85.9%	86.0%
Business Economics	Number	3,444	3,470	3,701	3,636	3,394	2,914	2,683	2,649	2,741	2,934
	% of Total	13.0%	13.0%	13.8%	14.8%	15.1%	14.4%	14.1%	14.1%	14.1%	14.0%
Total	Number	26,540	26,745	26,748	24,575	22,438	20,220	18,972	18,830	19,412	21,009
	% Female	32.2%	31.0%	30.8%	30.6%	30.3%	32.0%	31.0%	32.0%		34.1%

Note: Missing data by gender in 1997-98 make it impossible to compute percentage of females.

Table 2. Total Baccalaureate Degrees in Economics and the Average Number of Degrees per Institution at Public Institutions.

Classification	N	Degree	1989	1990	1991	1992	1993	1994	1995	1996	1997	1999	Growth Rate
Research	84	Economics	9,607	9,177	8,962	7,962	6,993	6,074	5,540	5,502	5,871	6,583	-5.60%
		% of Total	57.9%	55.5%	54.3%	52.2%	50.4%	50.0%	49.8%	51.5%	53.1%	55.3%	
		Business Economics	995	883	1,041	1,072	1,064	988	998	897	1,051	1,210	0.00%
		% of Total	6.0%	5.3%	6.3%	7.0%	7.7%	8.1%	9.0%	8.4%	9.5%	10.2%	
		Average	126.21	119.76	119.08	107.55	95.92	84.07	77.83	76.18	82.40	92.77	
		Average FTEs	21,475	21,789	21,856	21,702	21,513	21,469	21,560	21,612	21,887		
Doctoral	61	Economics	1,760	1,877	1,795	1,652	1,491	1,302	1,184	1,004	1,004	993	-7.70%
		% of Total	10.6%	11.4%	10.9%	10.8%	10.8%	10.7%	10.6%	9.4%	9.1%	8.3%	
		Business Economics	197	198	213	222	224	197	177	176	177	238	0.00%
		% of Total	1.2%	1.2%	1.3%	1.5%	1.6%	1.6%	1.6%	1.6%	1.6%	2.0%	
		Average	32.08	34.02	32.92	30.72	28.11	24.57	22.31	19.34	19.36	20.18	
		Average FTEs	11,451	11,704	11,843	11,811	11,693	11,652	11,713	11,678	11,730		
Master's	222	Economics	2,899	3,092	3,225	3,030	2,912	2,646	2,358	2,236	2,112	2,083	-4.75%
		% of Total	17.5%	18.7%	19.6%	19.9%	21.0%	21.8%	21.2%	20.9%	19.1%	17.5%	
		Business Economics	841	990	931	994	866	712	618	593	581	527	-6.77%
		% of Total	5.1%	6.0%	5.6%	6.5%	6.2%	5.9%	5.6%	5.6%	5.3%	4.4%	
		Average	16.85	18.39	18.72	18.13	17.02	15.13	13.41	12.74	12.13	11.76	
		Average FTEs	6,903	7,198	7,312	7,314	7,229	7,168	7,148	7,174	7,233		
Selective	6	Economics	147	163	181	152	162	122	131	137	150	162	0.00%
Liberal Arts		% of Total	0.9%	1.0%	1.1%	1.0%	1.2%	1.0%	1.2%	1.3%	1.4%	1.4%	
		Business Economics	58	54	37	29	17	2	1	2	0	0	
		% of Total	0.3%	0.3%	0.2%	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	-62.80%
		Average	34.17	36.17	36.33	30.17	29.83	20.67	22.00	23.17	25.00	27.00	
		Average FTEs	2,402	2,476	2,423	2,433	2,435	2,434	2,493	2,536	2,599		
Other	26	Economics	92	85	102	97	102	100	105	113	85	91	0.00%
Baccalaureate		% of Total	0.6%	0.5%	0.6%	0.6%	0.7%	0.8%	0.9%	1.1%	0.8%	0.8%	
		Business Economics	6	10	9	34	31	12	21	20	28	17	0.00%
		% of Total	0.0%	0.1%	0.1%	0.2%	0.2%	0.1%	0.2%	0.2%	0.3%	0.1%	
		Average	3.77	3.65	4.27	5.04	5.12	4.31	4.85	5.12	4.35	4.15	
		Average FTEs	3,055	3,214	3,275	3,325	3,332	3,313	3,243	3,229	3,249		
Total	399		16,602	16,529	16,496	15,244	13,862	12,155	11,133	10,680	11,059	11,904	

Note: If the estimated growth rate was not significantly different from zero, the growth rate is reported as zero.

Table 3. Total Baccalaureate Degrees in Economics and the Average Number per Institution at Private Institutions.

Classification	N	Degree	1989	1990	1991	1992	1993	1994	1995	1996	1997	1999	Growth Rate
Research	37	Economics	3,152	3,106	3,001	2,872	2,680	2,622	2,706	2,872	3,132	3,456	0.00%
		% of Total	31.7%	30.4%	29.3%	30.8%	31.3%	32.5%	34.5%	35.2%	37.5%	38.0%	
		Business Economics	170	186	184	164	140	127	98	97	108	144	-5.44%
		% of Total	1.7%	1.8%	1.8%	1.8%	1.6%	1.6%	1.3%	1.2%	1.3%	1.6%	
		Average	89.78	88.97	86.08	82.05	76.22	74.30	75.78	80.24	87.57	97.30	
		Average FTEs	11,327	11,368	11,598	11,626	11,614	11,696	11,772	11,781	11,886		
Doctoral	32	Economics	879	908	926	843	681	635	591	623	624	689	-4.35%
		% of Total	8.8%	8.9%	9.0%	9.0%	7.9%	7.9%	7.5%	7.6%	7.5%	7.6%	
		Business Economics	181	188	162	133	120	108	80	84	112	91	-8.30%
		% of Total	1.8%	1.8%	1.6%	1.4%	1.4%	1.3%	1.0%	1.0%	1.3%	1.0%	
		Average	33.13	34.25	34.00	30.50	25.03	23.22	20.97	22.09	23.00	24.38	
		Average FTEs	6,580	6,706	6,753	6,739	6,705	6,726	6,696	6,722	6,806		
Master's	155	Economics	983	1012	974	863	812	827	691	642	633	633	-5.65%
		% of Total	9.9%	9.9%	9.5%	9.2%	9.5%	10.3%	8.8%	7.9%	7.6%	7.0%	
		Business Economics	544	504	508	416	451	247	201	207	208	210	-12.38%
		% of Total	5.5%	4.9%	5.0%	4.5%	5.3%	3.1%	2.6%	2.5%	2.5%	2.3%	
		Average	9.85	9.78	9.56	8.25	8.15	6.93	5.75	5.48	5.43	5.44	
		Average FTEs	2,670	2,741	2,770	2,807	2,798	2,816	2,868	2,884	2,896		
Selective	139	Economics	3,252	3,462	3,401	3,085	2,834	2,701	2,730	2,830	2,855	3,118	-1.62%
Liberal Arts		% of Total	32.7%	33.9%	33.2%	33.1%	33.0%	33.5%	34.8%	34.7%	34.2%	34.2%	
		Business Economics	276	250	189	203	157	139	135	145	152	151	-6.40%
		% of Total	2.8%	2.4%	1.8%	2.2%	1.8%	1.7%	1.7%	1.8%	1.8%	1.7%	
		Average	25.38	26.71	25.83	23.65	21.52	20.43	20.61	21.40	21.63	23.52	
		Average FTEs	1,590	1,592	1,582	1,570	1,573	1,572	1,587	1,596	1,616		
Other	143	Economics	325	393	480	383	377	277	253	222	205	267	-6.50%
Baccalaureate		% of Total	3.3%	3.8%	4.7%	4.1%	4.4%	3.4%	3.2%	2.7%	2.5%	2.9%	
		Business Economics	176	207	427	369	324	382	354	428	324	346	
		% of Total	1.8%	2.0%	4.2%	4.0%	3.8%	4.7%	4.5%	5.3%	3.9%	3.8%	5.09%
		Average	3.50	4.20	6.34	5.26	4.90	4.61	4.24	4.55	3.70	4.29	
		Average FTEs	1,146	1,187	1,205	1,253	1,272	1,295	1,318	1,350	1,373		
Total Degrees	506		9,938	10,216	10,252	9,331	8,576	8,065	7,839	8,150	8,353	9,105	

Table 4. Cross-section analysis of the number of economics degrees by institutional category.

Dependent variable: Annual number of economics degrees at each institution

Independent Variable	Research Coefficient standard error	Doctoral Coefficient standard error	Master's Coefficient standard error	Selective Baccalaureate Coefficient standard error	Other Baccalaureate Coefficient standard error
Total baccalaureate	0.018	0.005	0.007	0.063	0.006
degrees	0.004	0.003	0.001	0.011	0.002
Percent business	-369.994	-7.175	-11.638	-111.844	-5.858
degrees	92.362	20.651	5.236	13.587	2.295
Business economics	-0.905	-0.563	-0.467		
degrees	0.403	0.278	0.175		
Percent employment	59.389	197.663	121.559	82.074	25.326
in FIRE	286.591	138.534	46.690	100.176	24.754
Total doctoral degrees	4.541	3.524			
	0.873	1.790			
Total master's degrees			0.787		
			0.568		
Control	11.345	3.870	-0.475	-4.333	0.069
	12.357	4.924	1.090	8.404	1.010
Constant	44.084	-8.848	-5.202	8.265	0.143
	29.199	9.033	2.909	11.186	2.268
n	112	80	312	132	122
R-Bar Squared	0.594	0.223	0.343	0.495	0.106

The Environmental Quality Incentives Program In Kentucky: Does It Address Environmental Quality Problems?

Angelos Pagoulatos and Ronald A. Fleming*

Abstract

The ability of Kentucky's EQIP program to address important natural resource quality problems is investigated by estimating a set of endogenous equations representing total county EQIP applications, resulting EQIP funding, and environmental quality concerns. This system was estimated using 2SLS where the dependent variables follow a Poisson distribution. Only the county animal waste concern ranking was consistent with the actual measure of animal waste for each county, but generated the least applications for cost share funding and received the least funding. Effectiveness of the EQIP program can be improved by decreasing its reliance on the ranking of local environmental concerns.

I. Introduction

Large amounts of money are spent by federal and state agencies within many states on programs designed to improve environmental quality. One program, called the Environmental Quality Incentives Program (EQIP), was established as part of the 1996 Farm Bill [also known as Public Law No. 104-127, or the Federal Agricultural Improvement and Reform Act of 1996 (see the National Agricultural Law Center)]. Section 334 of this act established the program. EQIP was the result of an effort to improve the performance of the Agricultural Conservation Program (ACP) in targeting watersheds and regions and to encourage farmers/rancher to adopt practices that reduce environmental and resources problems. EQIP, administered by USDA Natural Resources Conservation Service (NRCS), provides money to reduce soil erosion, improve water quality and related natural resource concerns in watersheds, regions, or areas of special environmental sensitivity. Cost-share money (up to 75 percent of the project cost) is granted to producers as an incentive to adopt best management practices (BMPs) that reduce environmental and resource problems (ERS NRCS 2000). EQIP funds are also used for providing education and technical assistance (Section 334 of H.R. 2854).

The purpose of this study is to evaluate the effectiveness of the EQIP program in addressing natural resource problems in Kentucky, a state that has substantial natural resource quality problems. Given the voluntary nature of the participation of farmers in the program, it is conceivable that EQIP is addressing priorities for environmental improvements

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in only a limited way. We attempt to determine if the money was spent instead to address natural resource quality problems that were perceived to be important at the local level as required by the "bottoms-up" approach of the EQIP program. If EQIP expenditures in a county are aligned more closely with perceived problems and perceptions, then these local perceptions must closely match real natural resource quality problems before EQIP can show that they are addressing key environmental and resource problems. How money is allocated is an indicator of revealed priorities.

A complicating factor in this study is that program expenditure data collected by NRCS is aggregated and is not tied to a particular environmental category. Expenditures on "popular" environmental problems could be wasted if the problem addressed comes from a priority ranking of concerns at the local level and does not correlate with actual environmental quality indicators. Furthermore, total aid is fixed, thus aid to one county may mean no aid to another county. Counties with actual problems where expenditures can have the greatest impact may not receive aid.

There are two levels of choice. The first level of choice is made by the farmers when they apply for an environmental project cost share. At this level the amount of money spent and environmental projects financed at the county level predetermines the second level of decision-making. The second level of decision-making is where EQIP can only choose from this set of applications and apply priority considerations in further limiting which of the farmer applications merit the allocation of funds.

A few studies have attempted through benefit-cost analysis to examine the balance between value gained and resources committed to water quality protection (Freeman 1982, Hahn 1994). When information on benefits has been difficult to obtain, cost-effectiveness has been used to evaluate costs per unit of pollution avoided (Fraas and Mumley, 1989). Given that the marginal cost of improving some resource and environmental problems is higher than others, it cannot follow that more money allocated to a given problem equates with a greater quality improvement. A simple comparison between expenditure and resource and environmental problems can only show that some problems are targeted rather than others. Thus, it is common to judge a pollution control regulatory program for its effectiveness rather than its efficiency, (Davies and Mazurek, 1998, Weiss, 1972). Effectiveness in this context refers to whether the program is accomplishing the objectives specified in legislation and regulation (Rossi, 1993).

It is possible to accomplish all the objectives but still have a deterioration in the resource and environmental quality simply because the program was not targeting the most important problems (Hahn, 1994, NAPA, 1995, Wholey et al., 1973). Park and Monteith (1989) evaluated the cost-effectiveness of the variable cost-share option versus the uniform cost share in the Agricultural Conservation Program (ACP) during the mid 1980s in West Tennessee. They concluded that the variable cost-share option was less cost-effective than the uniform cost-sharing approach in targeting highly erodible watersheds. The erodible lands required much higher total costs per acre for the BMPs.

Several studies examined the potential reduction in environmental program costs through use of incentive based policies and alternative policy approaches concluding that gains from trading and banking of marketable permit systems are significant (Carlin 1992, Rubin and Kling 1993) A subsidy based on the observed level of environmental quality, rather than emissions, can induce efficient abatement (as well as entry/exit behavior) on the part of non-point polluters (Segerson, 1988). Subsidies to induce adoption of best management practices have been the general policy approach to agricultural non point source pollution (Cook 1985, Reichelderfer 1990, Rubin and Kling 1993).

In this study, we specify a set of endogenous equations representing total county applications for the EQIP program and resulting EQIP funding and a set of equations representing environmental quality. The environmental variables of choice include county ranking of concerns related to animal waste management, soil erosion, water quality, and wildlife management that are targeted by EQIP. The endogenous aspect of the model is best described as follows. Funding increases with the number of applications, but larger funding levels generate more applications. However, the primary focus is the extent to which environmental concerns determine EQIP applications and funding given that county leaders have expressed their county constituent's interest in environmental concerns by ranking the importance of these and other non-environmental concerns. Thus, this research evaluates whether rankings of environmental concerns match actual environmental problems. To the extent that EQIP relies on these rankings, the EQIP program will be effective if these rankings match actual environmental problems. Furthermore, EQIP funding applications and actual expenditures are examined to determine whether, in general, funding can be found to match priority environmental concerns within a county.

II. The EQIP Program

EQIP is designed to be a bottoms-up program in which the local entities within each state decide on the ranking of environmental concerns that define “priority areas” and that focus on watersheds, regions, or areas of special environmental sensitivity. The range of EQIP targets include erosion, animal waste management, water quality and wildlife management.

All farmers in the state of Kentucky are required to file an environmental plan with the state and are required to choose from a list of approved BMPs (Best Management Practices) which also meet requirements for participation in some federal agricultural programs (Claasen et al., 2004). Because smaller farms and animal operations are included in the new USDA/EPA regulations, waste management costs can be reduced through EQIP. Large animal feeding in confinement operations may not use cost-share money to construct animal waste management facilities.

Prior to the 2002 Farm Bill, EQIP funds could be used either in “priority areas” or on a statewide basis. States were instructed to use at least 65% of their funds in priority areas. These areas were generally identified on a watershed basis and encompassed parts of one or more counties. The 2002 Farm Bill eliminated the required use of priority areas (Farm Security and Rural Investment Act of 2002).

During the period 2000-2002, Kentucky funded all of its priority areas. Just because a priority area was funded does not mean that every farmer application, or even every county in that area, received funding. During this period, 2,675 applications for federal cost-share funds were received totaling about $24 million. About 750 of these applications were funded with a total allocation of approximately $9.6 million. Technical assistance by NRCS over the period 2000-2002 was directed toward implementing and maintaining approved BMPs including livestock manure storage systems, livestock watering stations, filter strips, riparian buffers and fencing, wildlife plots, grassland restoration, and soil erosion control systems.

III. The Data

This investigation develops an empirical model of EQIP funding based on logical propositions and understanding of the EQIP program. We posit that EQIP expenditures in a county depend upon the demand for EQIP services measured by farmer applications for EQIP funds. But even if there are a number of applications, no EQIP funds will be transferred to farmers unless they live in an area with an identified environmental problem. Here, environmental problems ineligible for EQIP funding are determined by local consensus (via a ranking of concerns). Thus, EQIP expenditures, EQIP applications, and perceived environmental conditions are correlated or endogenous. An increase in the number of applications increases the likelihood of funding, and at the same time an increase in funding increases the number of applications. Both funding and applications depend on the presence of a higher-ranked environmental problem in that county.

A system of equations (developed below) is used to estimate the relationship between EQIP expenditures, EQIP applications, and perception of local environmental quality. Four variables are included to measure the perception of local environmental quality in animal waste management, soil erosion, local water, and wildlife habitat management. Thus we estimate a system of six equations using two-stage least squares where: AWR is animal waste ranking, SER is soil erosion ranking, WQR is water quality ranking, WMR is wildlife management ranking, TA is total applications, and EF is EQIP funding for each of the 120 Kentucky counties. The term “ranking” in the definitions for AWR, SER, WQR, and WMR measures local perception as to the importance of this environmental variable among all relevant environmental variables in a county.

The data for this investigation are obtained from the USDA - NRCS, USDA Soil Conservation Service (SCS), USDA Economic Research Service (ERS), USDA National Agricultural Statistics Service (NASS), the US Census Bureau, the Kentucky Department of Fish and Wildlife, the Kentucky Department of Mines, and the University of Kentucky Extension Service. Data were obtained for all 120 Kentucky counties. Most of the data represent a point in time (e.g., the 2000 census or the 2002 Census of Agriculture). The data for total applications (TA) and total funding (EF) are the sum of values from the years 2000 to 2002.

The Commonwealth of Kentucky exhibits great variation in geographic and socio-economic variables from north to south, and east to west. Thus, all estimated equations include an identical set of dummy variables that represent location within Kentucky. Local EQIP program responsibilities are administered at the county or NRCS Resource Conservation and Development Area (RCDA) level. In Kentucky there are 14 RCDAs and for each RCDA a dummy (or binary) variable was created. For example, the variable RCDA01 represents the Jackson RCDA in far western Kentucky. If a county resides in the Jackson RCDA, then the variable RCDA01 retains the value of 1 and is 0 otherwise.

In 2000, the Kentucky Division of Conservation with the aid of the State office of the NRCS conducted a county level environmental concerns survey to gauge priority concerns and assist in setting statewide priorities for EQIP (Coleman, 2001). "Blue Ribbon" panels comprised of local government, business owners, extension agents, and other civic leaders were asked to rank concerns within their county. The list of concerns was diverse and included topics related to environmental quality, flooding, land use, and economic development.

The Blue Ribbon Panels were given little guidance, thus some counties ranked concerns for specific locations within the county in addition to the "county-wide" concerns desired. As a result some counties ranked as few as twelve concerns while others ranked as many as fifty two with-in county and county-wide concerns. Only the county-wide concerns were included in this study. Because not all counties provided a ranking for all possible county-wide concerns, a value of 0 was assigned to all concerns that were not ranked for that county. Also, the variable RMax was added to the data set (as an exogenous variable) to control for the total number of with-in county and county-wide concerns ranked by each county. The logic behind RMax is that being ranked first out of four concerns is less meaningful than being ranked first out of fifty concerns. Finally, the set of all possible county-wide concerns was reduced to those targeted by the EQIP program, specifically, AWR, SER, WQR, and WMR.

Because AWR, SER, WQR, and WMR are rankings, these variables are endogenous. For example, if AWR is ranked the top concern, then SER, WQR, and WMR cannot be the top concern and if AWR and SER are ranked first and second, then WQR or WMR can only be ranked third. Furthermore, care must be exercised when interpreting model results. Given that the values contained in AWR, SER, WQR, and WMR are rankings, a smaller number indicates a higher ranking while a larger number indicates a lower ranking.

IV. The Model

What follows is a detailed description of each equation. Variable descriptions and parameter assignments are provided in Table 1. In Equations 1 through 6 (and Table 1) the symbol δ is used to identify the parameter estimates of endogenous variables and the symbol β is used to identify the parameter estimates of exogenous variables. Additionally, the first digit of the parameter subscript identifies the equation number.

Equation 1 is used to estimate the relationship between the endogenous and exogenous variables and animal waste management ranking (AWR). The variables Manure and PSYAWM are included to measure the extent to which actual environmental measures correlate with or relate to local county perception of environmental quality (in this case AWR). The variable Manure measures the quantity of manure produced by county grown livestock in pounds. The variable PSYAWM measures the percent of time that NRCS staff spent on animal waste management issues in the county.

The higher the amount of Manure produced and/or the percent of a NRCS staff year devoted to animal waste issues (PSYAWM), the greater is the likelihood that animal waste management issues are a concern in the county. However, actual presence of a concern does not guarantee that county leaders recognized the concern when they established their priority ranking. Thus, it is not possible to state a priori if AWR is correlated with Manure and (or) PSYAWM and, if correlated, the nature of the relationship. It is desirable, however, that AWR be negatively correlated with Manure and (or) PSYAWM (remember that a decrease in ranking number means that the issue is of a higher priority). Such a correlation would indicate that county leaders are cognizant of animal waste management issues in their county.

The variable RMax is included in Equation 1 to control for the total number of total concerns ranked by each county. Including RMax allows one to test if ranking a larger number of concerns increases the ranking of animal waste concerns.

Past studies have suggested that as income increases, the demand for environmental quality increases through an income effect, and that public and private resources available for environmental improvement and clean-up increase as well (Hilton and Levinson, 1998, Seldon and Song, 1994, 2003, Harbaugh et al, 2002). We use county median income (Inc) to test for increased demand for environmental quality (here AWR) where the demand for environmental quality is expressed as an increase in ranking of an environmental concern.

Kentucky counties have a large variation in size. Thus, the size of each county (Mi^2, in square miles) is used as an indicator variable. The variables unemployment (UnEmp), percent of population over 60 (% Over) and percent female head of households (F) in the county are also included as indicator variables. When county unemployment (UnEmp) is high, it is reasonable to expect that county leaders will respond to the needs of their unemployed constituents by promoting economic development. In such cases, environmental variables will be rated lower (or as less important). A higher proportion of individuals over 60 in a county could indicate a higher regard for environmental causes due to health and lifestyle factors.

County aggregate farm acres (FAc) are included to indicate the extent to which farm production is correlated with perception of environmental quality. County leaders who may or may not be involved in agriculture established the surveyed rankings. From the perspective of county leaders it is anticipated that more farm acres will increase the ranking of agriculture-related environmental concerns.

Resource limited farms (RLF) are typically smaller farms that have limited access to capital or other resources that can be used to improve the farm business. In Kentucky, resource limited farms tend to be minority owned. The relationship between environmental ranking and RLF is difficult to determine a priori. In some cases county leaders are simply not cognizant of resource limited farms in their county. In other cases, much political goodwill is extended to these farms. Thus, the relationship between RLF and environmental ranking depends on the extent to which county leaders viewed resource limited farms as having an impact on the environment.

The final 13 variables included in Equation 1 account for spatial or location specific differences across the state. As discussed above there are 14 RCDA's in Kentucky and each represents a unique area of the state. Note that the RCDA for region 6 (the Eagle district or RCDA06) is excluded from the analysis to avoid perfect collinearity between the included group of RCDA dummy variables and the intercept term. RCDA06 was chosen for exclusion because it is adjacent to major metropolitan counties that are not included in a RCDA (i.e., Jefferson, Boone, Kenton, and Campbell counties). The purpose of the RCDA dummy variables is to "absorb" some of the variation in the dependent variable (here AWR) due to differences in location. The error term for Equation 1 is represented by $e_{1,1}$.

Equation 1. Animal Waste Management Ranking

$$
\begin{aligned}
AWR_i = \; & \delta_{12}SER_i + \delta_{13}WQR_i + \delta_{14}WMR_i + \delta_{15}TA_i + \delta_{16}EF_i + \\
& \beta_{100} + \beta_{101}RMax_i + \beta_{102}Inc_i + \beta_{104}UnEmp_i + \beta_{106}\%Over_i + \beta_{107}F_i + \\
& \beta_{109}FAc_i + \beta_{110}RLF_i + \beta_{111}InAg_i + \beta_{113}Mi^2{}_i + \beta_{115}Manure_i + \beta_{126}PSYAWM_i + \\
& \beta_{134}RCDA01_i + \beta_{135}RCDA02_i + \beta_{136}RCDA03_i + \beta_{137}RCDA04_i + \\
& \beta_{138}RCDA05_i + \beta_{139}RCDA07_i + \beta_{140}RCDA08_i + \beta_{141}RCDA09_i + \\
& \beta_{142}RCDA10_i + \beta_{143}RCDA11_i + \beta_{144}RCDA12_i + \beta_{145}RCDA13_i + \\
& \beta_{146}RCDA14_i + e_{1,i}
\end{aligned}
$$

Equation 2 estimates the relationship between the county soil erosion-ranking (SER) and the rest of the endogenous variables. In Equation 2 the variables SE and PSYSE are included to measure the extent to which actual environmental measures correlate with local county perception of environmental quality (SER). The variable SE measures the potential for soil erosion in a county. The variable PSYSE measures the percent of time that NRCS staff spent on soil erosion issues in the county. The higher is SE or PSYSE, the greater is the likelihood that soil erosion is a concern in the county.

The variables Rmax, Inc, UnEmp, %Over, F, FAc, RLF, InAg, Mi^2, and RCDA are defined above. The variable county aggregate farm cash receipts (CR) is included in Equation 2 to indicate the extent to which the value of farm production is correlated with perception of environmental quality. Cash receipts do depend on farm acreage (FAc), but also depend on crop mix (or rotation) and crop price. Like FAc, it is anticipated that county leaders of counties with higher cash receipts will increase the ranking of agriculture-related environmental concerns (including SER).

Equation 2. Soil Erosion Ranking

$$SER_i = \delta_{21}AWR_i + \delta_{23}WQR_i + \delta_{24}WMR_i + \delta_{25}TA_i + \delta_{26}EF_i + \beta_{200} + \beta_{201}RMax_i + \beta_{202}Inc_i + \beta_{204}UnEmp_i + \beta_{206}\%Over_i + \beta_{207}F_i + \beta_{208}CR_i + \beta_{209}FAc_i + \beta_{210}RLF_i + \beta_{211}InAg_i + \beta_{213}Mi^2{}_i + \beta_{216}SE_i + \beta_{227}PSYSE_i + \beta_{234}RCDA01_i + \beta_{235}RCDA02_i + \beta_{236}RCDA03_i + \beta_{237}RCDA04_i + \beta_{238}RCDA05_i + \beta_{239}RCDA07_i + \beta_{240}RCDA08_i + \beta_{241}RCDA09_i + \beta_{242}RCDA10_i + \beta_{243}RCDA11_i + \beta_{244}RCDA12_i + \beta_{245}RCDA13_i + \beta_{246}RCDA14_i + e_{2,i}$$

Equation 3 is used to explain the county ranking of water quality concerns. Note that in the context of the survey, poor water quality was not defined. As a consequence, poor water quality could result from any contaminant including agricultural runoff, manure runoff or soil erosion. Thus, there is reason to believe that WQR is correlated with AWR and SER, not only in terms of ranking, but also by definition.

In Equation 3, Inc^2 is income squared, NF is nitrogen fertilizer losses from farm fields, PR is pesticide runoff from farm fields, PL is pesticides leached from farm fields, Coal is a dummy variable indicating if the county produced coal in 2000, Mined is the number of years that coal was mined in the county, DWV is the number of drinking water violations received by county based water treatment plants, AWQC is a measure of county ambient water quality for conventional contaminants, TRI is a measure of toxic materials released into the environment, (obtained from the EPSs Toxic Release Inventory) and PSYSE is percent of a NRCS staff year devoted to water quality issues. The variables RMax, Inc, UnEmp, %Over, F, FAc, RLF, InAg, Mi^2, and RCDA are defined above.

The variable Inc^2 is included to test if the relationship between perception of environmental quality (here WQR) and income is non-linear. We are testing whether the environmental Kuznets curve applies, i.e. that water pollution rises as income rises, but eventually the amount of pollution declines as income continues to rise (Grossman and Krueger, 1995; Hilton and Levinson, 1998; Shafik, 1994). If the Kuznets relationship holds in this investigation, then the parameter estimate for Inc^2 will be positive.

Poor water quality is not necessarily due only to agricultural polluting activities. As a result a number of exogenous variables are included to measure water quality. The variables NF, PR, and PL are included to account for agricultural sources of pollution. The variables Coal and Mined are included to account for water pollutants arising from the mining industry, and TRI is included to account for pollutants arising from manufacturing. The variable DWV (drinking water violations) is included to account for general water quality. It is assumed that municipal water treatment plants in areas with poorer water quality will receive more fines. However, it is acknowledged that fines are also a function of management. The variable AWQC (ambient water quality of conventional contaminants) is also included to account for general water quality, but unlike DWV, the variable AWQC is more directly tied to actual measures (recorded by the EPA) of water quality. For the water quality variables, a higher value of NF, PR, PL, Coal, Mined, TRI, DWV, and AWQC indicates poorer water quality.

Equation 3. Water Quality Ranking

$$
\begin{aligned}
WQR_i = {} & \delta_{31}AWR_i + \delta_{32}SER_i + \delta_{34}WMR_i + \delta_{35}TA_i + \delta_{36}EF_i + \\
& \beta_{300} + \beta_{301}RMax_i + \beta_{302}Inc_i + \beta_{303}Inc^2{}_i + \beta_{304}UnEmp_i + \beta_{306}\%Over_i + \\
& \beta_{307}F_i + \beta_{309}FAc_i + \beta_{310}RLF_i + \beta_{311}InAg_i + \beta_{313}Mi^3{}_i + \beta_{314}Den_i + \\
& \beta_{317}NF_i + \beta_{318}PR_i + \beta_{319}PL_i + \beta_{321}Coal_i + \beta_{322}Mined_i + \beta_{323}DWV_i + \\
& \beta_{324}AWQC_i + \beta_{325}TRI_i + \beta_{328}PSYWQ_i + \\
& \beta_{334}RCDA01_i + \beta_{335}RCDA02_i + \beta_{336}RCDA03_i + \beta_{337}RCDA04_i + \\
& \beta_{338}RCDA05_i + \beta_{339}RCDA07_i + \beta_{340}RCDA08_i + \beta_{341}RCDA09_i + \\
& \beta_{342}RCDA10_i + \beta_{343}RCDA11_i + \beta_{344}RCDA12_i + \beta_{345}RCDA13_i + \\
& \beta_{346}RCDA14_i + e_{3,i}
\end{aligned}
$$

Equation 4 is used to explain the county ranking of wildlife management concerns. In Equation 4 the variables PCW and PSYWM are included to measure the extent to which actual environmental measures correlate with local county perception of wildlife quality or wildlife management concerns (WMR). The variable PCW measures the percent change in wildlife population. Specifically, PCW is the percentage change in county rabbit and quail populations over a 4-year period measured via mail-carrier population surveys. The variable PSYWM measures the percent of time that NRCS staff spent on wildlife management issues in the county. The lower is PCW (and PCW can be negative in the case of a population decline) and the higher is PSYWM, the greater is the likelihood that wildlife management is a concern in the county.

As with Equations 1 through 3, the variables Rmax, Inc, UnEmp, %Over, F, FAc, RLF, InAg, Mi^2, and RCDA are defined above. Indicator variables added to Equation 4 include %Rur and %H2O. The variable %Rur controls for the percent of the county population living in rural areas. The effect of %Rur on WMR cannot be determined a priori. The variable %H2O controls for the percent of the county covered by water. Rivers, streams, lakes, ponds, and wetlands are essential for wildlife health and habitat. Thus, counties with more water area are hypothesized to be correlated with a higher ranking for wildlife management concerns.

Equation 4. Wildlife Management Ranking

$$
\begin{aligned}
WMR_i = {} & \delta_{41}AWR_i + \delta_{42}SER_i + \delta_{43}WQR_i + \delta_{45}TA_i + \delta_{46}EF_i + \\
& \beta_{400} + \beta_{401}RMax_i + \beta_{402}Inc_i + \beta_{404}UnEmp_i + \beta_{405}UnEmp_i + \beta_{406}\%Over_i + \\
& \beta_{407}F_i + \beta_{409}FAc_i + \beta_{410}RLF_i + \beta_{411}InAg_i + \beta_{412}\%H2O_i + \beta_{413}Mi^2{}_i + \\
& \beta_{420}PCW_i + \beta_{429}PSYWM_i + \\
& \beta_{434}RCDA01_i + \beta_{435}RCDA02_i + \beta_{436}RCDA03_i + \beta_{437}RCDA04_i + \\
& \beta_{438}RCDA05_i + \beta_{439}RCDA07_i + \beta_{440}RCDA08_i + \beta_{441}RCDA09_i + \\
& \beta_{442}RCDA10_i + \beta_{443}RCDA11_i + \beta_{444}RCDA12_i + \beta_{445}RCDA13_i + \\
& \beta_{446}RCDA14_i + e_{4,i}
\end{aligned}
$$

The remaining equations (5 and 6) concern total county applications (TA) to the EQIP program and total county funding (EF) of the EQIP program. Equations 5 and 6 include the variables FAc, RLF, Mi^2, and RCDA from above in addition to the variables representing actual environmental quality measures (Manure, SE, NF, PR, PL, and PCW). Again, the variable %Rur controls for percent of the county population living in rural areas. Most EQIP applications come from, and most EQIP funds go to, counties with larger rural populations. It is hypothesized that TA and EF increase with increases in %Rur.

In Equation 5, the variable Tobacco controls for variation in tobacco acreage across the state. Both burley and dark varieties of tobacco are included. The effect of tobacco acreage on county applications is not known *a priori*, but tobacco is an important cash crop with significant political ramifications in tobacco producing counties. The variable LVSTK, number of cattle and pigs in a county, is included to control for large variation in livestock numbers across the state. A large portion of EQIP applications and funding concerns livestock related BMPs including manure management (storage and application) systems (to improve water quality) and construction of watering stations and fencing to keep cattle out of streams (reduces stream bank erosion and improves water quality).

Equation 5. Total Applications

$$
\begin{aligned}
TA_i = \; & \delta_{51}AWR_i + \delta_{52}SER_i + \delta_{53}WQR_i + \delta_{54}WMR_i + \delta_{56}EF_i + \\
& \beta_{500} + \beta_{505}Rur_i + \beta_{509}FAc_i + \beta_{510}RLF_i + \beta_{513}Mi^2_i + \beta_{515}Manure_i + \beta_{516}SE_i + \\
& \beta_{517}NF_i + \beta_{518}PR_i + \beta_{519}PL_i + \beta_{520}PCW_i + \beta_{532}Tobacco_i + \beta_{533}LVSTK_i + \\
& \beta_{534}RCDA01_i + \beta_{535}RCDA02_i + \beta_{536}RCDA03_i + \beta_{537}RCDA04_i + \\
& \beta_{538}RCDA05_i + \beta_{539}RCDA07_i + \beta_{540}RCDA08_i + \beta_{541}RCDA09_i + \\
& \beta_{542}RCDA10_i + \beta_{543}RCDA11_i + \beta_{544}RCDA12_i + \beta_{545}RCDA13_i + \\
& \beta_{546}RCDA14_i + e_{5,i}
\end{aligned}
$$

In Equation 6, the variable PNE measures private non-farm employment and controls for economic forces that vary across counties. Conventional wisdom is that counties with higher levels of private non-farm employment are more engaged in business and development representing a more healthy local economy. Counties with larger values of PNE are also likely to be non-agrarian counties. Thus, it is hypothesized that EQIP funding will be lower in counties with larger levels of PNE.

Finally, CSA (county corn and soybean acreage) is included in Equation 6 to control for county variation in corn and soybean acreage. Although tobacco is Kentucky's most valuable crop, corn and soybean production accounts for 46% of all crop acreage (including tobacco and hay; 84% without hay). However, county corn and soybean acreage increases greatly from eastern to western Kentucky. State and local leaders regard counties with more acreage in corn and soybeans as being more "agrarian", and it is these counties that are assumed to receive more EQIP funding.

Equation 6. EQIP Funding

$$
\begin{aligned}
EF_i = \; & \delta_{61}AWR_i + \delta_{62}SER_i + \delta_{63}WQR_i + \delta_{64}WMR_i + \delta_{65}TA_i + \\
& \beta_{600} + \beta_{605}Rur_i + \beta_{609}FAc_i + \beta_{610}RLF_i + \beta_{611}InAg_i + \beta_{613}Mi^2{}_i + \\
& \beta_{615}Manure_i + \beta_{616}SE_i + \beta_{617}NF_i + \beta_{618}PR_i + \beta_{619}PL_i + \beta_{620}PCW_i + \\
& \beta_{630}PNE_i + \beta_{631}CSA_i + \\
& \beta_{634}RCDA01_i + \beta_{635}RCDA02_i + \beta_{636}RCDA03_i + \beta_{637}RCDA04_i + \\
& \beta_{638}RCDA05_i + \beta_{639}RCDA07_i + \beta_{640}RCDA08_i + \beta_{641}RCDA09_i + \\
& \beta_{642}RCDA10_i + \beta_{643}RCDA11_i + \beta_{644}RCDA12_i + \beta_{645}RCDA13_i + \\
& \beta_{646}RCDA14_i + e_{6,i}
\end{aligned}
$$

V. Estimation Results

This model is unique in that the dependent variables include a large number of 0 observations. Specifically, 60 of 120 Kentucky counties did not rank animal waste concerns (AWR), 14 did not rank soil erosion concerns (SER), 8 did not rank water quality concerns (WQR), 52 did not rank wildlife management concerns (WMR), 45 counties did not receive applications for EQIP funding (TA), and 50 counties did not receive funding (EF). Thus, count-data (or Poisson) models were estimated in place of ordinary least squares (OLS) models. Following standard two-stage (2SLS) estimation techniques, predicted values for the endogenous variables were determined from first round estimation of the appropriate reduced form equation. Next, appropriate predicted values were included as left-hand variables in second round estimation of the primary model equations.

In Table 3, we present the results of estimation of Equations 1 through 6. All rankings were affected by the total number of concerns expressed by each county (RMax). The higher the number of concerns expressed by a county, the lower the ranking of each of the relevant environmental and natural resource concerns (AWR, SER, WQR, and WMR). The variable representing the number of resource limited farmers (RLF) was never significant in any of the equations.

Animal waste concerns (AWR) ranked higher in counties that also had higher rankings for the wildlife management concerns (WMR) and lower rankings for water quality concerns (WQR: Equation 1). Counties with higher rankings for the animal waste (AWR) concern had higher median incomes and higher farm employment (InAg). Higher ranking for the animal waste concern (AWR) was associated with counties that have a higher proportion of the population is at least 65 years old (%Over), are larger in size (Mi^2), and have more acreage devoted to crops (FAc).

Counties with higher amounts of manure (MANURE), ceteris paribus, had a higher ranking for the animal waste management concern, thus reflecting the actual environmental conditions in the county. Counties with higher rankings for the animal waste concern had fewer applications for EQIP funding (Equation 1).

Soil erosion concerns (SER) by county were ranked lower as the number of concerns ranked by a county increased (RMAX; Equation 2). Higher rankings of the soil erosion concerns (SER) were associated with higher rankings for the water quality concern (WQR). Counties with higher rates of unemployment (UnEmp) and less cash receipts from farming (CR) had lower rankings for the soil erosion concern. There was no significant association of counties with high rankings for the soil erosion variable and the actual indicator for soil erosion (SE).

Higher rankings for water quality concern (WQR) came from counties that also ranked wildlife management concerns (WMR) highly (Equation 3). Counties with higher unemployment rates ranked the water quality concern lower. Drinking water violations (DWV) and ambient water quality contamination (AWQC) were associated with lower rankings of the water quality concern. The actual measures of nitrogen fertilizer application (NF), run off (PR) and leaching (PL) were not significant.

The wildlife management concern (WMR) was ranked higher in counties that also had higher rankings for animal waste (AWR) and soil erosion (SER) concerns (Equation 4). Although fewer applications for EQIP funding are associated with counties that ranked the wildlife management concern higher, there was more EQIP funding going to these counties. Counties with higher median incomes, higher rates of unemployment, more acres in crop production, a higher proportion of female head of households (F), and a higher percentage of surface covered by water (%H2O) had a higher ranking for the wildlife management concern. The actual measure of wildlife (PCW) was not significant.

From the results ranking the environmental concerns we can conclude that only the animal waste management concern ranking, as expressed by the counties, represents actual environmental conditions in the county. However counties with higher rankings for the waste management concern and corresponding actual environmental problems generated fewer applications for EQIP funding. Reliance on these rankings for allocating EQIP funding as required by legislation would help increase the effectiveness of the EQIP program. This is not the case, however, with the rankings for soil erosion, water quality and wildlife management. None of these correlates with the actual environmental condition in the county.

Simultaneity between the number of applications from each county (TA) and the proportion of cost-share money given to each county (EF) is indicated in Table 3, as both endogenous variables are significant (Equations 5 and 6). This simultaneity reflects the dependence of funding on applications received that follows the design of the EQIP program. Most applications for cost-share money came from counties that ranked the water quality concern (WQR) lower relative to the other environmental concerns. All other concern rankings were not statistically significant with the number of applications for each county. What we do not know is the nature of the environmental project proposed by the applicants. Counties with greater actual erosion problems (SE) generated a larger number of applications for cost-share assistance. A larger number of applications came from counties with relatively more acreage in crops (FAc). Larger size counties (Mi^2) that are more rural (%Rur), counties with more actual runoff (PR) and counties with more tobacco production (Tobacco) had a smaller number of applications.

The proportion of EQIP funding of projects in each county was positively related to the number of applications requesting cost-share funds from each county (Table 3). We do not know the amount of money requested by each applicant from each county or the type of environmental project for which they applied (soil erosion, water quality, animal waste, and wildlife management). A higher proportion of funds went to counties that had ranked soil erosion (SER) as a more important concern relative to water quality (WQR). Animal waste management,(AWR) concerns were negatively associated with EQIP cost-share funding. More EQIP cost-share money was given to counties that actually had a relatively higher soil erosion rate (SE) and higher nitrogen fertilizer loss rate (NF). More EQIP cost-share money was given to counties that actually had a relatively high population of wildlife (PCW) but had less acreage in row crops (CSA).

More EQIP funding went to counties that ranked soil erosion high as a concern (SER in Equation 6), despite the fact that soil erosion was ranked high by counties that did not have high actual levels of erosion (SE in Equation 2) and fewer application came from counties that had high actual levels of erosion (SE in Equation 5). Yet if a county did have high actual levels of soil erosion, this county received funding (SE in Equation 6).

More EQIP funding is going to counties that have higher nitrogen fertilizer loss rates (NF in Equation 6). Yet fewer applications for funding came from counties that ranked water quality high as an environmental concern (WQR in Equation 5). Furthermore, counties expressing a high ranking for water quality were not counties with actual water quality problems (Equation 3). Similarly, counties that had high rankings for wildlife management also had fewer applications for cost share funds (TA in Equation 4), but received relatively more EQIP funding (EF in Equation 4) although their concerns were not relating to the actual indicator for wildlife quality (PCW in Equation 4).

The rating for animal waste concerns did relate to the indicator for actual animal waste levels (Manure in Equation 4). However, counties that had ranked animal waste management problems higher received relatively fewer applications for EQIP cost-share money (TA in Equation 1). As a consequence, funds from EQIP did not end up in counties that highly ranked the animal waste management concern (AWR in Equation 6). Thus, probably, the EQIP program was not able to address concerns in counties that had more severe problems with animal waste management.

VI. Conclusions

The effectiveness of the EQIP program in Kentucky in addressing existing important natural resource quality problems was the subject of this investigation. The EQIP program is designed to address animal waste, soil erosion, water quality, and wildlife management concerns. However it can only provide project funds to those counties from which the farmer applications were generated and it must consider priority areas as determined by local environmental concern rankings. The results of this study show that counties expressing a high ranking for soil erosion, water quality, and wildlife management concerns were not counties with lower levels of environmental quality in those areas. Only the county animal waste concern ranking was consistent with the actual measure of animal waste for each county. However, the counties that had high animal waste levels generated the least applications for cost share funding and received the least funding.

In future studies, EQIP data needs to report the number of applications and the amount of funding going to address specific environmental concerns in each county. This would allow a complete evaluation of the effectiveness of EQIP in achieving it's goals. The EQIP program would improve its effectiveness in addressing important environmental and resource problems by decreasing its reliance on the ranking of local environmental concerns because they do not match well actual environmental conditions.

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Table 1. Variable names, descriptions, and assigned parameter values for all endogenous and exogenous variables used in Equations 1 through 6.

Variable	Variable Description	Parameter[1]
The Endogenous Variables		
AWR	County ranking for animal waste concerns	δ_{j1}
SER	County ranking for soil erosion concerns	δ_{j2}
WQR	County ranking for water quality concerns	δ_{j3}
WMR	County ranking for wildlife management concerns	δ_{j4}
TA	Total county applications for CREP funding	δ_{j5}
EF	Total county EQIP funding in $10,000	δ_{j6}
The Exogenous Variables		
Intercept		β_{j00}
RMax	Total number of county concerns ranked	β_{j01}
Inc	County median family income ($1,000)	β_{j02}
Inc^2	County median family income squared ($1,000)	β_{j03}
UnEmp	Number of unemployed persons of working age	β_{j04}
%Rur	Percent of the county population living in rural areas	β_{j05}
%Over	Percent of the county population that is 60 years of age or older	β_{j06}
F	Percent of the county population that is female head of household	β_{j07}
CR	County aggregate farm cash receipts ($1,000)	β_{j08}
FAc	County aggregate farm acres (10,000 acres)	β_{j09}
RLF	Number of resource limited farmers	β_{j10}
InAg	Number of individuals employed in agriculture	β_{j11}
%H2O	Percent of the county covered by water	β_{j12}
Mi^2	Size of the county in square miles	β_{j13}

1. The subscript j = 1,. .., 6 for each j equation (6 total) estimated in the endogenous system of equations (see Equation 1).

Table 1. (Continued) Variable names, descriptions, and assigned parameter values for all endogenous and exogenous variables used in Equations 1 through 6.

Variable	Variable Description	Parameter[1]
The Exogenous Variables (Continued)		
Den	Density of the county (Population/Mi^2)	β_{j14}
Manure	100,000 pounds of livestock produced manure	β_{j15}
SE	Soil erosion (an NRCS index value)	β_{j16}
NF	Nitrogen fertilizer loss from farm fields (an NRCS index value)	β_{j17}
PR	Pesticide runoff potential (an NRCS index value)	β_{j18}
PL	Pesticide leaching potential (an NRCS index value)	β_{j19}
PCW	Percent change in wildlife between 1996 and 2002	β_{j20}
Coal	A dummy variable that is 1 if the county produced coal in 2000	β_{j21}
Mined	Number of years that coal has been mined from the county	β_{j22}
DWV	Drinking water violations (measured by EPA)	β_{j23}
AWQC	Ambient water quality of conventional contaminants (from EPA)	β_{j24}
TRI	10,000 pounds of toxic release to the environment (from EPA)	β_{j25}
PSYAWM	Percent of a NRCS staff year devoted to animal waste issues	β_{j26}
PSYSE	Percent of a NRCS staff year devoted to soil erosion issues	β_{j27}
PSYWQ	Percent of a NRCS staff year devoted to water quality issues	β_{j28}
PSYWM	Percent of a NRCS staff year devoted to wildlife management	β_{j29}
PNE	Private non-farm employment (1,000 individuals)	β_{j30}
CSA	County corn and soybean acreage (1,000 acres)	β_{j31}
Tobacco	County tobacco acreage	β_{j32}
LVSTK	County head of cattle and pigs (1,000 head)	β_{j33}

1. The subscript j = 1,. .., 6 for each j equation (6 total) estimated in the endogenous system of equations (see Equation 1).

Table 1. (Continued) Variable names, descriptions, and assigned parameter values for all endogenous and exogenous variables used in Equations 1 through 6.

Variable	Variable Description	Parameter[1]
The Exogenous Variables (Continued)		
RCDA01	Dummy variable that is 1 if the county is located in Kentucky NRCS Resource Conservation and Development Area #1 (Jackson)	β_{j34}
RCDA02	Dummy variable that is 1 if the county is located in Kentucky NRCS Resource Conservation and Development Area #2 (Green River)	β_{j35}
RCDA03	Dummy variable that is 1 if the county is located in Kentucky NRCS Resource Conservation and Development Area #3 (Pennyrile)	β_{j36}
RCDA04	Dummy variable that is 1 if the county is located in Kentucky NRCS Resource Conservation and Development Area #4 (Lincoln)	β_{j37}
RCDA05	Dummy variable that is 1 if the county is located in Kentucky NRCS Resource Conservation and Development Area #5 (Mammoth Cave)	β_{j38}
RCDA07	Dummy variable that is 1 if the county is located in Kentucky NRCS Resource Conservation and Development Area #7 (Heritage)	β_{j39}

1. The subscript j = 1,..., 6 for each j equation (6 total) estimated in the endogenous system of equations (see Equation 1).

Table 1. (Continued) Variable names, descriptions, and assigned parameter values for all endogenous and exogenous variables used in Equations 1 through 6.

Variable	Variable Description	Parameter[1]
The Exogenous Variables (Continued)		
RCDA08	Dummy variable that is 1 if the county is located in Kentucky NRCS Resource Conservation and Development Area #8 (Cumberland/Green Lakes)	β_{j40}
RCDA09	Dummy variable that is 1 if the county is located in Kentucky NRCS Resource Conservation and Development Area #9 (Thoroughbred)	β_{j41}
RCDA10	Dummy variable that is 1 if the county is located in Kentucky NRCS Resource Conservation and Development Area #10 (Cumberland Valley)	β_{j42}
RCDA11	Dummy variable that is 1 if the county is located in Kentucky NRCS Resource Conservation and Development Area #11 (Licking River Valley)	β_{j43}
RCDA12	Dummy variable that is 1 if the county is located in Kentucky NRCS Resource Conservation and Development Area #12 (Gateway)	β_{j44}
RCDA13	Dummy variable that is 1 if the county is located in Kentucky NRCS Resource Conservation and Development Area #13 (Big Sandy)	β_{j45}
RCDA14	Dummy variable that is 1 if the county is located in Kentucky NRCS Resource Conservation and Development Area #14 (Kentucky River)	β_{j46}

1. The subscript j = 1,... ,6 for each j equation (6 total) estimated in the endogenous system of equations (see Equation 1).

Table 2. Estimated mean, standard deviation, maximum, and minimum values for all endogenous and exogenous variables used in Equations 1 through 6 for all 120 Kentucky counties.

Variable	Mean	Standard Deviation	Minimum Value	Maximum Value
The Endogenous Variables				
AWR	3.992	5.587	0.000	27.000
SER	4.183	3.699	0.000	19.000
WQR	3.100	2.862	0.000	14.000
WMR	7.417	7.791	0.000	31.000
TA	7.675	12.076	0.000	57.000
EF	8.067	13.158	0.000	65.000
The Exogenous Variables				
RMax	16.300	8.540	5.000	52.000
Inc	31.661	8.382	17.062	64.895
Inc^2	1,072.117	598.646	291.112	4,211.361
UnEmp	6.663	2.637	2.500	15.600
%Rur	75.961	24.931	2.800	100.000
%Over	17.692	2.930	10.343	24.363
F	10.757	1.982	0.300	18.000
CR	28.801	39.973	0.068	291.547
FAc	11.112	6.835	0.223	30.962
RLF	0.793	0.116	0.477	1.000
InAg	494.550	485.633	26.000	3,712.000
%H2O	1.791	2.635	0.000	15.876
Mi^2	336.742	130.597	100.110	788.840

Table 2. (Continued) Estimated mean, standard deviation, maximum, and minimum values for all endogenous and exogenous variables used in Equations 1 through 6 for all 120 Kentucky counties.

Variable	Mean	Standard Deviation	Minimum Value	Maximum Value
The Exogenous Variables (Continued)				
Den	108.103	204.057	21.500	1,801.200
Manure	194.975	228.756	1.997	1,190.129
SE	0.867	0.591	0.000	1.742
NF	4.175	3.775	0.007	16.450
PR	1.926	0.649	0.187	3.000
PL	2.261	0.987	0.000	3.000
PCW	91.404	199.104	-94.737	1,216.667
Coal	0.267	0.444	0.000	1.000
Mined	42.217	58.027	0.000	183.000
DWV	151.404	480.010	0.000	3,125.000
AWQC	0.558	0.591	0.000	2.000
TRI	59.045	138.134	0.000	1,042.304
PSYAWM	19.608	6.987	5.000	37.000
PSYSE	49.942	10.257	22.000	80.000
PSYWQ	0.933	4.555	0.000	26.000
PSYWM	11.642	4.823	4.000	25.000
PNE	12.232	39.769	0.155	406.891
CSA	19.888	34.983	0.000	151.700
Tobacco	1.105	0.914	0.000	3.590
LVSTK	22.055	19.298	0.000	87.400

Table 2. (Continued) Estimated mean, standard deviation, maximum, and minimum values for all endogenous and exogenous variables used in Equations 1 through 6 for all 120 Kentucky counties.

Variable	Mean	Standard Deviation	Minimum Value	Maximum Value
The Exogenous Variables (Continued)				
RCDA01	0.067	0.250	0.000	1.000
RCDA02	0.058	0.235	0.000	1.000
RCDA03	0.075	0.264	0.000	1.000
RCDA04	0.050	0.219	0.000	1.000
RCDA05	0.083	0.278	0.000	1.000
RCDA07	0.083	0.278	0.000	1.000
RCDA08	0.083	0.278	0.000	1.000
RCDA09	0.058	0.235	0.000	1.000
RCDA10	0.083	0.278	0.000	1.000
RCDA11	0.067	0.250	0.000	1.000
RCDA12	0.075	0.264	0.000	1.000
RCDA13	0.058	0.235	0.000	1.000
RCDA14	0.067	0.250	0.000	1.000

Table 3. Parameter estimates and statistical level of significance for each variable of the 6-equation system defined as animal waste ranking, soil erosion ranking, water quality ranking, wildlife management ranking, total EQIP applications, and total EQIP expenditures (Equations 1 through 6).

Variable	Parameter Estimates by Equation					
	Animal Waste Ranking	Soil Erosion Ranking	Water Quality Ranking	Wildlife Mgmt. Ranking	Total EQIP Applicants	Total EQIP Funding
	Equation1	Equation 2	Equation 3	Equation 4	Equation 5	Equation 6
The Endogenous Variables						
AWR		-0.0137	0.0041	-0.0274[b]	-0.0138	-0.0404[a]
SER	-0.0205		-0.0651	-0.0609[b]	0.0220	0.0548[b]
WQR	0.1176[a]	-0.1192[a]		0.0433	0.0612[c]	0.0516
WMR	-0.0381[a]	0.0147	-0.0366[b]		-0.0160	0.0048
TA	0.0261[c]	-0.0025	0.0221	0.0530[a]		0.0910[a]
EF	0.0035	-0.0047	-0.0273[c]	-0.0228[a]	0.0656[a]	
The Exogenous Variables						
Intercept	6.6183[a]	1.1854	0.2006	3.8938[a]	0.5868	0.4171
RMax	0.0814[a]	0.0395[a]	0.0514[a]	0.0694[a]		
Inc	-0.0925[a]	0.0080	-0.0647	-0.0411[a]		
Inc^2			0.0010			
UnEmp	-0.2256[a]	0.0684[c]	0.1041[b]	-0.0124		
%Rur				0.0006	-0.0084[a]	-0.0043[c]
%Over	-0.1401[a]	0.0140	0.0283	-0.0033		
F	-0.0331	-0.0069	0.0100	-0.0808[a]		
CR		0.0058[b]				
FAc	-0.0510[b]	0.0020	0.0021	-0.0489[a]	0.1189[a]	-0.0103

a. Parameter estimate is statistically different from 0 with 99% confidence or better
b. Parameter estimate is statistically different from 0 with 95 to 99% confidence
c. Parameter estimate is statistically different from 0 with 90 to 95% confidence

Table 3. (Continued) Parameter estimates and statistical level of significance for each variable of the 6-equation system defined as animal waste ranking, soil erosion ranking, water quality ranking, wildlife management ranking, total EQIP applications, and total EQIP expenditures (Equations 1 through 6).

Variable	Parameter Estimates by Equation					
	Animal Waste Ranking	Soil Erosion Ranking	Water Quality Ranking	Wildlife Mgmt. Ranking	Total EQIP Applicants	Total EQIP Funding
	Equation 1	Equation 2	Equation 3	Equation 4	Equation 5	Equation 6
The Exogenous Variables (Continued)						
RLF	-0.8009	-0.6730	-1.5814	-0.7458	0.3804	-0.1653
InAg	0.0001	-0.0003	-0.0001	-0.0002		0.0004
%H2O				-0.0525[a]		
Mi^2	0.0017[b]	-0.0004	-0.0009	0.0015[a]	-0.0030[a]	-0.0000
Den			-0.0005			
Manure	-0.0001				0.0005	-0.0005
SE		-0.0929			0.8437[a]	0.3055[c]
NF			0.0065		0.0749[a]	0.1202[a]
PR			0.3045		-0.6924[b]	-0.1088
PL			0.1195		-0.1402	0.1144
PCW				0.0001	-0.0003	0.0005[a]
Coal			-0.1714			
Mined			0.0021			
DWV			0.0004[a]			
AWQC			0.2993[b]			
TRI			-0.0001			

a. Parameter estimate is statistically different from 0 with 99% confidence or better
b. Parameter estimate is statistically different from 0 with 95 to 99% confidence
c. Parameter estimate is statistically different from 0 with 90 to 95% confidence

Table 3. (Continued) Parameter estimates and statistical level of significance for each variable of the 6-equation system defined as animal waste ranking, soil erosion ranking, water quality ranking, wildlife management ranking, total EQIP applications, and total EQIP expenditures (Equations 1 through 6).

Variable	Parameter Estimates by Equation					
	Animal Waste Ranking	Soil Erosion Ranking	Water Quality Ranking	Wildlife Mgmt. Ranking	Total EQIP Applicants	Total EQIP Funding
	Equation 1	Equation 2	Equation 3	Equation 4	Equation 5	Equation 6
The Exogenous Variables						
PSYAWM	0.0331[b]					
PSYSE		-0.0201[a]				
PSYWQ			0.0204			
PSYWM				-0.0006		
PNE						-0.0046
CSA						-0.0111[a]
Tobacco					-0.1602[c]	
LVSTK					-0.0025	

a. Parameter estimate is statistically different from 0 with 99% confidence or better
b. Parameter estimate is statistically different from 0 with 95 to 99% confidence
c. Parameter estimate is statistically different from 0 with 90 to 95% confidence

Table 3. (Continued) Parameter estimates and statistical level of significance for each variable of the 6-equation system defined as animal waste ranking, soil erosion ranking, water quality ranking, wildlife management ranking, total EQIP applications, and total EQIP expenditures (Equations 1 through 6).

Variable	Parameter Estimates by Equation					
	Animal Waste Ranking	Soil Erosion Ranking	Water Quality Ranking	Wildlife Mgmt. Ranking	Total EQIP Applicants	Total EQIP Funding
	Equation 1	Equation 2	Equation 3	Equation 4	Equation 5	Equation 6
The Exogenous Variables (Continued)						
RCDA01	0.7183[b]	0.1882	0.8095	0.1095	0.4082	0.3434
RCDA02	-0.4668	0.4154	-0.0249	0.4498[b]	-0.4795	1.1436[a]
RCDA03	0.8066[b]	0.2466	0.3697	-0.2957	1.5179[a]	0.1890
RCDA04	0.0279	0.4919	0.5987	-0.3109	1.0880[a]	-0.8092[a]
RCDA05	-0.2045	0.8140[b]	0.6517	-0.1842	0.8164[b]	-0.2344
RCDA07	0.7082[b]	0.9387[a]	0.7719[b]	0.4206[c]	0.7241[b]	0.2979
RCDA08	-0.3882	0.7617[b]	0.3070	-0.7508[a]	1.0876[a]	-0.6928[b]
RCDA09	0.7522[b]	0.4533	-0.4147	-0.3561	0.7897[b]	-0.3928
RCDA10	-0.6179	0.8752[b]	1.4690[a]	-0.6957[b]	1.3782[a]	0.1955
RCDA11	-0.6757	0.5746	0.4556	0.2265	0.9864[a]	0.1710
RCDA12	0.5591	1.2889[a]	1.3066[a]	0.2458	0.8679[b]	0.1033
RCDA13	-0.7558	0.5390	1.4178[b]	-0.6224[c]	1.2676[b]	0.5600
RCDA14	-0.0244	1.3450[a]	0.7890	-0.8872[a]	1.6414[a]	-0.961

a. Parameter estimate is statistically different from 0 with 99% confidence or better
b. Parameter estimate is statistically different from 0 with 95 to 99% confidence
c. Parameter estimate is statistically different from 0 with 90 to 95% confidence

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