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Estimates Of Aviators' Willingness-To-Pay For General Aviation Safety

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ABSTRACT

The hedonic pricing model described in this paper measures the effects of safety characteristics on the value of services provided by general aviation aircraft. In effect, the model provides information on aviators' willingness-to-pay for safety improvements. The implied estimate of the value of a statistical life is about $740,000, measured in 1986 dollars. A major conclusion is that general aviators recognize the implicit value of differences in safety performance between aircraft, and bid up the prices of safer aircraft. These findings could be used to evaluate the benefits of new regulations or investments in the airport and airway system.

INTRODUCTION

The model described in this paper measures the impact of safety on the value of services provided by general aviation aircraft. Specifically, the model provides information on aviators' willingness-to-pay for safety improvements which are used to obtain an estimate of aviators' implied value of a statistical life.

The model employs the hedonic technique which is especially well-suited to the analysis of markets in which "goods" are highly differentiated. The more traditional market analysis examines quantities of homogeneous goods exchanged as a function of prices which are established in explicit markets. In the hedonic approach, however, attributes (e.g., safety, speed, etc.) bundled with the product (e.g., the aircraft) are treated as goods exchanged in implicit markets.

A principal difficulty in using a traditional market-based approach for estimating the benefits associated with a reduction in accident rates is that safety is not traded in explicit markets and hence, the demand for safety is not directly observed. Although safety is not traded directly, it is exchanged in implicit markets. More specifically, safety can be regarded as an attribute that is tied to aircraft which are exchanges in explicit exchanged in explicit markets. The price of an aircraft depends on the net value of the flow of services provided by the vehicle. The value of services, in turn, depends on attributes which are embedded in aircraft. The basic rationale for using the hedonic approach is that explicit markets for aircraft provide information which can be used to identify the implicit demand for attributes, including safety. The demand for safety can then be employed to estimate an implied value of a statistical life.

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INTERPRETATION OF THE HEDONIC MODEL

The discussion below follows the general treatment given in Rosen (1974). It is assumed that aircraft buyers are utility maximizers. The extension of the model to the case in which buyers purchase aircraft for business use is relatively straightforward. Profit-maximizing behavior is a more appropriate assumption in this case.

Each aircraft can be characterized by a set of n attributes, $Z = (Z_1, \ldots, Z_n)$. These attributes are defined such that all buyers' perceptions of the various Z_i's are identical; of course, various buyers may value each of the attributes differently. It is also assumed that the number of different aircraft available in the market is sufficiently large so that choice among alternative combinations of attributes is approximately continuous.

The set of attributes jointly affects the market prices of aircraft. More specifically:

$$P(Z) = P(Z_1 \ldots, Z_n)$$

where P is a function relating attributes to market prices of aircraft. This equation is known as the implicit price equation or the hedonic function. It combines the market information available to both buyers and sellers and represents the minimum expenditure at which any aircraft with a given set of characteristics can be acquired.

P(Z) is determined by the joint behavior of buyers and sellers of aircraft. It is assumed that the markets for aircraft and their associated attributes are workably competitive. That is, no single buyer or seller can affect the market price of any attribute.

According to the theory of the consumer, a rational buyer will select an air craft with the set of attributes which is consistent with utility maximization. Each attribute, $Z_1, \ldots, Z_n$, can be viewed as an intermediate good which is used to produce the service offered by the aircraft. In the most general case, the safety and other attributes of the aircraft will affect both the utility and the budget of the buyer. The buyer's problem is to select attributes of the aircraft that maximize utility subject to a budget constraint. The "bids" that buyers offer in the market for various attributes embedded in the aircraft are presumed to be consistent with utility maximization.

Sellers are assumed to behave as though they attempt to maximize profits. More specifically, the hedonic model is based on the assumption that the design (in terms of attributes) and quantity of aircraft made available in the market by sellers satisfy the objective of profit maximization. The optimal design of the aircraft is obtained when the marginal revenue from each attribute is equal to its marginal cost. The optimal quantity of aircraft is obtained when the unit price equals the marginal supply cost.

The equilibrium price of an aircraft, P(Z), is simultaneously determined in the explicit market by consumers' bids and sellers' offers. The marginal implicit price of a given attribute, $P_i(Z)$, is formed as the first derivative of P(Z). In words, $P_i(Z)$ measures the increase in the price of an aircraft that results from a marginal increase in attribute Z_i.

ECONOMETRIC ISSUES

Identification

The implicit price function does not by itself generally provide the information necessary to identify the demand for safety because it is simply a trace of market equilibria for attributes of aircraft. The marginal implicit price function does provide limited information about the demand for safety in the neighborhood of market equilibrium and, accordingly, can be used to measure how much buyers are willing to pay for "small" or marginal reductions in accident rates. However, the demand for safety must be identified in order to value nonmarginal changes in accident rates.

Three approaches have been pursued in the literature to identify characteristics about the implicit markets of attributes of interest. The first approach is to specify demand (and/or supply) functions for the attribute. In the most general case, both the marginal implicit prices and the attributes are endogenously determined. Rosen (1974) suggests that the demand and supply equations will be identified if the usual rank and order conditions are satisfied. More recently, however, Brown and Rosen (1982) demonstrate that a priori restrictions are also necessary to identify the demand and supply functions. They note that if the implicit price equation is of order m in attributes, then the marginal equation will be of order m-1, and the demand and supply equations must be of order m-2 or less for identification.

A second alternative is to estimate several implicit price equations for different sub-markets and then use these to estimate a common underlying function for all markets. This approach, which has been used by Witte, et al. (1979), and Palmquist (1984), permits the identification of demand and supply functions, but it does require the assumption that the structure across all markets is the same, even if the equilibrium price loci are different.

Identification can also be achieved if a specific functional form is assumed for the utility function. Attribute demand equations can be derived from the utility function and the estimated marginal implicit price equations. Alternatively, changes in economic surplus can be computed directly as compensating variation. Compensating variation is defined here as the lump sum payment that is required to compensate a buyer exactly (i.e., to leave the individual at a given level of utility) in order to forego a given level of an attribute.

Under this third approach--which has been employed previously by Harrison and Rubinfeld (1978), and Atkinson and Halvorsen (1984)--it is first assumed that the aircraft attributes and all other goods are weakly separable in the utility function. In this case, define W such that:

$$U = U(W(Z), X)$$

Where: U is total utility; W(Z) is the aircraft subutility function; and X is a composite of all other goods. The function W is then specified such that its parameters can be imputed from the estimated implicit price equation. Note that since this approach requires only a single stage of estimation.

The last of these three alternatives was adopted for this study. There were several reasons for this choice. First, data on seller characteristics, which are necessary to identify the demand for safety, were unavailable and, moreover, data on buyer characteristics were difficult to construct. Second, once the model is estimated, the conceptually correct measure of willingness-to-pay for safety, compensating variation, can be obtained from the utility function. The other two methods require the use of consumer surplus as an approximate measure of the benefits associated with reduced accident rates. Third, imposing an a priori form on the utility function is no more restrictive than the assumptions required to implement the other two alternatives.

Functional Form

Although the choice of the functional form of the implicit price equation is largely an empirical question, there are important economic issues involved. Because the inverse demand for aviation safety is not identified if the implicit price function is linear, virtually all researchers have employed nonlinear forms. One exception is Palmquist (1984) who employs a linear implicit price equation and a two-stage estimation process over several cities to identify implicit demand. Rosen's (1974) result that the implicit price function need not be linear in the absence of costless repackaging of attributes provides further justification for the use of nonlinear forms. The issue of repackaging of attributes is relevant to this study in that it is unlikely that buyers can find all possible combination of attributes that may be desired without paying some additional cost for combining attributes.

Economic theory suggests that the marginal willingness-to-pay for safety diminishes eventually as safety is improved. If safety is viewed as a good, diminishing marginal utility gives rise to this phenomenon. Diminishing marginal returns to production provides the economic rationale if safety is treated as a productive input. This suggests that the second derivative of the utility function should be negative.

Until very recently, the log and the semi-log forms for implicit price equations have been used most often in previous studies. Note that, for the log form, the marginal willingness-to-pay for safety depends on the level of other attributes tied to the aircraft. The semi-log form, however, imposes independence; that is, the marginal willingness-to-pay for safety is assumed to be independent of other attributes of the aircraft. Because it cannot be assumed that safety is independent of other at tributes, the log form was used for the implicit price equation.

DATA AND ATTRIBUTE SPECIFICATION

Aircraft Safety

A commonly accepted measure of aviation risk is the number of fatal accidents per 100,000 flying hours. Since safety is an amenity, it is more appropriate to define it as the probability of not having a fatal accident. Safety is therefore defined as one minus the fatal accident rate.

The number of observations in the analysis is, in part, limited by the available accident rate data. Accident rates were derived from NTSB records of fatal accidents for the years 1978-1984. The yearly *General Aviation Activity and Avionics Survey* (GA Survey) for the same period provides estimates of yearly total fleet hours for 95 models with identifiable accident and aircraft characteristics information.

The accident data also provide information on occupant mortality rates in accidents involving some number of fatalities. The NTSB data for 1978-1984 (for the models considered in this study) indicates that an average of 87 percent of the occupants involved in a fatal accident were killed. Since the average aircraft in the sample had 1.9 persons on board, this implies that approximately 1.7 persons were killed per fatal accident.

Aircraft Prices

Aircraft price, P, is defined as the present value of the cost of owning and operating the aircraft over its expected useful life. Specifically:

$$P = P_k + \sum_{t=1}^{T} VC_t / (1+r)^t$$

Where: P_k is the present value of the annual capital costs; VC is variable operating and maintenance costs per time period; r is the discount rate; T is the expected useful life of the aircraft; and t indexes time.

Data for the price variables were collected for 95 different models of aircraft in each year they were available (1960-1986). Capital costs for aircraft traded in markets were obtained from the *Aircraft Blue Book* (1986). Estimates of variable operating and maintenance costs for various aircraft types for a baseline year were obtained from FAA (1978). The Federal Aviation Administration (FAA) also publishes annual operating cost and maintenance cost indices for the same aircraft in *FAA Aviation Forecasts*. However, the decision to purchase an aircraft is based on expected future costs and the FAA does not report forecasts of the two sets of aircraft cost indices.

The FAA aircraft cost indices, however, have moved very closely with the wholesale price index over the past several years. An $R^2 = .99$ for each of the aircraft types was obtained when the operating cost indices were specified as a linear function of the wholesale price index. Values of R^2 ranging from .94 to .99 were obtained for the maintenance cost indices. The estimated cost equations were used to predict future values of the aircraft cost indices as a function of FAA wholesale price index forecasts.

Life-cycle ownership costs were estimated over the remaining expected life of each aircraft, T, which is defined as:

$$T = T_m + T_1 - 1986$$

Where: T_m is the year of manufacture and T_1 is the expected life of a new aircraft (25 years for turbojets and 30 years for all other aircraft). T is assumed to have a minimum value of five years because interviews with aircraft dealers indicated that aircraft with shorter remaining lives would not likely be traded in the market.

A discount rate of 10 percent was used to compute the present value of future operating and maintenance costs. This rate approximated the average 1986 yield on 15-year corporate bonds, an alternative investment with about the same expected life as the average aircraft in the sample.

Other Aircraft Attributes

Apart from safety, the aircraft attributes that are likely to have a significant effect on price include year of manufacture, maximum cruising speed, maximum gross weight, number of seats, rate of climb, useful load, retractable gear and pressurization. The price data references cited earlier and *Jane's All the World's Aircraft* provided the information necessary to match these attributes to specific air craft models. The required data were constructed for 1,145 model-year cases of the 95 models included in the GA survey.

Several of the aircraft attributes are highly collinear. Principle component analysis was employed to replace the set of original attributes with a set of two created variables and a pressurization variable (factors). The first factor is made up principally of physical attributes including maximum cruising speed, maximum gross weight, number of seats, rate of climb and useful load. The second factor is made up principally of the year of manufacture.

RESULTS

The specification of the implicit price equation that was estimated is

$$\ln P = \alpha_o + \alpha_1 F_1 + \alpha_2 F_2 + \alpha_s PD + \alpha_s \ln S$$

Where: F_1 is the log of a factor made up principally of the physical characteristics of the aircraft; F_2 is the log of a factor principally made up of the year of manufacture; PD is a pressurization dummy variable; and S is the safety variable defined as one minus the fatal accident rate.

Weighted least squares estimates of the coefficients are reported in Table 1. The weights are inverses of the sampling fractions used in the GA survey. Each of the independent variables is statistically significant at a high level of confidence and the model explains about 92 percent of the variation in the price variable.

The factor score coefficients for the two principle components are reported in Table 2. These are linear weights on the standardized values of the aircraft attributes used to form the two factors. For example, the first factor is formed as

$$F_{1k} = \sum_{j} w_{1j} (X_{jk} - \bar{X}_j) / \sigma_j$$

Where: k indexes individual observations (aircraft model-years); j indexes the aircraft attributes; w is the factor score coefficient; X is the log of the aircraft attribute; and σ is the sample standard deviation of the aircraft attribute.

The direction of the marginal impact of any one of the aircraft attributes depends on the sign of the sum of the products of factor score coefficients for that attribute and the estimated coefficients of the two factors. As expected, each of the attributes has a positive effect on the price variable; that is, a marginal increase in each of the factors is associated with an increase in aircraft price.

WILLINGNESS TO PAY FOR SAFETY

The estimated implicit price equation can be used to measure aviators' willingness-to-pay for safety. In particular, since safety has been defined as one minus the fatal accident rate, an estimate of the implied value that aviators' place on a statistical life can be derived.

An estimate of aviators' willingness-to-pay for a reduction in mortality risk can be derived from the compensated (inverse) demand for safety. This is given by

$$P_s = 1,865,291,677 \; S^{-3307.85}$$

where P_s in the (marginal) implicit price of safety (the procedures employed to derive this expression and the value of a statistical life are described in the Appendix).

The area under the compensated demand curve yields a measure of aviators'

TABLE 1

Estimated Implicit Price Equation

Variable	Estimated Coefficients	T-Ratio
Intercept	12.546	-
F_1	0.844	53.1
F_2	0.562	50.5
PD	0.566	13.3
1n S	6488.030	8.5
Number of cases = 1,145		
Adjusted R^2 = .92		
F-Ratio = 3286		

TABLE 2

Factor Score Coefficients

Variable	F_1	F_2
Number of seats	.23781	-.15800
Year of Manufacture	-.17794	1.02036
Gross Weight	.21918	.00746
Cruising Speed	.22450	.00167
Climb Rate	.22905	-.05276
Useful Load	.21310	.02620

willingness-to-pay for a given reduction in mortality risk. The mean fatal accident rate of aircraft included in the sample is about two per 100,000 flight hours. Integrating between rates of 1.5 and 2.5 yields an estimate of aviators' willingness-to-pay for a unit reduction in the fatal accident rate of $19,930. This figure represents the present value of an aviators' willingness-to-pay for a small improvement in safety over the average remaining life of aircraft in the sample. Using a ten percent discount rate and a sample average remaining aircraft life of 14.36 years, the annual value of a unit reduction in fatal accidents per 100,000 flight hours is $2430. The average flight time for a typical aviator in 1986 was 188 hours; this implies a value of $1,292,553 is placed on the avoidance of one fatal accident (i.e., $2430 X 100,000/188). Since the average accident in the sample results in 1.7 fatalities, the implied value of a statistical life is $740,341.

Potential Bias

There are two potential sources of bias to the above estimate of aviators' willingness-to-pay for reduced mortality risk, both arising from the measure of safety adopted in this study. First, the safety variable captures the total variation in fatal accident rates across aircraft types. Some of this variation may be due to differences in the characteristics of pilots, airport characteristics and differences in regional accident rates. The problem here is that aviators, in theory, will be willing to pay only for safety embedded in the aircraft and not safety attributable to other factors (e.g., an inexperienced pilot cannot necessarily reduce risk by purchasing an aircraft typically flown by experienced pilots). Because the safety variable overstates the variation in safety embedded in aircraft, the model understates marginal willingness- to-pay for reduced risk (i.e., aviators would be willing to pay a given amount for a smaller improvement in safety).

The second source of bias may cause the estimate of the value of reduced mortality risk to be overstated if fatal and nonfatal accident rates are correlated. This will occur because some of the value attributed to reduced mortality may reflect willingness-to-pay for reduced risk of nonfatal accidents. The extent of the bias will depend on the degree of correlation between fatal and nonfatal accident rates and the extent to which variations in insurance premiums reflect variations in safety embedded in aircraft types.

Unfortunately, there are problems inherent in the data for nonfatal accidents. First, nonfatal accident rates reflect a wide range of severity, both in terms of bodily injury and property damage. Second, data on nonfatal accidents are probably less reliable than data on fatal accidents because the investigations of the former are less intensive.

Comparison to Other Studies

The estimated value of a statistical life reported above falls in the lower range of estimates reported in the literature to date. A recent survey of the literature by Miller (1986) updates the results of several studies and adjusts estimates of the value of life to a common year. Miller also filters out studies with obvious methodological inadequacies. The average estimate of the value of life included in the survey was $1.4 million in 1986 dollars. These studies generally cover a broad cross-section of the population, while the results reported here focus primarily on owners of small piston aircraft. Because flying is perceived to be risky by most of the public, the results of this study probably reflect, in part, lower risk aversion for general aviation pilots than is typical for the population at large. In addition, the estimate reported here may be understated to the extent that it reflects two countervailing sources of potential bias.

CONCLUSION

The findings reported here indicate that general aviators do recognize the implicit value of differentials in safety performance between aircraft, and bid up the prices that they are willing to pay to own and operate safer aircraft. This result is significant at a high level of statistical confidence.

The implied value of a statistical life is estimated at about $740,000, measured in 1986 dollars. This estimate falls in the lower range of previous estimates reported in the literature and may, in part, reflect lower risk aversion for general aviation pilots than is typical for the public at large. The estimate should also be interpreted in view of two countervailing sources of potential bias inherent in the measure of safety that is employed.

Since this is the first attempt to estimate general aviators' willingness-to-pay for reduced mortality risk, the results of this study have implications for public policy. Because Federal Aviation services are not provided in a market setting, the results of this study could be used to evaluate the safety benefits of new regulations or investments in airport or airway systems used by the general aviation community.

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ENDNOTES

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APPENDIX

A detailed description of the methods employed to compute the estimated value of a statistical life is provided. A Cobb-Douglas aircraft subutility function is employed because its parameters, which represent budget shares for the aircraft attributes, can be identified from the estimated implicit price equation (Step 4). The value of life calculations in Step 11 assume an annuity paid at the beginning of each time period. As before, the subscript j indexes aircraft attributes.

Step 1 – Estimated Hedonic Price Function

$$1nP = \alpha_0 + \alpha_1 F_1 + \alpha_2 F_2 + \alpha_3 PD + \alpha_s 1nS$$

$$1nP = 12.546 + .844F_1 + .562F_2 + .556PD + 6488.01nS$$

where,

F_1 = Factor 1 which is primarily made up of the following variables: maximum number of seats, gross weight, climb rate, cruising speed, and maximum carrying capacity.

F_2 = Factor 2 which is made up primarily of the year of manufacture of the aircraft.

PD = Pressurization dummy variable.

1nS = Natural log of safety, defined as one minus the fatal accident rate.

Then using: $F_1 = 1nX_1$

$F_2 = 1nX_2$

$PD = 1nX_3$

$$1nP = \alpha 0 + \alpha_1 1nX_1 + \alpha_2 1nX_2 + \alpha_3 1nX_3 + \alpha_s 1nS$$

$$1nP = 12.546 + .8441nX_1 + .5621nX_2 + .5561nX_3 + 6488.01nS$$

Step 2 – Take Antilog of Estimated Hedonic Function and Derive Mean Estimated Price Using Sample Mean Values

$$P = e^{\alpha_0} X_1^{\alpha 1} X_2^{\alpha 2} X_3^{\alpha 3} S^{\alpha_s}$$

$$P = 280{,}969 X_1^{0.844} X_2^{0.562} X_3^{0.556} S^{6488.03}$$

$$\bar{P} = 280{,}969 \bar{X}_1^{0.844} \bar{X}_2^{0.562} \bar{X}_3^{0.556} \bar{S}^{6488.03}$$

using sample mean values:

$\bar{X}_1 = 1.011$ $\bar{X}_2 = 1.312$ $\bar{X}_3 = 1.108$ $\bar{S} = .99998$

$$\bar{P} = 280{,}969\ (1.011)^{0.844}(1.312)^{0.562}(1.108)^{0.556}(.99998)^{6488.03}$$

$$\bar{P} = 307{,}154$$

APPENDIX (Continued)

Step 3 – Compute Mean Attribute Prices Using Mean Sample Values

$\bar{P} = \alpha P/\alpha x_1 = \alpha_1 (\bar{P}/\bar{X}_1) = 256{,}418$

$\bar{P} = \alpha P/\alpha x_2 = \alpha_2 (\bar{P}/\bar{X}_2) = 131{,}571$

$\bar{P} = \alpha P/a x_3 = \alpha_3 (\bar{P}/\bar{X}_3) = 154{,}132$

$\bar{P} = \alpha P/a s_s = \alpha_s (\bar{P}/\bar{S}) = 1{,}992{,}868{,}564$

Step 4 – Using Cobb-Douglas Utility Function for Utility Derived from Aircraft Use, Compute Budget Expenditure Share

$U = X_1^{\gamma 1} X_2^{\gamma 2} X_3^{\gamma 3} S^{\gamma s}, \ \Sigma j = 1$

γj = budget expenditure share $\alpha j/\Sigma\alpha j$

$\Sigma\alpha j = 0.844 + 0.562 + 0.556 + 6488.03 = 6490$

$\gamma 1 = 0.844/6490 = .00013004$

$\gamma 2 = 0.562/6490 = .00008659$

$\gamma 3 = 0.556/6490 = .00008567$

$\gamma s = 6488/6490 = .9996977$

Step 5 – Compute Mean Utility Using Sample Mean Values From Step 2

$\bar{U} = \prod_j X_j^{\gamma j} S^{\gamma s}$

$\bar{U} = \bar{X}^{.00013} \bar{X}_2^{.000086} \bar{X}_3^{.000086} \bar{S}^{.9997} = 1.000013$

Step 6 – Form Ordinary Demand Expressions

$D_{xj} = \gamma j (B/P_j)$

$D_s = \gamma s (B/P_s)$

where, $B = \text{Budget} = \Sigma P_j Q_j$

Step 7 – Form Indirect Utility Function by Substituting Ordinary Demand Functions in Step 6 into Direct Utility Function from Step 5

$\bar{U} = \prod_j (\gamma_j B/P_j)^{\gamma j} (\gamma s B/P_s)^{\gamma s}$

$= dB\, P_j^{-\gamma j} P_s)^{\gamma s}$

where,

$d = \prod_i \gamma j^{\gamma j} = .99692653$

APPENDIX (Continued)

Step 8 – **Solve For Expenditure Function (Minimum Cost Function) by Inverting Indirect Utility Function in Step 7 and Evaluate at Constant Utility (Mean Utility in this Case)**

$$B = (P_1^{\gamma 1} P_2^{\gamma 2} P_3^{\gamma 3} P_s^{\gamma s} \bar{U}) \, / \, d$$

Step 9 – **Derive Mean Compensated Demand for Safety by Differentiating Expenditure Function With Respect to the Price of Safety (Using Shephard's Lemma) and Evaluate Using Mean Attribute Prices and Mean Utility**

$$S = \alpha B / \alpha P_s = \gamma s (\Pi P_j^{\gamma j} P_s^{\gamma s\text{-}1} \bar{U}) \, / \, d$$

Using sample mean values:

$$S = 1.006473342 \; P_s^{-.0003023}$$

$$P_s = 1{,}865{,}291{,}677 \; S^{-3307.85}$$

$$P_s = 1{,}865{,}291{,}677 \; (1\text{-}F/100{,}000)^{-3307.85}$$

Step 10 – **Integrate Under Compensated Demand in Neighborhood of Sample Mean for a Change in Fatal Accidents of 1 per 100,000 Person-Hours of Flight (A Reduction in Accident Rate From 2.5 to 1.5 Around the Mean of 2.0) To Derive Willingness-to-Pay**

$$\int_{F_2}^{F_1} 1{,}865{,}291{,}677 \; (1\text{-}F_A/100{,}000)^{-3307.85} \, dF$$

$$= \Big|_{F_2}^{F_1} \frac{1{,}865{,}291{,}677}{1\text{-}3307.85} (1\text{-}F_A/100{,}000)^{1\text{-}3307.85}$$

$$= -564{,}069[F_1^{-3306.85} - F_2^{-3306.85}]$$

$$= -564{,}069[.999985)^{-3306.85} - (.999975^{-3306.85}]$$

$$= \$19{,}929.56$$

Step 11 – **Value of Life Calculations**

The value of life is computed for a single year using an annual annuity value equal to the total willingness-to-pay discounted over the average remaining life of all aircraft.

a. **Calculate annuity amount which over the average remaining life of all aircraft yields the willingness-to-pay calculated in steps 1-10.**

Interest Rate Used:	**10%**
Average Remaining Aircraft Life:	**14.36 Years**
Annual Willingness-to-Pay:	**$2,430.05**

APPENDIX (Continued)

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b. **Implied Value of Life**

Mean Flight time in 1986:	188.0 hours/year
Lives Lost per Accident:	1.7 Lives
Change in Fatal Accident Rate:	1 per 100,000

$$\text{Value of Life} = \frac{\$2{,}430 \times 100{,}000}{1.7 \times 188.0} = \$760{,}341$$
