Depreciation Systems

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IOWA STATE UNIVERSITY PRESS / AMES

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Printed on acid-free paper in the United States of America

First edition, 1994

Library of Congress Cataloging-in-Publication Data

Wolf, Frank K.
Depreciation systems / Frank K. Wolf, W. Chester Fitch.—1st ed.
p. cm.
Includes bibliographical references and index.
ISBN 0-8138-2457-5 (alk. paper)
1. Depreciation. 2. Public utilities—United States—Accounting. 3. Economic life of fixed assets.
I. Fitch, W. Chester. II. Title.
HF5681.D5W65 1994
657'.73—dc20 93-47634

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If these parameters remain constant, then the estimate of the average life will be correct.

Given the proper combination of parameters, it is possible for the Gompertz-Makeham equation to turn upward, so that the number of survivors increases with age and, possibly, exceeds 100%. If the curve exceeds 100% for a short period, then turns downward, the common solution is to set all points greater than 100% to 100%. If the curve takes in a continuous, upward trend, the parameters must be adjusted.

NOTES

1. This treatment assumes retirements occur uniformly during the final age interval and that the life of the longest lived unit is ML + .5 years. If the life of the longest lived unit is known, this value can be used as the end of the final age interval and can be used to calculate the midpoint of the final interval.

2. The maximum life for this Iowa R2 curve is 9.0 years. If the final age interval had been defined to be 8.5 to 9.0 years, the corresponding area would have been 0.21 percent-years, and the total area would have been 500.00 percent-years. See note 1.

4 Salvage Concepts

SALVAGE can be divided into two components: gross salvage and cost of retiring. *Gross salvage* is the value of a unit retired from service resulting from its sale for scrap or reuse. *Cost of retiring,* also called cost of removal, is the expense incurred to remove the unit from service, including expenses necessary to return the environment to an acceptable condition. Thus, *net salvage* is the gross salvage less the cost of retiring.

The original cost less net salvage is called the *depreciable base*. It represents the capital consumed during the life of the unit and the amount to be recovered through depreciation. If the net salvage is positive, then the capital consumed is less than the original cost. If the net salvage is negative, the capital consumed is greater than the original cost.

When net salvage is zero or near zero, its effect on the depreciable base is nil. However, industrial property exhibits a wide range of salvage, and the effect of salvage on the annual accrual is often substantial. Examples of property yielding positive salvage include land, which is generally assumed to be fully recoverable; buildings and vehicles, which often have significant resale value; and aluminum or copper wire, which has a gross salvage value determined by the intrinsic value of the material. Utility poles and railroad track are often reused, and if the accounting system defines a unit as retired when it is removed from a location, its salvage is determined by its value when it is installed in a new location. On the other hand, underground pipe used for transportation or distribution of gas or water must first be disconnected and then may be filled and capped, or even removed from the ground. These activities are costly because they require significant labor and heavy equipment, while the gross salvage is nil or negligible. The result is a net salvage that is often both large and negative. Decommissioning costs of a nuclear generating plant are a contemporary example of an investment with a significant negative net salvage.

Basic salvage concepts must be understood before either the analysis of realized salvage or the forecasting of future salvage can be discussed. Most of these concepts can be applied equally well to either gross salvage or cost of removal, so the term *salvage* is used generically to apply to net salvage, gross salvage, or cost of retiring.

Property placed in service during the same year forms a *vintage group*. The fraction of the vintage group remaining in service is a function of its age and is described by a survivor curve. An underlying functional relationship between the age at retirement and salvage is assumed. A formal development of how salvage changes as property ages is necessary to understand the effect of salvage on depreciation.

A salvage curve is the graph of the salvage ratio versus age. The salvage ratio is the ratio of the salvage to the original cost of the retired unit. The salvage received during any age interval is found by multiplying the salvage ratio for that interval by the dollars retired during that interval. The net salvage ratio is the gross salvage ratio less the cost of retiring salvage ratio.

As one example of a salvage curve, consider property that is easily removed from service and is still functional after retirement. Gross salvage of early retirements will be high if the property is in good condition and the technology is current, because the property will be valuable for sale or reuse. Older retirements would be less valuable because, besides their added wear, they would be competing for use with property that has a more current technology. If the cost of retiring is assumed to be near zero, this model would lead to a net salvage schedule where the salvage ratio is initially near one, but then decreases with age. This example could be expanded to include retirements resulting from damage from an accident or mechanical failure. Because of their physical condition, these units would have a salvage ratio near zero and would lower the overall salvage ratio.

A salvage curve need not decrease with age. The gross salvage of scrap copper, steel, or aluminum typically, because of inflation, increases with age. A cost of retiring that is labor and equipment intensive is another example of a salvage curve that, because of inflation, increases with age. Because this element of salvage is a cost, the term "increases with age" means the salvage becomes more negative with age. Retirement of a utility pole is an example of an activity for which the hours required to remove the pole might remain relatively constant, but the hourly labor rate, and therefore the cost of retirement, would increase as the pole ages.

There are three reasons why it is important to consider salvage as a

function of age, rather than simply using an overall average salvage. First, though the average life (AL) procedure uses an accrual rate based on the average net salvage, the equal life group (ELG) procedure uses the net salvage associated with each equal life group (i.e., salvage by age). Second, the calculated accumulated depreciation (CAD) model must reflect the change in salvage with age if it is to approximate the accumulated provision for depreciation. Because the CAD is the feedback measure used to determine the adequacy of the accumulated provision for depreciation, it is important that the model used be as lifelike as possible. When the remaining life method of adjustment is used, the amount to be recovered is found by adjusting for the future salvage. These first two reasons show that regardless of the system of depreciation used, both the average and the future salvage are required. Finally, considering salvage as a function of age results in a more realistic model and therefore enhances understanding of the depreciation process and aids in forecasting.

THE SALVAGE RATIO

One inherent characteristic of the salvage ratio is that the numerator and denominator are measured in different units; the numerator is measured in dollars at the time of retirement, while the denominator is measured in dollars at the time of installation. Inflation is an economic fact of life and although both numerator and denominator are measured in dollars, the timing of the cash flows reflects different price levels. Consider the pattern of installations and retirements illustrated in Figure 4.1 (see end of chapter).

Two replacement cycles are represented. The installation cost of the first unit is B dollars, it lasts K years, and has a net salvage of V dollars. The salvage ratio of the first unit is SR(present) = V/B. If the cost of the replacement when measured in constant dollars is equal to the cost of the first unit, then the replacement cost measured in inflated dollars is $B \times (1 + p)^K$. The factor $(1 + p)^K$ is called the compound amount factor and equals the value of $1 after K years when the annual rate of inflation is p. Suppose the life of the replacement unit is L years and during its life the annual rate of inflation is f. Then the future salvage of the replacement is $V \times (1 + f)^L$. The salvage ratio of the replacement is SR(future) = $V \times (1 + f)^L/B \times (1 + p)^K$. If the past inflation rate p equals the future inflation rate f, and if the life of the original equals that of the replacement, so that K equals L, then the two inflation factors will be equal. The salvage ratio for the replacement will equal V/B, unchanged from the original ratio.

This simple model illustrates two important characteristics of the salvage ratio when the uninflated original cost and uninflated salvage remain constant. One is that a change in the inflation rate will cause a change in the salvage ratio. The other is that a change in service life will change the salvage ratio.

The magnitude of the change in salvage ratio depends on p, f, K, and L. As an example, assume that the past inflation rate, p, has been 3% during the past K years, that V/B = 10%, and that the life of the replacement is also K years. Future salvage ratios are determined by the function $10\% \times [(1 + f)^K/(1 + p)^K]$. Table 4.1 (see end of chapter) shows future salvage ratios for different values of f, the inflation rate during the life of the replacement, and different lives. Notice that if the inflation rate does not change, then the salvage remains unchanged regardless of the life. But if the inflation rate increases, the salvage ratio increases. The longer the life and the greater the change in inflation rate, the more the future salvage ratio deviates from the present 10% ratio. Also note the nonlinear relationship between the salvage ratio and the variables f and K.

Table 4.1 uses future inflation rates that are equal to or greater than the inflation rate during the life of the first unit. If a similar table is constructed using future inflation rates that are equal to or less than the inflation rate during the life of the first unit, then the salvage ratios will be equal to or less than the 10% ratio experienced by the first unit.

Inflation does not affect all segments of the economy equally. The cost of construction, capital equipment, and labor can all increase at different rates. Because the cost of retiring is often labor and equipment intensive, this element of salvage may be closely tied to indexes that reflect labor and equipment costs. Gross salvage values may be closely tied to used equipment costs and are likely to inflate at a different rate than the cost of retiring. Allowing for different inflation rates for capital equipment, gross salvage, and cost of retiring requires modification to the model just presented.

Assume the inflation rates affecting the cost of replacing the first unit and the gross salvage are equal and constant during the replacement cycle; call this rate h. Assume that the cost of retiring inflates at a different rate; call this rate j. After L years the net salvage, V, will equal the (uninflated gross salvage) $\times (1 + h)^L$ − (uninflated cost of retiring) $\times (1 + j)^L$. We can use this model to find how the net salvage ratio is affected when these two inflation rates differ.

As an example, assume that the current gross salvage ratio is 20% and that the current cost of retiring ratio is 10%, so that the net salvage ratio is 20% − 10% or 10%. The future net salvage ratio will be the net salvage at the end of the life of the replacement unit divided by the installed cost of the replacement unit, or $[20\% \times (1 + h)^L - 10\% \times (1 + j)^L]/(1 + h)^L$. Assume that h is 3% and that the lives of the initial unit and the replacement unit both equal L years. Table 4.2 (see end of chapter) shows future salvage ratios for various values of L and j. Notice that as the difference between h and j becomes larger, the cost of retiring increases faster than the gross salvage. In our example, the cost of retiring catches and exceeds the gross salvage for the larger values of j and the longer lives. The result is negative net salvage.

The salvage ratio as a function of age and inflation rate can be modeled using the equation $(V/B) \times (1 + p)^A$. Table 4.3 (see end of chapter) shows that if the net salvage at time of installation remains constant except for inflation, the observed salvage ratio will vary significantly with time. For example, if the inflation rate was 6% and the salvage ratio at age zero is equal to 10%, the salvage ratio at age 5 would be 13.38% and by age 20 would have increased to 32.07% simply because of inflation. Because the value of the function $(1 + p)^A$ increases rapidly as A becomes large, the factors for a large age (e.g., 40 years) are significantly greater than the 10% initial value.

Recognition of the effect of inflation on salvage will influence the analysis and forecasting of salvage. To find the effect of inflation, it is necessary to understand and calculate the time value of money.

THE SALVAGE CURVE

A salvage curve has been defined as the graph of the salvage ratio as a function of the life of the property. To calculate the average salvage ratio, or the future average salvage ratio at any age, *both the salvage curve and the survivor curve must be known.*

The net salvage curve is the gross salvage curve less the cost of retiring curve. The method of calculating the average salvage ratio (ASR) is to calculate a weighted average of the salvage ratios for each age interval as shown below.

$$ASR = E(\text{salvage ratio}) = \Sigma\, f(i)g(i) \qquad \text{for } i = 1,2,3, \ldots, ML$$

where f(i) = the retirement frequency during age interval i and g(i) = the salvage ratio during age interval, or the ratio evaluated at the midpoint of interval i, where the age intervals and indexes i are defined as

i	interval i	x(i)
0	$0.0 \le$ service life < 0.5	.25
1	$0.5 \le$ service life < 1.5	1.00
2	$1.5 \le$ service life < 2.5	2.00
3	$2.5 \le$ service life < 3.5	3.00
ML	$ML - .5 \le$ service life $< ML + .5$	ML

where x(i) = the midpoint of age interval i and ML = the maximum service life.

The functions f(i) and g(i) also can be described as continuous functions and the equation written in integral form, but this offers little computational advantage. Discrete functions and the age intervals defined above are consistent with the methods used to describe service life.

Two more measures of salvage are

$$RSR(i) = \text{the realized salvage ratio at the start of age interval } i$$
$$= \Sigma f(k)g(k) / \Sigma f(k) \quad \text{for } k = 1, 2, 3, \ldots, i-1$$
$$FSR(i) = \text{the future salvage ratio at the start of age interval } i$$
$$= \Sigma f(k)g(k) / \Sigma f(k) \quad \text{for } k = i, i+1, i+2, \ldots, ML$$

Suppose that the frequency curve and the salvage curve of a group of property are as shown below. The units are retired at ages 0.25, 1, 2, or 3 years with corresponding salvage ratios of 15%, 10%, 5%, or 0%.

Retirement Frequency Curve	Salvage Ratio Curve
f(0) = .20	g(0) = .15
f(1) = .30	g(1) = .10
f(2) = .40	g(2) = .05
f(3) = .10	g(3) = .00
Total = 1.00	

The average salvage ratio is then calculated as

$$ASR = \Sigma f(i)g(i) \quad \text{for } i = 1,2,3,4$$
$$= (.20)(.15) + (.30)(.10) + (.40)(.05) + (.20)(0) = 0.08 \text{ or } 8.0\%$$

Suppose it is the start of the age interval 1.5 to 2.5 years, so that the index i equals 2. The realized salvage ratio at age 1.5 years, RSR(2), is determined by salvage realized during the first two age intervals, so that.

$$RSR(2) = [(.20)(.15) + (.30)(.10)]/[.20 + .30] = 0.12 \text{ or } 12\%$$
$$FSR(2) = [(.40)(.05) + (.10)(.00)]/[.40 + .10] = 0.04 \text{ or } 4\%$$

Note that the weighted average of the realized and future salvage ratios equals the average salvage ratio:

Weight for RSR(2) = .20 + .30 = .50
Weight for FSR(2) = .40 + .10 = .50
Weighted average salvage = ASR = .50 × 12% + .50 × 4% = 8%.

Table 4.4 (see end of chapter) shows the salvage calculations for an Iowa R2 curve with a 5-year average life (R2–5). Column (c) is the percent retired during the age interval and is found by subtracting successive points on the survivor curve shown in column (b). Column (d) shows the average salvage ratio during the age interval. Note that the salvage ratios in this schedule increase with age.

The salvage observed during the age interval depends on both the salvage per unit and the number of units retired. Column (e) is the product of the salvage ratio and the fraction retired. It equals the salvage during the age interval as a percent of the initial cost. During the age interval 2.5 to 3.5 years, the salvage equals 1.21% of the initial cost. The sum of these amounts is the total salvage over the life of the group expressed as a percent of the initial cost; this is the average salvage ratio, which is 13.46%.

Column (f) is the realized salvage ratio and represents the average that would result if an observer recalculated the average salvage ratio at the start of each age interval or each year. The average salvage at age 2.5 years depends on the salvage during each of the preceding three age intervals. The salvage during these intervals is summed to obtain 0.11% + 0.38% + 0.70% or 1.19%. This amount must be divided by the fraction retired by that age, or 1 − 0.8913 or 0.1087, to obtain 1.19%/0.1087 or 10.92%. The realized salvage ratio at the start of the second age interval equals the average during the first age interval. As the age increases, the realized salvage ratio approaches the average salvage ratio. At the end of the final age interval the realized salvage ratio, 13.46%, equals the average salvage ratio.

Column (g) is the future salvage ratio, or salvage expectancy, at the start of each age interval. The future salvage ratio at any age is the average salvage ratio observers would calculate if they recorded the salvage from that time on. At age zero the future salvage ratio and the average salvage ratio are equal because both averages include all future salvage ratios. At age 6.5 years, future salvage depends on the salvage during each of the three remaining age intervals. The salvage during these intervals is summed to obtain 2.25% + 1.04% + 0.14% or 3.43%. This amount must be divided by the future amount to be retired, which is the fraction in service at age 6.5, or 22.32%, to obtain 3.43%/0.2232 or 15.37%. Because the ratios in this salvage schedule increase with age, the future salvage ratios also increase with age.

At any time, the average of the realized and future salvage ratios will equal the overall average salvage. At age 3.5 years, the weighted average of the realized and future salvage ratios is 11.40% × (1 − .7901) + 14.01% × (.7901) or 13.46%. Figure 4.2 (see end of chapter) is a graph of the salvage ratio, future salvage ratio, and realized salvage ratio versus age.

Salvage Schedule Models

A survivor curve must start at 100% and decrease monotonically to zero, but there are no similar constraints for the salvage schedule. The salvage curve can be either increasing or decreasing and need not be monotonic. It need not start at 100% nor end at 0%. There are, however, several basic models that approximate actual patterns and are therefore useful to the analyst and forecaster. We will describe each first in constant dollars and then add inflation. The curve with inflation represents the salvage curve that would be constructed from observed data. The curve without inflation shows the underlying model and is therefore useful when analyzing salvage data.

The first model is a salvage ratio that, when measured in constant dollars, remains constant. This model could reflect the gross salvage of property whose major value is as scrap so that the gross salvage would equal the intrinsic value of the material. It also could be applied to the cost of retiring when the method of removal remains unchanged with time. Table 4.5 (see end of chapter) shows a salvage curve with ratios equal to 10% at all ages. The survivor curve in column (b) is an Iowa R2–5. The salvage curve is shown in column (c); all ratios are equal to 10%. Column (d) is the product of the fraction retired during the age interval and the salvage ratio shown in column (c), and when these are summed the average salvage ratio is found to be 10%. Because the future salvage is needed when calculating depreciation, the future salvage ratios are shown in column (e).

Columns (f), (g), and (h) contain the inflated curves. The inflated ratio is found by multiplying the corresponding, uninflated ratio by the compound amount factor $(1 + i)^{AGE}$ where i is the inflation rate. The salvage curve for the constant model with inflation increases exponentially with age. The 6% inflation rate increases the average salvage ratio from 10% to 13.46% and the salvage ratio at the maximum life, 9 years, to 16.89%. Figure 4.3 (see end of chapter) is a graph of these salvage ratios both with and without inflation. Remember that the difference between the uninflated and inflated salvage ratios increases with age. If an example using a survivor curve with an average life longer than 5 years had been used, the difference between the two ratios would be even larger.

The second model is one in which the salvage ratio decreases uniformly with age. The linear model shown in Table 4.6 and Figure 4.4 (see end of chapter) starts at 100% at age zero (and averages 97.37% during the first age interval) and ends at 0% at age 9.5 years with a resulting annual decrease of 100%/9.5 or 10.53%. The initial value need not be 100%. Suppose, for example, that 20% of the capitalized cost was installation cost. If the property was removed immediately after installation, installation cost

would be lost and, if the full price of the unit was recovered, the salvage ratio would be 80%.

If the survivor curve is symmetrical, the average salvage ratio for the constant dollars model will be the salvage ratio at the midpoint of the curve, which here is the average of the initial and final salvage ratios. Because the survivor curve is the right modal R2 curve, more weight is given to early retirements and the average salvage is less than 50%.

The linear model with inflation also decreases, but in a nonlinear fashion. The shape of the linear model with inflation depends on slope of the line and the inflation rate. The constant model can be considered a special case of the linear model.

The third model reflects an accelerated rate early in life. This model would be particularly applicable to gross salvage when the value falls rapidly early in life and then decreases more slowly later in life. Property such as automobiles and electronic equipment are examples that might follow this pattern. Several mathematical functions could be used to describe this pattern, but a function similar to that used to calculate sum-of-years–digit depreciation was chosen.

To obtain an accelerated curve, first identify the maximum life, ML, and then sum the digits $1 + 2 + 3 + \ldots + ML = (ML)(ML + 1)/2 = D$. Next find the total amount by which the salvage ratio will decrease, which is $S(0) - S(ML)$. Then find the numerator of the rate for each age interval i. For age interval 0 to 0.5 years, this is ML/2. For all other age intervals it is $ML - i + 0.5$. The annual decrease of salvage during age interval i is the product of the total amount of decrease times $(ML - i + .5)/D$.

Table 4.7 (see end of chapter) shows the calculation of the average salvage ratio curve using the accelerated model. The initial salvage ratio, S(0), was chosen to equal 100% and the salvage ratio at the maximum life was chosen to equal zero, so that S(ML) = 0%. The maximum life of the R2–5 occurs during age interval i = 9, or during the age interval 8.5 – 9.5 years. The sum of digits 1 through 9 is 45. Column (b) shows the numerator of the rate, which is $L/2 = 9/2 = 4.5$ for the first interval and $9 - (i + 0.5)$ thereafter. The numerator decreases by 1 each year and the value during the final age interval is always 0.5. Each year the salvage decreases by an amount equal to the total decrease, 100%, times the weight in column (b) divided by 45. During age interval 2.5 – 3.5 this amount is $100\% \times (9 - 3 + 0.5)/45$ or 14.44%. Because the salvage at age zero is 100%, the value at the end of the first age interval, column (e), is 100% less the decrease of $(4.5/45) \times 100\%$ or 10%, or 90%. This amount is carried forward to the start of the next age interval. The average salvage during the age interval is shown in column (f).

Table 4.8 (see end of chapter) shows the salvage ratios that would result if life characteristics are described by the Iowa R2–5 survivor curve and the salvage shown in Table 4.7 is used; the table also shows the salvage ratios with an inflation rate of 6% applied. Figure 4.5 (see end of chapter) shows the salvage ratios without and with inflation plotted versus age.

Aged Data

Salvage curves reflecting historical salvage can be constructed from aged retirement data using the same techniques used to develop life tables. Because the forces affecting gross salvage and cost of retiring are often independent, these two costs should be recorded, analyzed, and forecasted separately. The net salvage is obtained by subtracting the cost of retiring from the gross salvage.

The requirements for aged salvage data are similar to the requirements for aged retirement data. As with aged retirement data, aged salvage data can be organized in a matrix with rows designating placement years and columns designating experience years.

Data from two sources are necessary to calculate the salvage curve for a vintage group. One set of data is the total salvage dollars during each experience year for the vintage under consideration. The salvage is either the gross salvage or the cost of retiring, depending on which salvage curve is being developed. The second set of data is the annual dollars retired during each experience year of the vintage under consideration. The salvage ratios are calculated directly from these data. The total salvage during the year depends on both the total number of retirements per year and the salvage per unit. The quotient of the total salvage divided by the original cost of the retirements equals the salvage ratio for that experience year.

The first three rows in Table 4.9 (see end of chapter) show the gross salvage, the cost of retiring, and the dollars retired from a 1982 vintage. Remember that the retirements are measured in original cost dollars (i.e., 1982 dollars), but the gross salvage and cost of retiring are measured in experience-year dollars. The ratios are the salvage dollars divided by the dollars retired for the same year. The survivor curve for this placement group shows about 22% of the property installed in 1982 is still in service at the end of 1988, so the resulting survivor curves do not reflect the complete history of the vintage group.

Conversion to Constant Dollars

An observed salvage ratio is a ratio of dollars at time x + age over dollars at time x, where x represents the year in which the property was installed. This ratio of mixed dollars often obscures underlying salvage patterns. For example, in the constant model presented in the previous section, the ratios were uniform only when measured in constant dollars, and the shape of the inflated, or observed, curve concealed the uniform pattern. The underlying patterns are also concealed in the linear and accelerated models. Conversion of the inflated ratios to ratios of constant, or uninflated, dollars reveals the underlying model and is therefore of value to the analyst.

The examples shown in Tables 4.5 through 4.9 assumed inflation at a constant annual rate of 6%. A more accurate view would be that each year is associated with a unique inflation factor and that the product of the annual factors, rather than an average, should be used in the discounting or adjusting process.

An important question centers on which inflation factor to use. Perhaps the most common index is the consumer price index (CPI), which is familiar because it reflects changes in the weighted price of goods and services used by the typical U.S. consumer. It recognizes that different segments of the economy, (e.g., health care, food, housing, energy) have different rates of inflation and that the result is a weighted average of these.

It is desirable to obtain specialized indexes that reflect the inflation rates in special segments of the economy, and in fact firms specialize in estimating these factors. Different indexes may apply to gross salvage and cost of retiring, and the appropriate index for gross salvage in one account will generally differ from that of another account. Once the historical indexes are obtained, they can be stored in the data base and updated each year.

The matrix containing the salvage dollars can be adjusted to convert all entries to a common year or reference point. Most indexes have a base year at which the index is set to 1, and other years are measured in reference to it.

Table 4.9 contains an example of salvage data. Suppose that during the period 1982 to 1988 the annual inflation rate was 6%. Table 4.10 (see end of chapter) shows the salvage values introduced in Table 4.9 converted to 1982 dollars, so that salvage and original cost are measured at the same price level. The resulting salvage ratios now have the inflation removed. The annual salvage dollars can be converted to 1982 dollars by dividing by the factor $(1 + .06)^{AGE}$. In 1985 the age is 3, and the factor is $1/(1.06)^3 = 1/1.19$ or 0.840. The observed gross salvage during 1985 was $768 and the observed cost of retiring was $329; multiplying by 0.840 yields 1982 price level values of $645 and $276 respectively.

The underlying patterns can now be seen more easily. Examine the gross salvage ratio and observe that it is approximately linear and declines by about 6% each year. With inflation removed, the cost of retiring ratio is constant and equals 17%.

A first step in salvage analysis is to convert the observed dollars to constant dollars. Then the constant dollar salvage curves can be examined and fit to a model.

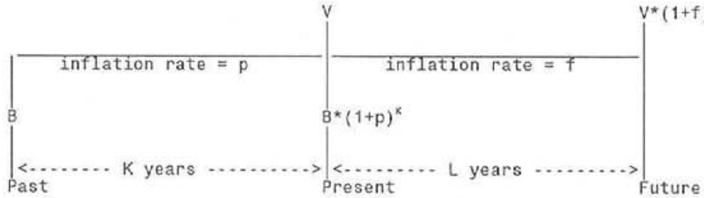

Figure 4.1. A cash flow diagram of investment and salvage costs.

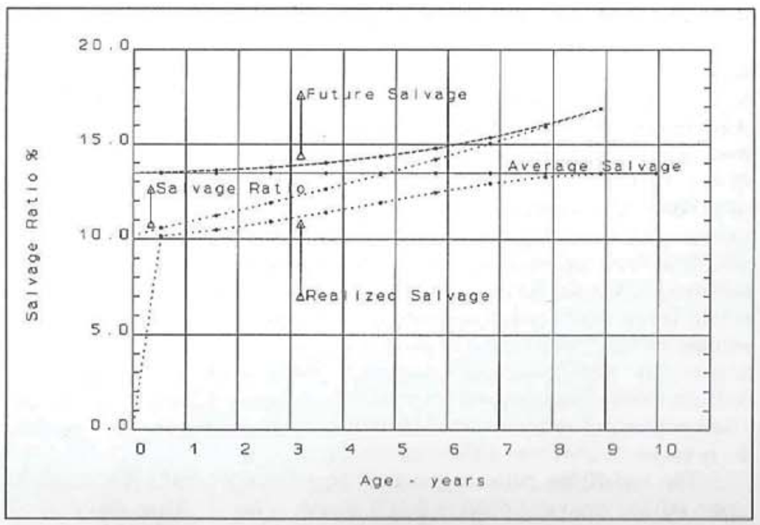

Figure 4.2. A graph of the salvage ratios and the realized and future salvage ratios versus age are for the data shown in Table 4.4.

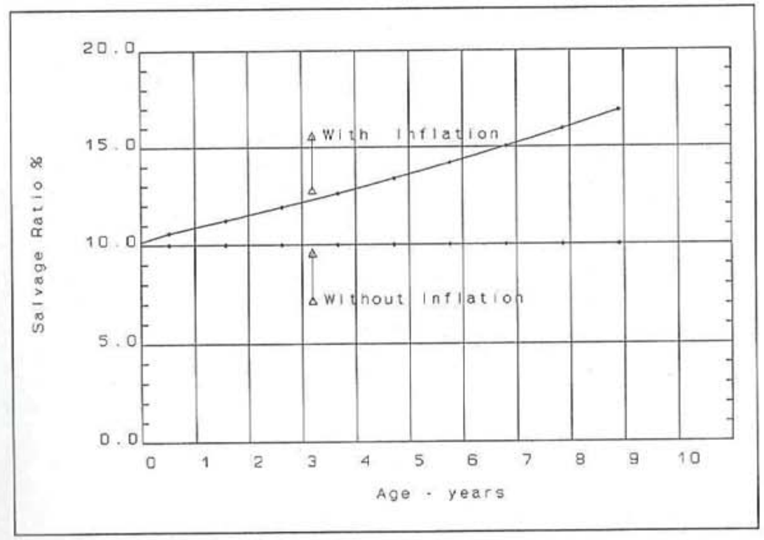

Figure 4.3. A graph of the salvage ratios shown in Table 4.5.

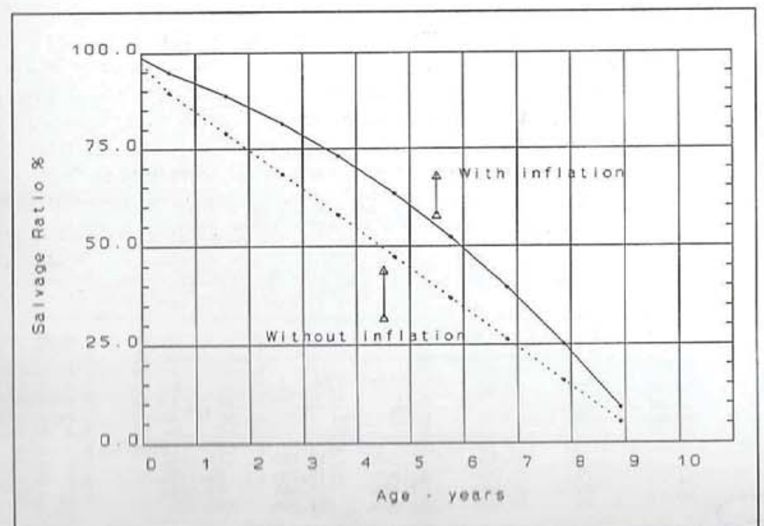

Figure 4.4. A graph of the salvage ratios shown in Table 4.6.

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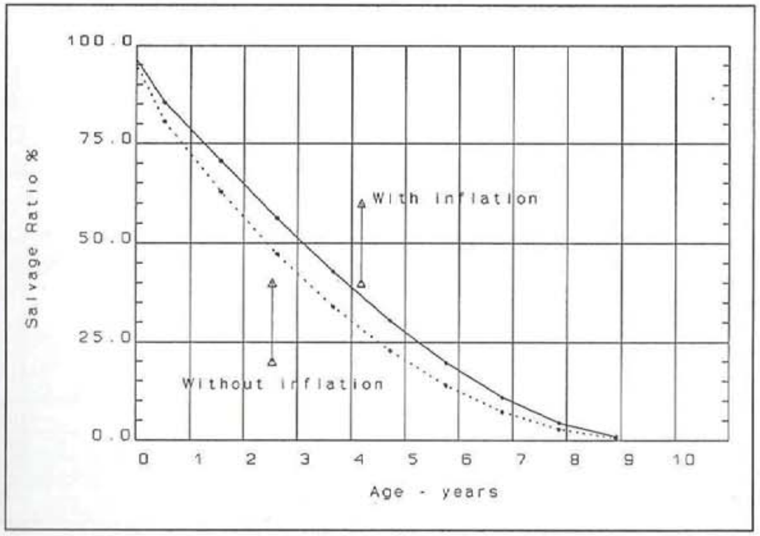

Figure 4.5. A graph of the salvage ratios shown in Table 4.8.

Table 4.1. Future salvage ratios as a function of the future inflation rate, f, and the life of the unit, K. The salvage ratio of the first unit is V/B = 10% and p, the annual rate of inflation during its life, is 3%. The life of the first unit equals the life of the replacement unit (i.e., K = L).

K	Inflation rate - f			
Years	3%	6%	10%	12%
5	10.00%	11.54%	13.89%	15.20%
10	10.00%	13.33%	19.30%	23.11%
20	10.00%	17.76%	37.25%	53.41%
40	10.00%	31.53%	138.75%	265.25%

Table 4.2. Future salvage ratios as a function of the cost of retiring inflation rate, j, when p = 3%, the current gross salvage = 20% of first cost, and the present cost of retiring = 10% of first cost. The life of the first unit equals the life of the replacement unit.

L	Inflation rate - j			
Years	3%	6%	10%	12%
5	10.00%	8.46%	6.11%	4.80%
10	10.00%	6.67%	.70%	-3.11%
20	10.00%	2.24%	-17.25%	-33.41%
40	10.00%	-11.53%	-118.75%	-265.25%

Table 4.3. Salvage ratios as a function of life and inflation rate when V/B = 10%.

Life	Inflation rate - p			
Years	3%	6%	10%	12%
0	10.00%	10.00%	10.00%	10.00%
5	11.59%	13.38%	16.11%	17.62%
10	13.44%	17.91%	25.94%	31.06%
20	18.06%	32.07%	67.27%	96.46%
40	32.62%	102.86%	452.59%	930.51%

Table 4.4. Calculation of average, realized, and future salvage ratios for the salvage schedule shown in column (d) and with life characteristics described by an Iowa R2-5 survivor curve. The percent surviving, realized salvage ratio, and future salvage ratio are all shown at the start of the age interval.

Constant rate w/inflation							
Age interval (a)	Percent survive (b)	Percent retired (c)	Salvage ratio % (d)	Weighted ratio % (e)	Realized salvage % (f)	Future salvage % (g)	Average salvage % (h)
0- 0.5	100.00	1.11	10.15	.11	.00	13.46	13.46
.5- 1.5	98.89	3.56	10.60	.38	10.15	13.50	13.46
1.5- 2.5	95.33	6.20	11.24	.70	10.49	13.61	13.46
2.5- 3.5	89.13	10.12	11.91	1.21	10.92	13.77	13.46
3.5- 4.5	79.01	15.31	12.62	1.93	11.40	14.01	13.46
4.5- 5.5	63.70	20.30	13.38	2.72	11.91	14.34	13.46
5.5- 6.5	43.40	21.08	14.19	2.99	12.44	14.79	13.46
6.5- 7.5	22.32	14.99	15.04	2.25	12.91	15.37	13.46
7.5- 8.5	7.33	6.51	15.94	1.04	13.26	16.05	13.46
8.5- 9.5	.82	.82	16.89	.14	13.43	16.89	13.46
9.5-10.5	.00	--	--		13.46	--	13.46
			Average =	13.46%			

Table 4.5. A salvage curve with a constant rate and 6% inflation.

		* Constant rate			* Constant rate w/inflation *		
Age interval (a)	Percent survive (b)	Salvage ratio % (c)	Weighted ratio % (d)	Future salvage ratio % (e)	Salvage ratio % (f)	Weighted ratio % (g)	Future salvage ratio % (h)
.0- 0.5	100.00	10.00	.11	10.00	10.15	.11	13.46
.5- 1.5	98.89	10.00	.36	10.00	10.60	.38	13.50
1.5- 2.5	95.33	10.00	.62	10.00	11.24	.70	13.61
2.5- 3.5	89.13	10.00	1.01	10.00	11.91	1.21	13.77
3.5- 4.5	79.01	10.00	1.53	10.00	12.62	1.93	14.01
4.5- 5.5	63.70	10.00	2.03	10.00	13.38	2.72	14.34
5.5- 6.5	43.40	10.00	2.11	10.00	14.19	2.99	14.79
6.5- 7.5	22.32	10.00	1.50	10.00	15.04	2.25	15.37
7.5- 8.5	7.33	10.00	.65	10.00	15.94	1.04	16.05
8.5- 9.5	.82	10.00	.08	10.00	16.89	.14	16.89
9.5-10.5	.00	--	--	--	--	--	--
		Average =	10.00%		Average =	13.46%	

Table 4.6. A linear salvage curve starting at 100% and declining to 0%, with 6% inflation.

		* Linear rate			* Linear rate w/inflation *		
Age interval (a)	Percent survive (b)	Salvage ratio % (c)	Weighted ratio % (d)	Future salvage ratio % (e)	Salvage ratio % (f)	Weighted ratio % (g)	Future salvage ratio % (h)
.0- 0.5	100.00	97.37	1.08	47.35	98.80	1.10	60.94
.5- 1.5	98.89	89.47	3.19	46.79	94.84	3.38	60.51
1.5- 2.5	95.33	78.95	4.89	45.19	88.71	5.50	59.23
2.5- 3.5	89.13	68.42	6.92	42.84	81.49	8.25	57.18
3.5- 4.5	79.01	57.89	8.86	39.57	73.09	11.19	54.07
4.5- 5.5	63.70	47.37	9.62	35.16	63.39	12.87	49.49
5.5- 6.5	43.40	36.84	7.77	29.45	52.26	11.02	42.99
6.5- 7.5	22.32	26.32	3.94	22.47	39.57	5.93	34.24
7.5- 8.5	7.33	15.79	1.03	14.61	25.17	1.64	23.35
8.5- 9.5	.82	5.26	.04	5.26	8.89	.07	8.89
9.5-10.5	.00	--	--	--	--	--	--
		Average =	47.35%		Average =	60.94%	

Table 4.7. Calculation of an accelerated salvage curve starting at 100% and declining to 0%.

Age interval (a)	Weight (b)	Change (c)	Salvage at start (d)	Salvage at end (e)	Average salvage (f)
0 - .5	4.5	10.00	100.00	90.00	95.00
.5 - 1.5	8.5	18.89	90.00	71.11	80.56
1.5 - 2.5	7.5	16.67	71.11	54.44	62.78
2.5 - 3.5	6.5	14.44	54.44	40.00	47.22
3.5 - 4.5	5.5	12.22	40.00	27.78	33.89
4.5 - 5.5	4.5	10.00	27.78	17.78	22.78
5.5 - 6.5	3.5	7.78	17.78	10.00	13.89
6.5 - 7.5	2.5	5.56	10.00	4.44	7.22
7.5 - 8.5	1.5	3.33	4.44	1.11	2.78
8.5 - 9.5	.5	1.11	1.11	.00	.56

Table 4.8. A salvage curve with the accelerated model shown in Table 4.7 and with 6% inflation.

		* Accelerated rate			*Accelerated rate w/inflation*		
Age interval (a)	Percent survive (b)	Salvage ratio % (c)	Weighted ratio % (d)	Future salvage ratio % (e)	Salvage ratio % (f)	Weighted ratio % (g)	Future salvage ratio % (h)
0- 0.5	100.00	95.00	1.05	26.60	96.39	1.07	32.99
.5- 1.5	98.89	80.56	2.87	25.83	85.39	3.04	32.28
1.5- 2.5	95.33	62.78	3.89	23.79	70.54	4.37	30.29
2.5- 3.5	89.13	47.22	4.78	21.08	56.24	5.69	27.50
3.5- 4.5	79.01	33.89	5.19	17.73	42.78	6.55	23.81
4.5- 5.5	63.70	22.78	4.62	13.85	30.48	6.19	19.25
5.5- 6.5	43.40	13.89	2.93	9.67	19.70	4.15	14.00
6.5- 7.5	22.32	7.22	1.08	5.68	10.86	1.63	8.62
7.5- 8.5	7.33	2.78	.18	2.53	4.43	.29	4.04
8.5- 9.5	.82	.56	.00	.56	.94	.01	.94
9.5-10.5	.00	--	--	--	--	--	--
		Average =	26.60%		Average =	32.99%	

Table 4.9. Partial retirement and salvage data from the 1982 vintage group. The upper portion of the table shows the gross salvage dollars, cost of retiring, and dollars retired for a vintage group. The lower portion of the table shows the resulting salvage ratios.

	Experience year						
	82	83	84	85	86	87	88
Gross salvage	94	357	470	768	1053	1191	1021
Cost of retiring	27	113	183	329	552	721	784
Annual retirements	157	627	941	1568	2508	3135	3292
Gross salvage ratio	.60	.57	.50	.49	.42	.38	.31
Cost of retiring ratio	.17	.18	.20	.21	.22	.23	.24
Net salvage ratio	.43	.39	.30	.28	.20	.15	.07

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Table 4.10. Conversion of salvage in Table 4.9 to 1982 dollars.

	Experience year						
	82	83	84	85	86	87	88
Gross salvage	94	337	418	645	834	890	720
Cost of retiring	27	106	163	276	437	539	553
Annual retirements	157	627	941	1568	2508	3135	3292
Gross salvage ratio	.60	.54	.44	.41	.33	.28	.22
Cost of retiring ratio	.17	.17	.17	.18	.17	.17	.17
Net salvage ratio	.43	.37	.27	.23	.16	.11	.05

5 Depreciation Systems

THE recovery of capital through depreciation accruals may be thought of as a dynamic system. A system is an arrangement of things that are connected to form a complete organization of integrated parts. The state of the system at any time is defined by current values of the characteristics that define the system. A dynamic system is one where the state of the system depends on the history of the input variables. To define and study a system is to better understand the system so that more efficient methods of control can be designed to accomplish the desired ends.

There are two methods of controlling a system. One is to select an input and wait for the result or final output. If a different output is desired, the input is changed and the new output is obtained. The other method of control is to select an initial input, monitor the process, and when necessary, alter the input to achieve the desired goal. The first method is called an open control loop and the second a closed control loop. A necessary feature of the closed control loop is the feedback resulting from the monitoring of the system. A home heating system is a common and simple example of a dynamic system with a closed feedback loop. The parts of the system are a furnace and a thermostat. The thermostat monitors the room temperature and creates feedback, in the form of electrical signals, when the room temperature rises above or falls below the desired temperature. The electrical signals turn the furnace off or on to achieve the desired goal, a constant, predetermined room temperature.

Think of a depreciation accounting system as a dynamic system controlled with a closed feedback loop. Estimates of life and salvage and the

Depreciation Systems

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94 Iowa State University Press, Ames, Iowa 50014

rinted on acid-free paper in the United States of America

edition, 1994

Library of Congress Cataloging-in-Publication Data

f, Frank K.
Depreciation systems / Frank K. Wolf, W. Chester Fitch.—1st ed.
p. cm.
Includes bibliographical references and index.
ISBN 0-8138-2457-5 (alk. paper)
1. Depreciation. 2. Public utilities—United States—Accounting. 3. Economic life of fixed assets.
Fitch, W. Chester. II. Title.
681.D5W65 1994
.73—dc20 93-47634

Contents

Preface

THIS book grew from our recognition of the need for a systematic explanation of depreciation using simple, easy-to-follow illustrations. In particular, we examine the portion of depreciation that relates to accounting, specifically as found in public utilities. However, many of the topics covered relate to other applications of depreciation, including valuation of property and taxation. Several conceptual difficulties surround depreciation. One is the lack of understanding that the determination of depreciation involves an intricate system comprising most aspects of the operation of a company. Another is the tendency to view components of the system as being independent of one another. Finally, the use of complicated arithmetic examples, frequently requiring lengthy, time-consuming calculations when explaining ideas, distracts the reader and obfuscates the idea being illustrated.

Asset management includes four actions: (1) the decision, based on analysis of the associated costs and revenues, to acquire property; (2) its acquisition, installation, and associated accounting; (3) its use and related accounting, including the proration of capital expenses to each accounting period; and (4) its retirement and associated accounting. Each action interacts with the other. As management decisions are often based on information from these accounting records, it is essential to exercise careful control over the annual and cumulative results of the depreciation system. This means that the methods used to make estimates of the variables used in calculating and adjusting depreciation should be scrutinized, because they significantly affect the management of the assets of the company.

Investments in capital assets, such as a turbine used to turn an electri-

14 Salvage Analysis and Forecasting

THIS chapter discusses the analysis of aged salvage data and illustrates the use of a mathematical model to help estimate future salvage. Table 8.1 at the end of Chapter 8 shows the aged retirements for Account 897, Utility Devices. These data will be needed in this chapter. For convenience, Table 8.1 will be called the *retirement matrix*.

Net salvage is composed of gross salvage and cost of retiring.[1] Data reflecting these two categories often are kept separately. Different economic forces act on each, so that the pattern of gross salvage versus age differs from the pattern of cost of retiring versus age. If separate records are kept, each pattern can be analyzed. If the records are combined, the separate patterns may be obscured.

Though the patterns of gross salvage and cost of retiring versus age may be different, the general process for analyzing the patterns is the same. The gross salvage for Utility Devices will be assumed to be zero. This will simplify our illustration, and the cost of retiring will provide an example on which to base a discussion of analyzing and forecasting salvage.

Table 14.1 (see end of chapter) shows the cost of retiring by age for Account 897. Each row represents a vintage (or placement or installation) year, and each column represents an experience (or calendar) year. Each entry in the table is the total cost of retiring units from that vintage during that experience year. Vintage years run from 1962 through 1990 and experience years from 1968 through 1990.

Table 14.2 (see end of chapter) shows the salvage ratios (SR) for Account 897. The SR is the salvage divided by the original cost of the retirements and usually is expressed as a percentage. During 1974, $9.00 from the 1971 vintage was retired (see the retirement matrix). The cost of retiring these dollars, shown in Table 14.1, was $2.03, and the resulting SR is −2.03/9.00 or −22.6%.

SALVAGE ANALYSIS

Salvage analysis starts with an examination of the data reflecting the total annual costs. Often these are the only data available. The final row in Table 14.1 shows the sum of each column and equals the total cost of retiring during the calendar year. The original cost of all retirements during the calendar year is shown in the retirement matrix. Table 14.3 (see end of chapter) combines these annual retirement amounts. Column (a) shows the calendar year, column (b) shows the total dollars retired during the year, and column (c) shows the total cost of retiring during the year. Column (d) is the salvage ratio (SR) for the year (i.e., column (c)/column (b) times 100%). Statistics based on single years are often erratic, making any underlying pattern difficult to detect. The final four columns are used in the calculation of SRs for 3-year "rolling bands" or moving averages. This averaging process smooths the pattern of ratios. Column (e) defines the rolling bands. Each band has 2 years in common with the bands on either side of it. The retirements, column (f), during the 1968–1970 band equal 18.00 + 30.00 + 42.00 or $90.00, and the cost of retiring, column (g), is (−4.28) + (−7.65) + (−10.42) or −22.35. Column (h) is the average SR during the 3-year rolling band.

The average realized salvage is the total cost of retiring divided by the total retirements, or −1452.28/3833.00 or −37.9%. The SRs steadily become more negative, from about −24% during the early years to about −40% during the most recent years. One reason for this trend is that the average age of the annual retirements has increased. The first additions were made in 1962. The average life of the property in Account 897 is known to be about 10 years. During 1969 the account was "young," because a retired unit could not have been older than 7 years (i.e., a retirement from the 1962 vintage), and most retirements were younger than 7 years (i.e., retirements from more recent vintages). The average age of the units retired during 1969 was 4.8 years (the age and number of dollars retired during 1969 can be found in the retirement matrix). As time passed, the average age of the retirements increased. By 1989 the average age of retirements was 10.2 years.

In a stable account with zero growth (see Chapter 9), the average age of the retirements equal the average life. Though the annual additions to

Account 897 vary from year to year, the net growth in the account is near zero. By 1989 the account is "mature." The oldest vintage was installed more than 25 years ago, so the age of retirements can range from less than a year to the maximum life. Thus, the average age of the retirements during 1989 would be expected to be near the average life, and they are. If no more additions were made to the account, the average age of retirements would increase with time, and, as the plant remaining in service becomes less and less, the average age of the retirements will increase and approach the maximum life. The sum of all future costs of retiring divided by the sum of future retirements (i.e., the current balance) is the future salvage ratio (FSR). The average salvage ratio (ASR) is the sum of the realized cost and the future cost of retiring, divided by the original cost of all additions.

The data in Table 14.3 show that the cost of retiring increases with the age of the retired unit. Though the average cost of retiring all units retired to date is known, the future cost of retiring must be estimated before the ASR can be estimated. Without additional data or adoption of a retirement model, it is difficult to describe how to estimate the future cost of retiring.

Before attempting to forecast the future cost of retiring, the depreciation professional should become familiar with the physical characteristics of the property in the account and with the manner of retiring the property from service. This knowledge will provide the basis for developing a preliminary model describing the relationship between age and salvage. One cost of retiring model is based on the observation that the cost of retiring a unit is often independent of the age of the unit. For example, the process of removing a gas service or a utility pole typically has little to do with the age of the service or pole. This model can be extended by assuming that the process of retiring the unit is labor intensive, and that the hours of labor required to retire a unit have remained constant during the history of the account. This implies the technology used to retire a unit has remained constant.

This model will be adopted and applied to Account 897. Remember that this is one of many possible models, and the depreciation professional cannot adopt a model unless he or she is familiar with the property involved and the company operations that affect the method of retirement. The logic of the mathematical model must reflect the actual world. Whether the model reflects reality is a judgment made by the analyst.

If the model just described reflects the cost of retiring a utility device, then, during periods of inflation, the SRs can be expected to increase as a unit becomes older. Though the hours of labor required to retire the unit remain constant, labor rates can be expected to inflate each year. Thus, the SR for a group of property installed during the same year can be expected to increase (i.e., become more negative) each successive year in direct proportion to the annual rate of inflation. A more comprehensive analysis of

the aged data will reveal the historical relationship between age and salvage ratio and may provide support for the model. Chapter 8 introduced the idea of placement bands and experience bands. A placement band follows the history of a vintage through different experience years, while an experience band follows the history over all vintages during the specified experience years.

These ideas are used to construct a graph of the SR versus age for the placement band consisting of the 1970, 1971, and 1972 vintages. Table 14.4 (see end of chapter) reproduces part of the annual cost of retiring during 1970, 1971, and 1972 from Table 14.1. The cost of retiring is shown in the upper portion of Table 14.4.

Table 14.5 (see end of chapter) shows how the data are used to construct salvage ratios by age. Column (a) of Table 14.5 shows the age interval and column (b) shows the sum of retirements from the 1970, 1971, and 1972 vintages during each age interval. Column (c) shows the corresponding cost of retiring. To obtain the total cost of retiring during the 0.0–0.5 year age interval, refer to the upper portion of Table 14.4. Sum the first entry in each row, $0 + 0 + (-1.02)$ or -1.02. These are the costs of retiring during 1970 from the 1970 vintage, during 1971 from the 1971 vintage, and during 1972 from the 1972 vintage, respectively. Column (d) is the SR, or the cost of retiring divided by the original cost expressed as a percentage. Observe that the SR during the initial age interval is about -20%, and that the SRs steadily become more negative as the property ages. After 20 years, the SR is almost -70%. Because these figures represent costs, the costs increase but the SRs decrease (become more negative).

Because the SR is the quotient of dollars in different price levels (i.e., the retirement year price level is reflected in the numerator and the installation year price level is reflected in the denominator), it may be helpful to calculate the SR using a constant price level. This removes inflation from the ratio so that the salvage schedule adjusted for inflation[2] can be analyzed.

To calculate the adjusted SR shown in column (f) of Table 14.5, return to Table 14.4 and note the row labeled CPI-U. These data are the July consumer price indexes for all urban consumers (CPI-U) from the U.S. Bureau of Labor Statistics for the years 1970 through 1977. The July figures were chosen because both additions and retirements are assumed to take place at midyear. During 1975, the cost of retiring units placed in service during 1971 totaled $-\$1.49$. To adjust 1975 dollars to 1971 dollars, multiply the 1975 dollars by the ratio of the 1971 index/1975 index. This is $-1.49 \times (40.70/54.20)$ or $-\$1.12$ measured in July 1971 dollars. The lower portion of the table shows the salvage from the upper portion of the table after being adjusted to dollars during the placement year. The adjusted cost of retiring can now be used to calculate the adjusted cost of retiring shown in column (e) of Table 14.5. The original cost of the retirements shown in column (b) and the salvage shown in column (e) are measured in dollars of the same price level. Column (f) shows the adjusted SR, i.e., column (e)/column (b) × 100%.

Figure 14.1 is a graph of columns (d) and (f). Observe the graph of the SRs with inflation. If the SRs are increasing in proportion to inflation, they will form a pattern that is curved upward, reflecting the exponential growth of the price levels. However, it is difficult to tell the underlying shape of this curve. Observe the graph of the SRs when inflation is removed. The pattern of constant SRs, with a value of about −20%, is clear. Though a formal statistical test of the relationship can be made, such a test is not necessary because the graph is strong evidence that when inflation is removed, the cost of retiring is independent of age. Thus, the data supports, or verifies, the model that the time required to retire a unit is constant and that the increased cost of retiring is proportional to the rate of inflation.

Can this model be used to forecast future cost of retiring? *If* the depreciation professional believes that the same procedure for retiring that has been used in the past will continue to be used in the future, *then* the model can be used to forecast future cost of retiring. Under this model, future SRs

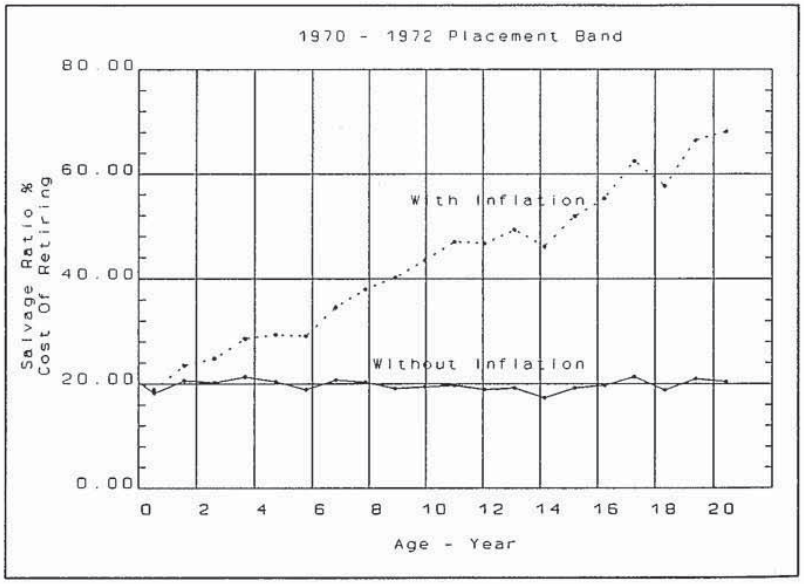

Figure 14.1. Salvage ratios versus age both with and without inflation. Data are from Table 14.3.

can be derived if three parameters are estimated. They are (a) the SR during the 0.0–0.5 year age interval, (b) the annual rate of inflation, and (c) the life characteristics of the property.

Table 14.6 (see end of chapter) shows the construction of the salvage schedule for the 1981 vintage. Construction of the survivor curve for this vintage is shown in Table 6.12 of Chapter 6, and the survivor curve from that table is shown in column (b) of Table 14.6. The values from age 0.0–8.5 years are based on the observed exposures and retirements. The values from age 8.5–21.5 years are based on the estimate that the future life characteristics will be described by an Iowa S0–12 survivor curve. The SRs, column (d), from age 0.0–8.5 years are the observed values shown in Table 14.2. The forecast for all age intervals beyond 8.5 years is the SR from the previous age interval inflated by *5%* (i.e., the SR during age interval 9.5–10.5 is 29.72 × 1.05 or 31.20%). The 5% rate is the estimate of the future inflation rate. Column (e) is the SR weighted by the fraction retired, i.e., column (c) × column (d)/100%, and the sum of column (e) is the ASR, −34.81%. The realized salvage ratio is shown in column (f) and the future salvage ratio (FSR) is shown in column (g). Because the observed SRs were used during the early age intervals, it was not necessary to estimate the initial SR.

THE BROAD AND VINTAGE GROUP MODELS

Depreciation calculations require an estimate of the average salvage ratio (ASR) and the future salvage ratio (FSR) for each vintage. The method of determining these ratios depends on whether the broad group or vintage group model is used.

If the broad group model is used, the same salvage schedule is applied to each vintage. Chapter 6 contains an illustration of the application of a single salvage schedule to each vintage. Table 6.11 of that chapter is a salvage schedule used in the calculation of the annual accrual using both the AL and ELG procedures. The salvage ratio during the 0.0–0.5 year age interval is −15%, and it increases (becomes more negative) at an annual rate of 5%. These ratios are used with the ELG procedure. The Iowa S0–12 curve describes the life characteristics of each vintage. The resulting ASR, −28%, is used with the AL procedure. The FSR at the start of each age interval is matched to the appropriate vintage. Depending on the depreciation system, the CAD of the future accrual is then calculated using the proper FSR. Thus, a single salvage schedule provides the information to calculate the annual accrual for each vintage.

If the vintage group model is applied to salvage, a different salvage schedule is applied to each vintage. The calculation of the schedule for the 1981 vintage is shown in Table 14.6. It results in the ASR and the FSR for the 1981 vintage, and similar calculations must be made for all other vintages. The vintage group model, which uses observed life and observed salvage data to construct the realized portion of the schedule, is a refinement of the broad group model. It has the advantage of more accurately reflecting the actual world transactions then does the broad group model.

THE SIMULATION OF SALVAGE BY AGE

It is not uncommon to record only the total salvage during the year. The data shown in Table 14.3 are of this type. Estimates of the ASR and an average FSR must be based on the unaged salvage data. When retirements are recorded by age, an alternate method of using this data is available. The alternative requires the depreciation professional to adopt a salvage model and use it to allocate the total annual salvage to each vintage. The result is salvage by age, as shown in Table 14.1, except the data are simulated rather than observed. The simulated data can be used in the manner described earlier in this chapter. However, the simulated data cannot be used to verify the model because to do so would be circular logic.

Table 14.7 (see end of chapter) shows how the $10.42 cost of retiring during 1970 can be allocated to the 1962 through 1970 vintages *if* the cost of retiring model discussed earlier in this chapter is adopted. The depreciation professional must be familiar with the account Utility Devices so that he or she can judge whether the model will result in a reasonable representation of the cost of retiring. Column (a) shows the vintage year and column (b) shows the original cost of the retirements during the 1970 calendar year. Column (c) shows the consumer price index (CPI-U) for July of the vintage year. Column (d) shows the ratio of the CPI-U for the vintage year to the CPI-U for the 1970 calendar year. For 1963, the ratio 61.0/39.0 or 1.56 suggests that a dollar spent in 1963 would purchase 1.56 times as much as a dollar spent in 1970. Column (e) is the product of column (b) times column (d), and represents a restatement of the vintage dollars to 1970 price level dollars. The $14.00 retired in 1963 are restated as $21.90 in the 1970 price level.

Thus, entries in column (e) are proportional to the *units* retired during 1970 *if* the model is applicable *and* the CPI-U is an appropriate index. The entries in column (e) are used as weights to allocate the $10.42 cost of retiring. Column (f) is the entry from column (e) divided by the sum of column (e). The fraction of the $10.42 allocated to the 1963 vintage is 21.90/61.84 or 0.3541. The allocation to the 1962 vintage is 0.3541 × 10.42 or $3.69, as shown in column (g). If this process is repeated for each calendar year, the result is the simulated cost of retiring by age. The simulated data can be used to construct salvage schedules similar to the schedule shown in Table 14.5.

SUMMARY

It is desirable to analyze gross salvage and cost of retiring separately. The two salvage schedules can be combined to find the average net salvage ratio and the future net salvage ratios by age. Data that reflect salvage by age, rather than only the total annual salvage, provide valuable information.

In practice, the procedure for estimating salvage varies widely. The depreciation professional's judgment of whether a procedure is reasonable is based on several variables. These include the magnitude of the salvage ratio, the available data, and the importance of the depreciable group. It is not unusual for a mass property account of a utility to exhibit large negative salvage. In such cases, the depreciation accrual rate may be more sensitive to the salvage estimate than to the life estimate.

If both the realized gross salvage and realized cost of retiring are near zero, extensive analyses may not be productive because the depreciation calculations are not sensitive to salvage ratios near zero. In such cases, the key to forecasting is predicting whether there will be a significant change in future operations that will change the levels of gross salvage or cost of retiring.

Often the only available data are the total annual gross salvage and cost of retiring. An example of this type of data is shown in Table 14.3. When analyzing unaged salvage, remember that realized salvage depends on the age of the retirements. Realized salvage starts at zero and does not reach the average until the final unit in the group is retired. Thus, the average age of the annual retirements and the average life of the group are important variables. Continuous property groups showing growth typically have large differences between the average age of the retirements and the average life of the group.

Salvage ratios are a function of inflation. For long-lived property, the salvage associated with the longest-lived property is affected most. However, this effect may not be reflected in the data for some time. A mathematical model that includes the effect of salvage can be a valuable forecasting tool. Salvage data by age contains information helpful for constructing and verifying a mathematical model.

NOTES

1. Cost of retiring is also called cost of removal.
2. See Chapter 4 for a discussion of inflation and salvage ratios.

Table 14.1 The cost of retiring by age for Account 897.

Account 897 - Utility Devices

Cost of Retiring

Calendar Year / Year installed	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
1962	1.92	1.87	3.21	.72	2.42	2.77	5.04	.87	.00	.00	.00	2.51	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
1963	.00	.89	3.17	1.84	2.75	2.51	5.34	4.37	5.06	9.89	2.29	4.13	3.96	4.00	3.16	3.07	4.09	.00	.00	.00	.00	.00	.00
1964	.66	.50	1.00	1.94	1.06	2.35	2.99	6.77	18.36	15.50	11.02	1.33	4.63	3.93	.00	.00	.00	.00	.00	.00	.00	.00	.00
1965	.00	1.54	.00	2.93	2.21	2.66	2.74	1.76	1.40	.00	2.40	3.15	2.12	13.34	5.10	3.61	.00	.00	.00	.00	.00	.00	.00
1966	1.71	1.96	1.75	2.88	4.88	3.20	4.68	11.57	5.82	.77	14.60	2.59	3.08	26.85	2.27	1.23	1.70	12.56	3.94	9.68	.00	.00	12.45
1967	.00	.44	.89	3.26	3.70	8.84	4.14	6.40	6.67	2.99	2.64	10.61	2.50	12.68	4.68	8.78	6.71	5.44	.00	.00	.00	.00	.00
1968	.00	.44	.40	.50	.00	.89	.95	1.58	1.76	2.33	2.24	2.50	2.46	4.79	19.23	6.67	6.79	8.46	4.55	.00	10.78	.00	.00
1969		.00	.00	2.25	.00	.00	.00	.00	.56	.00	10.12	.00	7.55	.00	.00	.00	7.25	.00	.00	.00	.00	.00	2.13
1970			.00	.20	.19	1.58	.80	.81	.88	2.48	1.73	2.35	3.64	3.15	1.93	2.81	2.30	1.70	3.83	2.39	.00	2.66	8.18
1971				.00	.71	.63	2.03	1.49	1.57	2.79	3.19	4.26	2.95	5.85	.87	4.47	4.92	.00	8.62	13.47	9.09	11.60	.00
1972					1.02	.41	1.30	2.83	3.13	7.03	7.97	6.78	7.29	9.98	4.44	20.88	4.34	6.09	.00	4.20	5.40	5.38	6.88
1973						1.72	.00	.00	.00	2.11	11.54	7.09	5.56	3.41	15.67	10.23	9.82	24.77	10.68	16.94	.00	.00	6.73
1974							.00	.22	.73	1.86	.56	2.48	2.01	2.86	4.97	4.59	3.20	2.80	1.37	3.44	4.86	5.19	2.29
1975								.00	.00	.00	.00	.00	1.54	2.00	9.31	8.46	5.52	3.94	2.52	1.78	3.73	3.61	.00
1976									.00	3.29	1.65	10.88	8.86	20.24	7.16	27.59	9.78	7.55	23.88	10.28	8.16	5.71	5.34
1977										1.46	.00	.00	1.10	.85	2.13	4.15	3.82	6.49	20.16	24.95	23.93	7.00	.00
1978											.00	.99	.00	2.02	.00	5.39	.00	26.01	7.82	9.10	8.52	7.06	.00
1979												.00	.00	.00	.00	1.91	5.92	8.76	5.36	11.44	9.95	8.95	4.38
1980													.64	.00	.00	.95	.00	22.51	4.96	11.11	9.96	9.82	1.89
1981														1.22	.00	.45	.90	.66	1.39	2.57	2.39	3.11	.00
1982															1.05	1.14	.00	.00	1.48	.44	.51	2.67	2.40
1983																.00	.00	.46	.92	1.24	1.64	2.30	.27
1984																	.00	.00	.00	.00	.00	8.11	.00
1985																		2.18	.93	1.48	2.28	3.66	.00
1986																			.75	.00	.00	.00	.00
1987																				.00	.00	1.69	.45
1988																					1.43	1.15	.00
1989																						.00	.00
1990																							.00
Total	4.28	7.65	10.42	16.51	18.93	27.57	30.02	38.67	45.94	52.48	71.96	61.65	59.89	117.16	81.97	116.39	77.04	140.41	103.17	124.50	102.63	89.68	53.38

Table 14.2. The salvage ratios (SR) by age for Account 897.

Account 897 - Utility Devices

Salvage Ratios ** All Ratios Are Negative

Calendar Year / Year installed	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
1962	23.9	31.2	29.2	35.8	34.5	30.8	38.8	43.3	.0	.0	.0	50.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1963	.0	22.2	22.6	30.6	22.9	31.4	31.4	36.4	31.6	44.9	45.7	45.9	56.6	66.7	63.2	61.4	68.2	.0	.0	.0	.0	.0	.0
1964	22.0	25.1	25.0	27.7	26.6	29.4	33.2	29.4	36.0	35.2	36.7	44.4	57.9	49.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
1965	.0	25.6	.0	22.6	27.6	26.6	30.5	35.2	35.0	.0	48.0	45.0	52.9	55.6	63.8	72.2	.0	.0	.0	.0	.0	.0	.0
1966	24.4	24.5	25.0	26.2	22.2	26.7	29.2	36.2	32.3	38.4	38.4	43.2	51.3	62.4	56.7	61.4	56.7	66.1	65.6	74.5	.0	.0	83.0
1967	.0	22.2	22.3	21.7	28.4	23.9	31.9	37.6	35.1	33.2	37.7	44.2	50.1	52.8	58.4	58.5	67.1	60.4	.0	.0	.0	.0	.0
1968	.0	22.0	20.2	24.8	.0	22.2	31.8	31.6	35.3	38.8	32.1	41.7	49.2	53.2	60.1	60.7	61.7	60.5	56.9	.0	77.0	.0	.0
1969		.0	.0	20.5	.0	.0	.0	.0	28.1	.0	34.9	.0	44.4	.0	.0	.0	55.7	.0	.0	.0	.0	.0	70.9
1970			.0	20.2	19.1	22.6	26.7	27.1	29.2	31.0	34.6	39.2	45.5	45.0	48.2	46.8	46.1	56.8	63.8	59.8	.0	66.5	68.2
1971				.0	17.8	21.0	22.6	29.8	26.1	31.0	31.9	38.8	42.1	41.8	43.5	44.7	49.2	.0	50.7	53.9	60.6	58.0	.0
1972					20.3	20.5	25.9	28.3	28.5	30.6	28.4	37.7	38.4	39.9	44.4	47.5	48.2	50.8	.0	52.5	54.0	67.2	57.3
1973						21.5	.0	.0	.0	26.4	31.2	37.3	39.7	37.8	36.4	46.5	49.1	48.6	50.9	54.7	.0	.0	61.2
1974							.0	22.1	24.4	23.3	27.8	31.0	33.4	40.8	45.2	41.7	45.7	46.7	45.8	49.1	53.9	51.9	45.8
1975								.0	.0	.0	.0	.0	30.8	33.3	35.8	35.2	34.5	39.4	42.1	44.5	46.7	45.1	.0
1976									.0	21.9	23.6	29.4	26.8	33.2	34.1	32.1	37.6	37.8	44.2	41.1	40.8	44.0	44.5
1977										18.2	.0	.0	27.4	28.5	30.5	34.6	34.7	32.4	38.0	39.6	43.5	35.0	.0
1978											.0	24.7	.0	25.2	.0	33.7	.0	32.5	34.0	35.0	34.1	35.3	.0
1979												.0	.0	.0	.0	27.3	29.6	27.4	28.2	29.3	33.2	35.8	33.7
1980													21.5	.0	.0	23.8	.0	26.5	26.1	29.2	29.3	33.9	31.4
1981														20.4	.0	22.7	22.4	22.0	23.2	25.7	26.6	28.3	.0
1982															20.9	22.8	.0	.0	24.6	21.9	25.4	26.7	24.0
1983																.0	.0	23.1	23.1	24.9	23.5	28.8	26.8
1984																	.0	.0	.0	.0	.0	23.2	.0
1985																		21.8	23.3	18.5	22.8	24.4	.0
1986																			18.8	.0	.0	.0	.0
1987																				.0	.0	21.1	22.5
1988																					17.9	19.2	.0
1989																						.0	.0
1990																							.0

Table 14.3. Salvage ratios by calendar year for Account 897, Utility Devices. Column (d) is the SR for a single year and column (h) is the average SR for 3-year rolling bands.

Year (a)	Dollars retired (b)	Cost of retiring (c)	SR % (d)	Years (e)	Dollars retired (f)	Cost of retiring (g)	SR % (h)
1968	18.00	-4.28	-23.8				
1969	30.00	-7.65	-25.5	1968-70	90.00	-22.35	-24.8
1970	42.00	-10.42	-24.8	1969-71	140.00	-34.57	-24.7
1971	68.00	-16.51	-24.3	1970-72	186.00	-45.86	-24.7
1972	76.00	-18.93	-24.9	1971-73	252.00	-63.01	-25.0
1973	108.00	-27.57	-25.5	1972-74	281.00	-76.51	-27.2
1974	97.00	-30.02	-30.9	1973-75	320.00	-96.25	-30.1
1975	115.00	-38.67	-33.6	1974-76	350.00	-114.62	-32.7
1976	138.00	-45.94	-33.3	1975-77	415.00	-137.09	-33.0
1977	162.00	-52.48	-32.4	1976-78	510.00	-170.38	-33.4
1978	210.00	-71.96	-34.3	1977-79	535.00	-186.08	-34.8
1979	163.00	-61.65	-37.8	1978-80	524.00	-193.49	-36.9
1980	151.00	-59.89	-39.7	1979-81	574.00	-238.69	-41.6
1981	260.00	-117.16	-45.1	1980-82	597.00	-259.01	-43.4
1982	186.00	-81.97	-44.1	1981-83	733.00	-315.51	-43.0
1983	287.00	-116.39	-40.6	1982-84	644.00	-275.40	-42.8
1984	171.00	-77.04	-45.1	1983-85	834.00	-333.84	-40.0
1985	376.00	-140.41	-37.3	1984-86	806.00	-320.62	-39.8
1986	259.00	-103.17	-39.8	1985-87	943.00	-368.09	-39.0
1987	308.00	-124.50	-40.4	1986-88	823.00	-330.31	-40.1
1988	256.00	-102.63	-40.1	1987-89	814.00	-316.81	-38.9
1989	250.00	-89.68	-35.9	1988-90	608.00	-245.69	-40.4
1990	102.00	-53.38	-52.3				
Total	3833.00	-1452.28	-37.9				

Table 14.4. Aged cost of retiring for the 1970 through 1972 vintage, as extracted from Table 14.1. The lower portion of the table adjusts the annual cost of retiring to the price level during the year the property was installed using the consumer price index for all urban consumers (CPI-U) from the U.S. Bureau of Labor Statistics, 1982-1984 = 100.

	70	71	72	73	74	75	76	77	78
1970	.00	-.20	-.19	-1.58	-.80	-.81	-.88	-2.48	-1.73
1971		.00	-.71	-.63	-2.03	-1.49	-1.57	-2.79	-3.19
1972			-1.02	-.41	-1.30	-2.83	-3.13	-7.03	-7.97
CPI-U	39.00	40.70	41.90	44.30	49.40	54.20	57.10	61.00	65.70
1970	.00	-.19	-.18	-1.39	-.63	-.59	-.60	-1.58	-1.03
1971		.00	-.69	-.58	-1.67	-1.12	-1.12	-1.86	-1.98
1972			-1.02	-.39	-1.10	-2.19	-2.30	-4.83	-5.08

Table 14.5. The salvage ratio schedule for the 1970-1992 placement band. The nonadjusted retirement cost is measured in dollars during the year of retirement. The adjusted retirement cost is measured in dollars during the year of installation.

Age interval (a)	Dollars retired (b)	Non-adj cost of retiring (c)	Non-adj SR (d)	Adjusted cost of retiring (e)	Adjusted SR (f)
0- 0.5	5.00	-1.02	-20.3	-1.02	-20.3
.5- 1.5	7.00	-1.32	-18.9	-1.27	-18.2
1.5- 2.5	9.00	-2.12	-23.5	-1.86	-20.6
2.5- 3.5	26.00	-6.44	-24.8	-5.25	-20.2
3.5- 4.5	19.00	-5.43	-28.6	-4.05	-21.3
4.5- 5.5	32.00	-9.41	-29.4	-6.53	-20.4
5.5- 6.5	40.00	-11.63	-29.1	-7.54	-18.9
6.5- 7.5	36.00	-12.45	-34.6	-7.45	-20.7
7.5- 8.5	35.00	-13.29	-38.0	-7.10	-20.3
8.5- 9.5	38.00	-15.28	-40.2	-7.27	-19.1
9.5-10.5	32.00	-13.93	-43.5	-6.22	-19.4
10.5-11.5	53.00	-24.90	-47.0	-10.46	-19.7
11.5-12.5	23.00	-10.74	-46.7	-4.34	-18.9
12.5-13.5	28.00	-13.81	-49.3	-5.39	-19.2
13.5-14.5	5.00	-2.30	-46.1	-.86	-17.3
14.5-15.5	28.00	-14.52	-51.9	-5.37	-19.2
15.5-16.5	41.00	-22.69	-55.3	-8.09	-19.7
16.5-17.5	27.00	-16.86	-62.5	-5.75	-21.3
17.5-18.5	32.00	-18.47	-57.7	-6.00	-18.8
18.5-19.5	4.00	-2.66	-66.5	-.83	-20.9
19.5-20.5	12.00	-8.18	-68.2	-2.45	-20.4

Table 14.6. The salvage schedule for the 1981 vintage. Observed values are used through age 8.5 years. The future survivor curve is an Iowa SO-12 curve. Future salvage ratios are found by inflating the SR from the previous year by 5%.

Age interval (a)	Percent surviving (b)	Percent retired (c)	SR % (d)	Wtd SR (e)	Realized SR% (f)	Future SR% (g)
0.0- 0.5	100.00	3.17	-20.40	-.65	.00	-34.81
0.5- 1.5	96.83	.00	.00	.00	-20.40	-35.29
1.5- 2.5	96.83	1.06	-22.40	-.24	-20.40	-35.29
2.5- 3.5	95.77	2.12	-22.00	-.47	-20.90	-35.43
3.5- 4.5	93.65	1.59	-23.20	-.37	-21.27	-35.73
4.5- 5.5	92.06	3.17	-25.70	-.82	-21.65	-35.95
5.5- 6.5	88.89	5.29	-26.60	-1.41	-22.81	-36.32
6.5- 7.5	83.60	4.76	-28.30	-1.35	-24.03	-36.93
7.5- 8.5	78.84	5.82	.00	.00	-24.99	-37.45
8.5- 9.5	73.02	5.77	-29.72	-1.71	-19.60	-40.44
9.5-10.5	67.25	5.92	-31.20	-1.85	-21.38	-41.36
10.5-11.5	61.33	6.02	-32.76	-1.97	-22.89	-42.34
11.5-12.5	55.31	6.06	-34.40	-2.09	-24.22	-43.38
12.5-13.5	49.24	6.02	-36.12	-2.18	-25.43	-44.48
13.5-14.5	43.22	5.92	-37.92	-2.24	-26.57	-45.65
14.5-15.5	37.30	5.78	-39.82	-2.30	-27.64	-46.88
15.5-16.5	31.52	5.53	-41.81	-2.31	-28.67	-48.17
16.5-17.5	25.99	5.25	-43.90	-2.30	-29.65	-49.52
17.5-18.5	20.74	4.88	-46.10	-2.25	-30.59	-50.94
18.5-19.5	15.86	4.43	-48.40	-2.15	-31.49	-52.44
19.5-20.5	11.43	3.90	-50.82	-1.98	-32.34	-54.00
20.5-21.5	7.53	3.26	-53.36	-1.74	-33.12	-55.65
21.5-22.5	4.27	2.48	-56.03	-1.39	-33.81	-57.39
22.5-23.5	1.79	1.52	-58.83	-.89	-34.37	-59.28
23.5-24.5	.27	.27	-61.78	-.17	-34.74	-61.78
24.5-25.5	.00	.00	-64.86	.00	-34.81	
				-34.81		

Table 14.7. Allocation of the total cost of retiring during 1970, $10.42, to each vintage.

Year (a)	Retired (b)	CPI-U (c)	Ratio of CPI-U to 39.00 (d)	Adjusted retired (e)	Factor (f)	Allocated cost of retiring (g)
1962	11.00	65.7	1.68	18.53	.2996	3.12
1963	14.00	61.0	1.56	21.90	.3541	3.69
1964	4.00	57.1	1.46	5.86	.0947	.99
1965	0.00	54.2	1.39	.00	.0000	.00
1966	7.00	49.4	1.27	8.87	.1434	1.49
1967	4.00	44.3	1.14	4.54	.0735	.77
1968	2.00	41.9	1.07	2.15	.0347	.36
1969	0.00	40.7	1.04	.00	.0000	.00
1970	0.00	39.0	1.00	.00	.0000	.00
	42.00			61.84		10.42