Computing Economic Loss in Cases of Wrongful Death

Elizabeth M. King, James P. Smith
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Preface

In 1985 the Institute for Civil Justice undertook a detailed study of aviation accident litigation in the United States. Like earlier ICJ studies of automobile, asbestos, and medical malpractice litigation, this research provides a detailed picture of the unique features, transactions costs, and compensation levels of a particular kind of litigation. To meet the interests of different audiences, the study’s findings have been published in six separate volumes:


Economic Loss and Compensation in Aviation Accidents, by Elizabeth M. King and James P. Smith, R-3551-ICJ, 1988.


The executive summary volume is a compendium of the summaries of the individual studies. The second report describes the general character of aviation accident litigation and compares plaintiffs’ and defendants’ litigation expenses with the compensation paid to the survivors of those who died in the accidents. The present report reviews the underlying principles and detailed procedures used to compute the economic loss associated with individual decedents. The fourth report describes the characteristics of the decedents and compares the
compensation paid to their survivors with the levels of economic loss they suffered. The fifth report analyzes the legal and economic determinants of the litigation decisions that plaintiffs and defendants faced. The sixth volume contains the forms used to compile the data used in the separate analyses.

In combination, these volumes provide a comprehensive profile of aviation accident litigation and a basis for assessing the policy issues surrounding it.
Summary

Although every state has its own statutes governing wrongful death litigation, the general objectives of the tort system require that tortfeasors make some compensation for the value of life lost. Consequently, the system’s success depends heavily on how accurately that value can be calculated. Clearly, some elements that make life valuable cannot be quantified, and survivors can hardly be compensated for their loss. However, settlement negotiations and court awards operate on the assumption that the economic loss resulting from an individual’s death can be reasonably calculated. Conceptually, that assumption is justified, but, in practice, there is no accepted standard for calculating economic loss in wrongful death cases. Moreover, many of the existing methods are deficient, and some assumptions held by expert witnesses have been inconsistent with scientific principles of economics.

PURPOSE OF THE STUDY

Our purpose was to develop a methodology that overcomes these deficiencies and improves the means for accurately calculating the economic loss associated with the death. This effort is part of a larger study of litigation over aviation deaths—the RAND Aviation Accident Study. The study data provided actual case information on the variables that must be used in calculating loss. They also provided a basis for estimating how close actual awards, based on currently used methods, have come to compensating for economic loss, as computed by our methodology. The data files contain information on 88 percent of the aviation deaths that occurred between 1970 and 1984, involving major U.S. airlines. They include details of the accidents; characteristics of the decedents, claimants, and defendants; the size of the awards; the costs of litigation; and other facts pertinent to the litigation.

Our companion volumes to this report describe and analyze the relationships among decedent characteristics, economic loss, and compensation. This volume focuses on the methodology, discussing the
principles informing it and describing the methods for calculating the major elements of full economic loss and loss to survivors. The principles involved are similar to those in any tort case involving wrongful death. Moreover, many components of this methodology are equally relevant to damage estimates in personal injury cases. In this Summary, we discuss the rationale for the individual elements of the methodology, focusing on the ways our methods differ from standard procedures.

CONCEPTUAL ISSUES AND ELEMENTS OF THE KING-SMITH METHODOLOGY

Although calculations of economic loss can be based on one of several conceptual models, we have chosen the human capital (or lost economic output) approach, primarily because it dominates actual litigation. Thus, adopting another conceptual model would make the methodology irrelevant to current policies and practices of the tort system. In this conceptual model, economic loss is the value of the decedent's lost future productivity, market and nonmarket.

Given this conceptual model, economists would generally agree on the elements involved in calculating full economic loss and loss to survivors: Full economic loss is the sum of the discounted value of present and future market and nonmarket economic losses. Market loss is the value of decedents' lost future earnings. Nonmarket loss represents the present and future value of goods and services they would have produced in the home. To determine future earnings, it is necessary to estimate future wage rates, including rates of salary growth and the worklife discount—that is, the probable amount of time the decedent would have worked in the future.

Estimating loss to survivors involves two adjustments to the calculation for full economic loss. Where loss to survivors is the legal death damage principal, the objective is ensuring that their economic situation is no worse than if the death had not occurred. Thus, the decedent's personal consumption must be deducted because it would not have accrued to survivors anyway. Taxes must also be considered because dependents would have benefited only from the individual's after-tax income and because beneficiaries will have to pay taxes on interest from the compensation award.

Based on these premises, our methodology includes seven elements: (1) base-year incomes, (2) salary growth, (3) worklife discounts, (4) nonmarket loss, (5) personal consumption offset, (6) taxes, and (7) discount rates.
Base-Year Income

Base-year income is a key variable in calculating economic loss in wrongful death litigation. For full economic loss, base-year income indexes the value of the initial output that decedents contributed to the economy. For loss to survivors, it is a major determinant of the surviving dependents' living standard. It is also a major element in calculating salary growth and nonmarket loss.

For calculations of both kinds of loss, base-year incomes must include not only decedents' regular salaries but also their fringe benefits, which provide for health insurance, retirement, etc. and must be considered in compensation. We used generally accepted methods for calculating fringe benefits and for imputing them when data were unavailable for individual decedents. Base-year incomes must also include any other regular second-job incomes, bonuses, or commissions that decedents might have earned.

Our methodology distinguishes between potential and expected base-year incomes and calculates both. Potential income is what decedents could have earned if they had worked full time in the labor market. Expected income is what they would actually have earned in the accident year. This important distinction recognizes that, for various reasons, most people do not choose to realize their full earning capacity. Consequently, calculating potential income alone would overestimate not only base-year income but future earnings as well. For our calculations, expected income equals potential earnings multiplied by the fraction of the year that decedents would have worked.

When income information is missing, it is necessary to impute decedent incomes based on external sources of information on what similar workers earn. Similarity is determined by such demographic attributes as sex, race, age, education, occupation, and citizenship. However, if the decedents do not represent a random sample of the population of people with similar demographic attributes, imputation may be biased by income selectivity: That is, it may over- or underestimate incomes roughly in proportion to the sample's difference from the "average." This proved to be a problem in our sample.

We had to impute incomes for 45 percent of the airline decedents, through regressions using data from the appropriate years of U.S. Current Population Surveys (CPS). Although the imputed salaries conform to well-established empirical regularities in the labor-market wage structure, the results for the whole sample led us to suspect selectivity bias. Those results showed that relative to the typical American worker, the air-death victims represent an economic elite. Not only were a much higher percentage of them (than of the general
population) in professional occupation brackets but, within those brackets, they tended to earn more. Many of the decedents with missing income information were represented in the higher-paying occupations, but our algorithm consistently imputed incomes for them that were much lower than for those whose earnings we knew.

The skewed distribution of incomes in our sample led us to suspect that the imputation algorithm might systematically understate the incomes of the decedents. We conducted an experiment to test this suspicion: We treated the decedents for whom we had income information as though that information were missing and used the assignment algorithm to “impute” incomes for them. On average, the actual incomes of these decedents are 80 percent larger than the incomes we assigned. These results suggest how important it is to have accurate salary information for wrongful death actions and, where that is impossible, to anticipate the problem of bias in imputation.

Salary Growth

If the decedents had survived, it is unlikely that their earnings would have remained at the base-year income levels. Thus, estimations of economic loss must include projections of future salary growth. Our methodology models future salary growth as the sum of three components: economy-wide wage growth, life-cycle salary growth, and individual-specific wage growth.

*General economic growth* must be considered in these calculations because of its effect on wages, independent of workers’ age and education. Estimating this effect depends on projecting how much economic expansion has affected wage growth in the past. To allow for the sharp reversals in U.S. economic performance, we take a long-term view, using growth rates in white-male incomes for 1940 to 1980. The expansion rate over those years is 2.0487 percent per year. However, to project future salaries of decedents, we have used a rate of 1.9029, instead, to adjust for the 21 percent of 1940–1980 growth that resulted from workers’ increasing education levels. Rising education in each new worker cohort will no doubt result in rising future wage levels. This effect must be considered in salary growth estimations because it will not enhance the income prospects of workers who are already in the labor force and have fixed education levels.

*Life-cycle salary growth* enters into the calculation because workers’ salaries grow as they become more experienced and gain seniority on the job; but the growth pattern is not regular, nor is it similar for all subgroups. Research has consistently shown that men and women have very different rates of wage growth. Consequently, we estimate separate life-cycle earnings profiles for the sexes.
For men, we used data from the CPS (over a period roughly corresponding to the airline crashes) in regressions to assign the salary growth an individual could have expected at each of his subsequent ages. The salary-age relationship we estimated for men equated another year of age with another year of experience in the labor market, and our results followed the widely documented inverted "u" shape of salary growth. However, for women, another year of age does not necessarily equal another year of experience in the work force, largely because many women still postpone or interrupt careers to raise children.

To estimate women's salary growth, one must know how much additional labor force experience they typically accumulate for each year of age. We used a model developed by Smith and Ward (1984) to calculate that relationship at each age for the years 1968–1985. Other variables in the equation came from the CPS for those years. The estimation of female salary growth also requires taking a woman's actual experience level into account. Where that information is missing, the method relies on imputing to a decedent the average labor force experience of women her age and employment status in the accident year.

Wage growth specific to individuals is also one of our components for calculating salary growth, because not all people with the same education, age, or experience get similar salaries or increases. The income selectivity bias for the airline sample suggested how large differences from the "average" could be. However, computing individually determined wage growth requires more than one year of salary information. Otherwise, temporary and unrepresentative salary actions may be extrapolated into the future.

We developed a statistical model for computing individually determined salary growth (see Sec. IV and App. A), which we were able to test because the airline claims files contained at least two years of salary history for 30 percent of the decedents. The model meets two important criteria for these calculations: It measures how much of the observed salary change in the files represented permanent differences in the decedents’ salary prospects and how much was statistical noise. It also places greater confidence on the decedents' projected salary growth when we have data on salary history for many years. The results support the hypothesis that airline passengers would have anticipated larger salary increases than the "average" person with similar characteristics. Thus, they indicate the importance of this component for estimating salary growth in economic loss calculations.
Worklife Discounts

Calculation of future earnings involves not only base-year incomes and salary growth but worklife discounts—that is, an adjustment for the individual’s likelihood of working in all future years. That likelihood can be quantitatively predicted only on the basis of employment status at the time of death. However, the predictive relationship between present and future employment differs for men and women. Therefore, we developed different models for calculating male and female worklife discounts.

For men, we used the standard demographic increment-decrement model to forecast labor-force behavior. This model is a “two-state, one-period” Markov in which people can be either in or out of the labor force at any given period, but can change employment status from period to period. The “one-period” designation assumes that the probability of working this year depends only on whether or not a person worked last year, not on any prior work history. Our model for male worklife discounts explicitly incorporates the relationship between current work status and year-by-year probabilities of future employment.

Increment-decrement models are poor predictors of women’s future labor-force behavior for two reasons: First, the labor-force transition rates are based on cross-sectional data. Thus, they fail to capture the rapid, sustained increases in women’s labor-force participation, and underestimate future labor-force participation, especially for younger women. Second, the models’ one-period assumption makes them unable to accommodate the large differences for women between probable accumulated experience of current workers and nonworkers.

The “one-period” assumption causes considerable labor-force turnover in the model, making the expected labor-force participation of workers and nonworkers very similar. For men, this is not a major problem. Because 95 percent of them will finally be in the labor market, the differences for male current workers and nonworkers actually are small. For women, the reality is different. Women who are working tend to stay in, while housewives persistently remain out of the labor force.

For estimating women’s worklife discounts, we developed an alternative approach based on the work of Smith and Ward. Their model’s essential innovation is that it incorporates population heterogeneity, allowing it to capture women’s tendency to remain in or out of the workforce for extended periods. We demonstrated the relative merits of the increment-decrement and Smith-Ward models by using them to calculate retrospective experiences of women and comparing the results
to the actual experience. The Smith-Ward model more closely replicates the past work experience of currently working and nonworking women.

Nonmarket Loss

People engage in a range of productive activities outside the formal labor market—e.g., cooking, shopping, caring for children, and making home repairs. Although the resulting goods and services are not exchanged in a formal market, they have economic value and should be counted equally with the decedent's forgone earnings in loss calculations. Our method for estimating nonmarket loss is to calculate the hours that each decedent would have spent in nonmarket activities, project these hours into the future, and place a value on each hour.

We estimated the number of hours for only those activities traditionally associated with housework. These are the activities that most litigation focuses on, whether full economic loss or loss to survivors is the mandated principle. We calculated total nonmarket hours for each decedent from regressions estimated with the University of Michigan's 1975-1976 Time Allocation Study. Separate regressions were estimated by sex and current work status.

The results predict nonmarket time only for the first year after the accident. To calculate full nonmarket loss, the next step is establishing levels of nonmarket activity at all subsequent ages for workers and nonworkers. Once these levels are established for each decedent, the final, and most problematic, step is placing a value on each nonmarket hour. Because the goods and services produced in the home are not exchanged in a formal market, no explicit prices are attached to them or to the time used to produce them.

A concept often invoked in valuing household services is "replacement cost," that is, what it would cost to purchase a replacement for the decedent's former services. While intuitively appealing, the concept presents formidable methodological problems for evaluating nonmarket hours. Largely because of the way household activities are logged in time budget studies, the hours that people report devoting to a given "service" (e.g., child care) may provide a vastly inadequate measure of the actual time that must be purchased as a replacement for that service.

Our method relies on the concept of opportunity cost. It provides a basis for correctly measuring nonmarket time value. Under this concept, the value of an hour of household work is the market income the individual could have realized by spending that hour in the labor market instead. If an individual has an hourly wage of $10, a fringe
package worth $3 per hour, and a marginal tax rate of 50 percent, the opportunity cost of spending another hour in household work is the $8 forgone from an hour of work at the job ($5 in after-tax pay, plus the $3 fringe). If the individual decides to purchase a substitute to supply the household service, opportunity cost is still a viable measure: For any given level of quality, people will choose the alternative that is less expensive—that is, performing the service themselves or working to purchase a substitute.

Personal Consumption Offset

In most states, wrongful death statutes mandate loss to survivors as the death-damage principle. Many of these statutes require that the decedent's personal consumption be subtracted from full economic loss in estimating the survivors' compensation. The objective in compensating survivors is to maintain their general standard of living, despite the absence of the decedent. If the decedent’s share of consumption is not deducted from loss, the surviving family would, in principle, have a higher standard of living. The same level of resources would be shared by fewer people.

Our method of calculating the personal consumption offset involves establishing the individual's proportion of family consumption; calculating the size of the “effective” family—that is, the survivors who are actually dependent on the decedent—and adjusting for the effects that savings might have had on the family’s future consumption.

Economic research has produced “equivalence scales” to establish the consumption levels that make families of different sizes and compositions equally well-off. Unfortunately, economists do not agree on the single best methodology for creating these scales. Advancing a new methodology was beyond the scope of this project. Thus, we averaged three of the more widely accepted equivalence scales. We used the resulting scale to estimate each decedent’s proportion of family consumption.

The consumption offset must also reflect whether and how much reported family members actually shared in family consumption and the effects of savings. The individuals who would have been actually consumption-dependent on the decedent, in each period, constitute the "effective" family. Our method for calculating effective family size involves establishing dependency values for the survivors. We also factor the effect of savings into the offset, including savings from non-market as well as market income.
Taxes

Where the objective of the tort system is compensating loss to survivors, taxes must enter the calculation in at least two ways. First, the decedent’s support of his dependents’ consumption is based only on his after-tax income. Thus, basing calculations on his gross income would overcompensate survivors. Second, survivors will be taxed on any investment return they realize on the compensation award. Consequently, sufficient compensation must be allowed not only to replace their lost consumption but to finance these future tax liabilities. Our tax treatment addresses three issues: computation of family income, the selection of effective tax rates, and the computation of future tax liabilities.

To apply the correct tax rate to the decedent’s income and estimate future tax liabilities of his survivors, we must first establish family income: Tax liability depends on total family income not simply on the decedent’s income. Similarly, the beneficiaries’ future tax liability will be a function of both the award-generated interest and family income. Family incomes represent the sum of labor-market earnings of each family member as well as nonearnings income, such as interest, dividends, pensions, etc. In many wrongful death cases, information is available only for the decedent’s income. Consequently, our methodology includes procedures for imputing family incomes for before and after the accident.

To calculate the (pre- and postaccident) effective tax rates, we map average tax rates onto family income levels. This is not a trivial procedure, because alternative sources of income are treated differently, allowances are made for many expenses and deductions, the tax system is in flux, and every state has a different tax code. To simplify the problem, we rely on accurate average tax rates for individuals whose family incomes were similar to the decedents’ incomes. For federal taxes, these rates are available from IRS tax-rate tables that are published annually. For state taxes, we relied on summary descriptions of the system operating in each state.

Discount Rate

The discount rate is vital to calculations of economic loss. If plaintiffs were paid one dollar for every one dollar lost, they would effectively be overcompensated because they can earn interest on compensation awards. Discounting serves the essential function of expressing future-year economic losses in terms of their present worth. Although economists agree that discounting is essential, they have not reached
any consensus about what discount rate is appropriate. The controversy is compounded by the variety of interest rates that exist at any given time.

The role of inflation has unnecessarily confused the issue for some courts. When inflation spurs, so do interest rates. Faced with this phenomenon, some courts have refused to adjust discount rates or allow salary growth based on future inflation, deeming inflation estimates "too speculative." This response is based on faulty scientific reasoning and would unnecessarily undercompensate survivors. It fails to recognize the basic distinction between nominal and real interest rates.

Nominal rates are promises to pay a specified number of dollars in the future, and they are the rates usually quoted in the newspapers. Real rates are promises to pay a return in inflation-adjusted dollars. The link between them is the expected rate of inflation. The nominal interest rate equals the real interest rate plus the expected rate of inflation. Thus, existing nominal rates already incorporate a "speculation" about future inflation rates. To use a nominal interest rate (which reflects inflation) but refuse to allow inflation's effect on salary growth is simply illogical.

Most courts have recognized this and insist on a consistent treatment of inflation. This can be accomplished by expressing both salary growth and the discount rate in nominal or in real dollars. We have chosen the latter, using the long-term discount rate of 2.75 percent.

**Special Cases**

Some unique issues arise in computing loss for foreign decedents and juvenile children. The study's foreign residents presented special problems because they came from 40 different countries: We could not develop a separate set of assumptions and compile data specific to each of these countries for each element of the methodology. However, we did use different data for these countries in computing base-year income, calendar-year economic growth, and fringe rates. While the other elements involved in economic loss also differ across countries, these three elements account for a significant part of our loss calculations.

Calculating full economic loss for juvenile children is problematic because their earning potential is not established at the time of death. Further, families would have to make considerable (schooling and other) additional investments in them before they could receive their eventual adult earnings. To address these unknowns, we projected the
amount of schooling they would receive, their future market earnings, and the value of their household services. We estimated full economic loss by subtracting the projected cost of raising the child from these projected values.

It is even more problematic to calculate loss of juvenile children to survivors. This loss may be substantial because the parents have invested resources, both pecuniary and nonpecuniary, in the child. To estimate loss to survivors, we used the analogue of investment in goods (e.g., an automobile): What is the replacement cost of the investment that parents have already made in the lost child.

CONCLUSIONS

We believe that, under present economic conditions and scientific thought, our methodology represents a considerable improvement over existing methods of calculating economic loss. It can also be applied in a wide range of tort cases besides wrongful death. However, it should not be applied automatically to individual cases, ignoring their specific nature, the economic changes that affect numerical values, and the changes in scientific thought.

The Methodology’s Wider Application

The methodology is not limited to aviation wrongful death cases. The sample naturally dictated the particulars of income and time period in our demonstration. However, the principles, components, and procedures can be fully applied in other cases of wrongful death. They can also be applied in personal injury cases, with two important differences. We would not deduct the injured person’s personal consumption from loss, and we would add all medical costs associated with the injury. Because wrongful termination and discrimination cases involve economic loss, the methodology can also apply to them. In such cases, we would exclude the personal consumption offset and omit nonmarket loss (since people out of work actually spend more time in such activities).

Adapting the Methodology for Specific Cases

To make the correct valuation in specific cases, one must vary assumptions, as appropriate, for a decedent’s demographic characteristics. In this study, we intended to provide a general approach to calculating loss for the “average” person. We were dealing with 2113 very
diverse cases, and the assumptions had to be general enough to apply in all cases. The discount rate used for elderly decedents provides an example of cases where our general assumptions would not apply. We used a long-term discount rate in the air-crash analysis. For elderly decedents, a short-term interest rate might be more appropriate to calculate the present worth of future economic loss.

Just as the assumptions must vary to fit specific cases, the numerical magnitudes we used will change as economic and social realities evolve. For example, at any given time of litigation, economic experts might well argue for different discount and salary growth rates than we have used. The numerical magnitude of the elements will depend on how the national economy stands, as well as on longer growth trends, when the methodology is applied.

Finally, as science evolves, the methodology for computing economic loss should improve. Some economic assumptions used in the early cases would not be used today, and some principles that were considered controversial then are now commonly considered essential.
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I. INTRODUCTION

When an individual is killed, whether in an airplane, automobile, or some other accident, economic experts are sometimes called upon to compute the compensation that the decedent's beneficiaries will receive. Even when economic experts are not called in, settlement negotiations take place with these economic evaluations in mind. Despite the considerable importance that economic expert evaluations have in setting compensation, there is no generally accepted procedure for computing these damages, and the actual practices vary widely. In this report, we present a comprehensive and systematic methodology for calculating compensation in wrongful death cases.

Although state laws vary in the principles that govern damages in wrongful death cases, compensation paid in the system has three general aims: to compensate survivors fully and fairly; to deter harmful behavior; and to punish any wrongdoing that may have caused an accident. All three objectives require that tortfeasors make some compensation for the value of the life lost.

Despite these generally accepted aims, the legal and economic treatment of wrongful death cases has varied considerably—if diversity of compensation awards is any indication. This diversity raises questions of equity and equal justice, leading to demands that the tort system's treatment of wrongful death claims be reformed. However, the debate over reform measures has been stymied by lack of evidence. There is little comprehensive, accurate data on the characteristics of decedents, compensation awards, and the transactions costs of the current system.

Without such data, the debate has operated largely on intuition, anecdotal evidence, and imperfect induction. Lack of data has also precluded systematic research on the relationship between compensation paid and the economic losses suffered by plaintiffs. Such systematic research also depends on establishing a more scientifically based method for calculating loss than is currently used.

PURPOSES OF THIS REPORT

This report is part of the RAND Aviation Accident Study, which has gathered such comprehensive data for the first time. The study collected data on 88 percent of the aviation deaths that occurred between 1970 and 1984 involving major U.S. airlines. For these cases, we have information on the details of the accidents; the size of the
awards; the costs of litigation; the characteristics of the decedents, claimants, and defendants; and other facts pertinent to the litigation. While our data cover only wrongful death cases in air crashes, the principles involved in damage calculations for aviation accidents are similar to those in any tort case involving wrongful death.

This volume describes the methodology we developed to calculate economic loss for the decedents in our sample. We acted to improve upon existing methods because, in some important respects, they remain seriously deficient. Typically, economic experts must rely on standardized tables simply because they are readily available, and on cookbook methodologies, about which they have serious reservations, because it is far too costly to develop alternatives for a single claim. Moreover, current practices for computing economic loss have largely evolved in litigation—a context where each side has vested interests in the results. This project provided a unique opportunity to evaluate impartially and to improve the methodology for calculating economic loss and compensation in wrongful death.

The primary goal of this report is methodological—to provide a comprehensive guide to the steps involved in computing loss. Although we have used data resulting from aviation accidents, and our findings answer some important questions about the resulting litigation, nothing in the methodology inherently limits it to aviation wrongful death cases. In our demonstration of the model, the particulars of income and time period were naturally dictated by the sample. However, the principles, components, and procedures can be fully applied to all cases of wrongful death. In fact, with some modification, the methodology also applies to other kinds of damage litigation, including personal injury, wrongful termination, discrimination, etc.

The methodology, as we describe it here, cannot be applied without any modification in any given case or time period. In this study, we provide a general approach to calculating loss for the “average” person. To make the correct valuation in specific cases, assumptions must account for a decedent’s demographic characteristics. The same is true of the numerical magnitudes for given elements. The methodology is not an inflexible “set of numbers.” Rather, it is a way of thinking about calculating damages.

The King-Smith methodology outlined in this report has a number of unique features. Among others, it

- provides a consistent and systematic method for calculating all the elements involved in computing economic loss (however, our methodology does not deal with the important complementary issue of calculating damages for noneconomic loss)
• outlines procedures for computing full salaries (including fringe benefits) of decedents at the time of their deaths
• presents a model for computing all the elements involved in expected salary growth (in particular, our methodology incorporates a new model of individual-level salary growth, and a new method of estimating life-cycle salary growth for women)
• illustrates how to estimate the value of nonmarket economic loss associated with the death
• develops a new model for calculating future worklife expectancies for women
• evaluates the critical practical problems plaguing actual litigation of substantial amounts of missing data (to impute some of these missing values, we identify a number of external data sources that we feel are superior to many that are now commonly used)
• offers solutions to the often-mistaken current treatment of taxes and the personal consumption offset

This volume does not present any of the economic loss values we compute for the aviation sample. In a companion volume, we compare the values of economic loss (calculated with the King-Smith methodology) with the compensation that beneficiaries actually received.¹

In our companion volume, we also describe and analyze the economic determinants of the compensation provided and evaluate how well the current tort system achieves its aim of equitably compensating survivors. In a third volume, we analyze how characteristics of the decedents, claimants, defendants, accidents, and legal environment affect the litigation decisions made by plaintiffs and defendants.²

ORGANIZATION OF THE REPORT

In the next section, we discuss the premises of our study and the assumptions and principles informing the methodology. In the next seven sections, we consider, in turn, the major elements in calculating full economic loss and loss to survivors: base-year income, salary growth, worklife discounts, nonmarket economic loss, personal consumption offset, taxes, and the discount rate. The penultimate section deals with two kinds of decedents whose characteristics create special calculation requirements—foreign citizens and juvenile children. In the final section, we discuss the general applicability of the methodology.

II. AN OVERVIEW OF THE STUDY: LEGAL CONTEXT, CONCEPTUAL APPROACH, AND METHODOLOGY

Our purpose was to develop a scientifically rigorous methodology for calculating economic loss. As the Introduction notes, this methodology can be applied in any case of wrongful death and, with some modification, in other kinds of damage litigation as well. However, the legal context of aviation litigation and the data collected by the RAND Aviation Accident Study influence the development of our method, the numbers used, and the outcomes. Consequently, we should provide some of the background before detailed discussion of the methodology.

In this section, we describe the legal context—the wrongful death statutes governing wrongful death litigation, judicial interpretation, and calculation of loss—which dictated our return to first principles in developing a methodology. We then discuss conceptual approaches to measuring loss, explain our rationale for using the human capital approach, and define the elements of our methodology. Finally, we describe the study data.

THE LEGAL CONTEXT: WRONGFUL DEATH STATUTES

In this country, every state has its own statutes governing compensation in wrongful death litigation. However, there are three basic types of statutes: loss to survivors, loss to estate, and punitive damages.

Loss to survivors is the mandated form of compensation in 80 percent of the states. Under this principle, tortfeasors are required to compensate survivors for the financial and, often, other kinds of loss suffered because of a wrongful death. Loss-to-estate statutes generally take three forms: (1) net contribution to survivors, (2) net accumulations (i.e., the decedent’s probable future savings), and (3) gross earnings (i.e., all the decedent’s lost future economic output).

Punitive damages are estimated according to the tortfeasor’s culpability and apply in only one state (Alabama). For both reasons, this principle is not strictly relevant to our purposes here, and we do not discuss it further.
Loss to Survivors

The legal concept of loss to survivors can be traced back to at least 1846, when Lord Campbell's act was passed in England. This act was passed in reaction to Lord Ellenborough's 1808 dictum in *Baker vs Boltan*, which promulgated the common law rule denying right of recovery in wrongful death. The denial of recovery in common law meant that recovery for damages had to be statutorily based. Lord Campbell’s act provided decedents' relatives the right to compensation for their pecuniary loss, and it became the model for many of the wrongful death statutes in the United States.

Although the state statutes modeled after Lord Campbell’s act vary a great deal, particularly in how they have been construed, they all share a common philosophical intent of compensating the decedent's beneficiaries for the pecuniary loss incurred by the wrongful death. Under loss-to-survivor statutes, damages are awarded for the present value of probable contributions the deceased would have made to his survivors.

Lord Campbell's act was originally interpreted as allowing compensation only for pecuniary damages. However, the definition of “pecuniary” eventually became quite broad. In most jurisdictions, it included loss of consortium; loss of services; and loss of nurture, training, and guidance of children. In the pioneer treatise on wrongful death, Tiffany recognizes that pecuniary loss is "by no means confined to the loss of money or what can be estimated in money." Similarly, in the 1974 landmark Gaudet decision, the Supreme Court endorsed the broad sweep of loss to society as including "love, care, affection, attention, companionship and comfort." Whatever the concept of pecuniary loss, the central character of loss-to-survivor statutes is that the decedents' own expenses or consumption are not included in the loss.

Loss to Estate

Loss-to-estate statutes can take three forms. The first defines loss as the present value of net contribution to survivors, and for all practical purposes is equivalent to loss to survivors. In the second form, net accumulations, the loss is equivalent to the decedent's net future contributions to his estate (his future savings). The third form is gross earnings—the decedent’s lost future economic output—which equals *full economic loss*. Under this form, there is no deduction for the amount the decedent would have incurred on his own expenses. Where full economic loss is the principle, the focus shifts from loss to survivors to the lost value of the decedent’s life. Full economic loss is the
damage principle in Georgia and Kentucky, states whose statutes applied for some of the sample’s aviation death suits.

Our purpose in this study was to estimate, for each decedent, the economic loss suffered. However, our approach was shaped by other conditions of the legal context.

THE LEGAL CONTEXT: JUDICIAL INTERPRETATION

As with other areas of tort law, not only has wrongful death undergone a period of significant statutory change but a number of landmark court decisions have altered judicial interpretation. As one authority summed the situation up: “The original statutes were not so varied in wording, except in a handful of states, but the way they have been construed and applied has produced a horrendous miscellany” (Speiser, 474).

In aviation deaths, the confusion is compounded by the question of which state has jurisdiction. Until the middle of this century, the settled rule in wrongful death was that the law of the state where death occurred would apply (the lex loci rule). However, that tradition has weakened over the last two decades. Today, it is often an issue of dispute whether the substantive law governs in the state of death, the residence of the decedent, the domicile of claimants, the place where the ticket was purchased, etc.

For our purposes here, the confusion is further compounded by legal restrictions that applied for some of the aviation sample. Today, no state law limits total compensation for aviation deaths, although some states do limit payments for nonpecuniary loss. In the early years of our sample of accidents, however, some states still maintained limits capping the size of the award. In 1971, eight states had limits on recovery but only two states had such limits by 1975. These caps were stringent—often set well under $100,000. To the extent that specific cases were directly affected by these limits or that such limits influenced the context in which settlements were made, actual compensation will be affected.1

In addition to state laws, there are international treaties such as the Warsaw Convention and the Montreal Agreement that potentially limit the maximum award to survivors of decedents who were flying with

1Two of the states where crashes occurred during this period—West Virginia and Massachusetts—had caps on recovery. Evaluated in March 1966 dollars, the cap in Massachusetts was $441,032 and $308,034 in West Virginia at the time the accidents occurred. Speiser reports that the Massachusetts cap was raised to $200,000 on January 1, 1973. This cap was abolished on January 1, 1974. At the time of the West Virginia crash (1970), the cap on recovery in West Virginia was $110,000.
international tickets. For example, the current limit set by the Montreal Agreement is $75,000 for each decedent.²

THE LEGAL CONTEXT: CALCULATION OF LOSS

Another significant source of “disarray” has been the economic principles invoked and the methods applied. Experts use too many assumptions that are frankly inconsistent with the scientific principles of economics. Moreover, courts have differed widely in their decisions regarding the correct application of economic principles. Partly at the direction of the court, some economic experts put aside worklife discounts completely and assume uniform retirement at age 65. Others have invoked the total offset rule, so that discounting does not enter the calculation. Others have ignored salary growth in any form. And some experts have computed only market loss.

On many of these issues, economics and the courts have progressed considerably over the period covered by our data. Economic assumptions were put forth in the early years that would simply not be used by any credible expert today, and some are used today that were unacceptable or even unheard of then. Although individual economists will differ on issues of implementation, most would accept the necessity of discounting, the symmetry between market and nonmarket loss, and life-cycle salary progression as essential principles in calculating loss.

Further, these scientific advances in economics have been matched by the courts’ increasing sophistication in interpreting the economic principles at work in calculating economic loss. When reading the major decisions of the last decade, one can only be impressed at how far the courts have come in applying sound economic reasoning to meet statutory objectives.

Despite these improvements, economists and the courts have not reached a consensus about the scientific principles and methods for computing loss and compensation. Further, we cannot identify and evaluate a “typical” process through which the courts awarded compensation for the cases that went to trial or a process implied by the vast majority that did not. Given the “horrendous miscellany” across jurisdictions, and the ambiguity about which jurisdiction governs, that would be an impossible task. Neither can we replicate and evaluate assumptions used by expert witnesses in these cases. Experts made calculations for only 10 percent of the decedents. In many of these cases, we have only partial information concerning what assumptions

²See Cagle (1986) for a comprehensive review of these different international agreements.
were made about the individual elements (discount rate, salary growth, etc.) that make up the calculation of economic loss.

**USING FIRST PRINCIPLES**

Under the circumstances, a return to first principles is the most useful approach, beginning with what statutes aim to achieve and what principle of compensation they imply or (sometimes) specify. Given the basic principles and the elements involved in computing loss, we have aimed at developing a methodology that improves on the methods currently used. The criterion by which methods (including ours) must be judged is how well they meet the overriding objectives of tort law—that is, given the two basic death-damage principles, does the method lead to fair compensation, based on sound scientific principles?3

We calculate two compensation values for each decedent. The first is “full economic loss” and the second “loss to survivors.” These two compensation values correspond to a basic legal distinction: whether damages should reflect the principle of loss of the value of a decedent’s life or loss to survivors. Each principle implies a somewhat different methodology to compute compensation. (Each also implies a different set of criteria on which to judge whether the objectives of the tort system are being met.)

Although loss to survivors is the compensation principle mandated in most states, we calculate full economic loss for several reasons. First, in several states, including the site of one of our crashes (Georgia), full economic loss is the statutory damage principle in wrongful death cases. Second, it is the benchmark to determining how much the tort system contributes to the deterrence of unsafe practices. To provide the appropriate incentives for deterring harmful behavior, tortfeasors should pay the full cost of the harm done in some combination of tort damages and other economic costs—for example, loss of market

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3In developing and applying our methodology, and comparing compensation with loss, we have not answered larger ethical questions concerning the equity of compensation. We are concerned here only with how close compensation is to the actual economic loss suffered as the loss is implicitly defined by the rules of the tort system. In other words, we have taken the working principles of the tort system as our guide. For example, the courts have enforced the “collateral source” rule, which makes any other sources of compensation (such as life insurance) irrelevant to the estimates of loss to and compensation owed survivors. Thus, we have not considered the effects these other sources might have on loss. Although the existence of collateral sources may raise ethical questions about the equity of compensation, those questions are outside the scope of this study.
share.

Third, full economic loss is the initial basis for calculating loss to survivors, which is the death-damage principle in most states.

CONCEPTUAL APPROACHES TO MEASURING LOSS

In recent years, measuring the value of life has been extensively discussed. Although various approaches have been proposed, no consensus has been reached about the most effective approach for all applications. There are several conceptual models possible for estimating full economic loss and loss to survivors: the human capital approach, the insurance principle, and the willingness-to-pay criterion.

The human capital (or lost economic output) approach is by far the most widely used in legal applications. In this approach, economic loss is the value of the decedent’s lost future productivity, both market and nonmarket. This approach has been criticized for measuring only society’s loss (in terms of national income) and ignoring many aspects of the satisfaction that a person derives from life. Nevertheless, the human capital approach provides a lower bound on what an individual would pay to preserve his life—if he values it at least as much as the satisfaction he gets from lifetime consumption. Moreover, it can be modified to take account of the decedent’s suffering and his family’s bereavement.

When the human capital approach is used to estimate loss to survivors, the decedent’s future consumption is subtracted from future earnings. Then, the award equals only the value of future losses accruing to his dependents. This modified award suggests what society values is the resulting net loss or net gain to surviving members of society. Unfortunately, this implies that if a person was making no earnings contribution to society when he died, his death actually results in a net benefit to society.

The insurance principle involves calculating the premium a person would be willing to pay to insure that his beneficiaries would be com-

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4In the evaluation of the deterrence objective, it is important to remember that the tort system is not the only way to ensure airline safety. Other mechanisms, including regulatory agencies and market forces, exist for this purpose. These other mechanisms may impose substantial costs on tortfeasors, so we should not expect or demand that the tort system carry the full load of deterrence. We discuss the issue of deterrence in our companion report, Economic Loss and Compensation in Aviation Accidents.


pensated if he died. The crucial, unresolved methodological problem with this approach is how to establish empirically what that premium would be. The insurance principle considers only the compensation to a person’s family and dependents. It implies that an unmarried person with no dependents would have no reason to take out an insurance policy and that no one would lose from his death.

Most economists would agree that willingness-to-pay is the most conceptually appropriate criterion for establishing the value of life. It equates that value with how much a person would be willing to pay to preserve his life. This approach does not necessarily include the economic loss of a person’s death to others—that is, to dependents, kin, or friends who are affected by the death. If the welfare of dependents and kin enters the individual’s utility function, then their welfare would be reflected in the amount he would be willing to pay. If not, this approach would not measure the full economic loss caused by his death.

Past studies relying on the willingness-to-pay approach have used two statistical techniques to measure the value of life. The first technique estimates implicit values by computing the wage differential that compensates people for risks on the job or in consumption choices. For example, workers in risky occupations typically demand a wage premium to compensate them for the extra risk their work entails. If such workers demand $10,000 more in salary for a job where risk of death is one percentage point higher (and their risk function is linear), their implicit value of life is $1 million. In the second method, individuals are asked directly how much they would pay for improving their health and safety conditions.

The willingness-to-pay approach would be most appropriate for determining the benchmark for evaluating the deterrence objective of the tort system. However, it has two primary limitations. The first problem is empirically establishing the numerical magnitude of the value of life. Viscusi’s summary of estimates in past studies shows that they range from $635,000 to over $12 million. Without compelling criteria for choosing among the estimates, they become impractical and irrelevant for a judicial system that must adhere to a particular number.

The second limitation is the exclusive focus on the decedent’s perceived value of life. The tort system has often adopted the ex post view of beneficiaries, not the ex ante view of the decedent. There is

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8See Dardis, 1980; Blomquist, 1982.
11See Viscusi (1983) for a critical review of prior work.
little systematic research on how to adjust the willingness-to-pay con-
cept when beneficiaries are the principal focus of compensation.

In this study, we have taken the human capital approach, not
because we believe it is conceptually superior to the others, but because
it completely dominates actual litigation. Economists have long recog-
nized that what we label full economic loss understates (probably sub-
stantially) the true cost of a death. The human capital approach
invariably produces much smaller estimates for the value of life than
the theoretically more well-grounded, willingness-to-pay concept.12 We
also believe that willingness to pay provides a more appropriate basis
for valuing life than the human capital approach does. However,
because the courts have allowed only the latter, using another approach
would make our research irrelevant to any major public policy issues
surrounding tort reform in wrongful death. In Economic Loss and
Compensation in Aviation Accidents, we contrast our estimates of full
economic loss with those obtained using willingness to pay.

ELEMENTS OF THE METHODOLOGY

Definitions of Loss

Given the human capital approach, economists would generally agree
on the components involved in calculating full economic loss and loss
to the decedent’s survivors. Full economic loss is the total discounted
value of present and future market and nonmarket economic losses.
Market loss is the value of the decedent’s lost future earnings, while
nonmarket loss captures the present and future value of his productive
work performed in the home.

To obtain the value of market loss, we rely on the decedent’s yearly
income at the time of death. To calculate the value of a decedent’s
nonmarket economic loss, we estimate both the number of household
production hours and the value of those hours. Because most of these
losses would occur in the future, we have to determine the decedent’s
future earnings. This requires estimating future wage rates, including
rates of salary growth and the probability that a decedent will work in
the future. Finally, we must discount economic loss in future time
periods to reduce that loss to a present value.

Estimating loss to survivors requires two adjustments to the calcula-
tion of full economic loss. First, the decedent’s personal consumption
must be deducted because it would not be a loss to his survivors.

12 For an illuminating discussion of the methods used to compute the value of life
using willingness-to-pay, see Viscusi (1987).
Second, and similarly, taxes must be deducted because dependents would have benefited only from the decedent’s after-tax future income. Tax effects must also be considered because beneficiaries will have to pay taxes on the interest from a compensation award. Although individual economists will differ on how they apply these principles, the symmetry between market and nonmarket loss, life-cycle salary progression, and the necessity of discounting are now core economic principles in calculating both kinds of loss.

Many states permit recovery for some types of noneconomic loss (e.g., loss of affection and consortium) or for punitive damages. However, our research focuses on the relationship between compensation and economic loss. Although the strict distinction often made between economic and noneconomic loss does not survive much scrutiny, we focus on economic loss for two reasons: First, there is no market for most elements involved in noneconomic loss; thus, it is difficult to measure what their actual value is. Second, the files did not contain information that would allow us to directly extract noneconomic from economic loss in the awards.  

Elements of the Methodology

There are seven elements in our methodology for calculating full economic loss and loss to survivors: (1) base-year income, (2) salary growth, (3) worklife discount, (4) nonmarket loss, (5) personal consumption offset, (6) taxes, and (7) discount rates.

**Base-Year Income.** The “base-year” is the first year of work after the accident, and base-year income is a key variable in computing both kinds of loss. For full economic loss, the base-year income indexes the value of the decedent’s initial contribution to the economy. For loss to survivors, it largely determines the surviving dependents’ standard of living. The calculation of base-year income must include not only basic salary, but also fringe benefits, incomes from regular second jobs, bonuses, commissions, etc.

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13 Because we exclude loss of consortium and mental anguish from our calculation of loss to survivors, our treatment of loss to survivors and actual compensation paid is not symmetric. Actual compensation includes payments for nonpecuniary losses. However, we cannot directly separate these losses from economic losses because they are generally not separated in the claims files. Actual compensation would obviously be smaller if we were able to subtract these nonpecuniary losses. Conversely, if actual compensation, including nonpecuniary losses, is still lower than the loss to survivors that we calculate, then we can assume that we are understating the inadequacy of the compensation paid. Although we cannot directly separate compensation for economic and noneconomic loss, we develop an indirect method of making this separation in *Economic Loss and Compensation in Aviation Accidents*. We show there that compensation for economic loss is two-thirds of total compensation received.
Salary Growth. Calculations of economic loss must include projections of future salary growth, because decedents' earnings would probably not have stayed at the base-year level throughout their working lives. We model future salary growth as the sum of three components that ordinarily affect it: economy-wide growth in productivity, the "normal" life-cycle career wage progression (estimated separately for men and women), and the comparative productivity of individuals.

Worklife Discounts. Future earnings depend not only on the wage rate people can command but also on how much they will actually work. Consequently, to calculate forgone earnings, we must forecast the likelihood that each decedent would have worked in all future years. Our forecast model predicts the most likely labor-force behavior of individuals in our sample, given what we know about current labor-force status. This is also estimated separately for men and women.

Nonmarket Loss. Individuals engage in a variety of productive activities outside the formal labor market. Although these activities do not pass through a formal market and do not carry explicit prices, they are, in principle, no different from a car produced on the assembly line. Thus, they must be counted equally with the decedent's forgone market earnings in calculating full economic loss. We compute nonmarket loss by estimating the total hours each decedent would spend in nonmarket activities during the base-year, projecting these hours into the future and placing a value on each hour. Because we do not have precise information on time the decedents spent on nonmarket activities, we rely on estimates from the study of individual time budgets.

Personal Consumption Offset. Under loss-to-survivors statutes, the personal consumption of the decedent must be subtracted from total economic loss to arrive at the legally mandated compensation. Isolating the unique consumption of an individual family member is not a trivial problem. Economic research has produced "equivalence scales" for this purpose. Unfortunately, economists do not agree on the single best methodology for creating these scales, and advancing a new methodology was beyond the scope of this project. Thus, for this calculation, we averaged three of the more prominent methodologies available.

Taxes. Different objectives of tort law require different treatment of taxes. Where the objective is deterrence, this full cost is correctly measured by the before-tax total market and nonmarket economic loss. However, where the objective is compensation to survivors, taxes must enter the calculation in at least two ways. First, the decedent would have been able to support his dependents' consumption only from his after-tax income. Thus, basing calculations on his gross income would overcompensate survivors. Second, survivors will be taxed on any investment return they realize on the compensation award.
Consequently, sufficient compensation must be allowed not only to replace their lost consumption but to finance these future tax liabilities. Our tax treatment addresses three issues: computation of family income, the selection of effective tax rates, and the computation of future tax liabilities.

Discount Rates. Because the decedent’s survivors can earn interest on compensation awards, they would effectively be overcompensated if they were paid one dollar for every one dollar lost in the future. Consequently, a discount rate must be used in computing economic loss. Discounting serves the essential function of expressing future-year economic losses in terms of their present worth. Although economists agree on the need to discount, there is much controversy over the choice of an actual discount rate. For reasons explained later, we use a real interest rate to discount future economic losses in our calculations.

In subsequent sections, these elements of the model are discussed more fully, including the scientific principles involved. Many of the assumptions in our methodology are dictated by the specific characteristics and limitations of the claims file data. For each of the elements of economic loss, we describe what is implied by our specific assumptions for the values assigned to the decedents.

THE STUDY DATA

Developing a methodology to compute economic loss is an artificial exercise unless that methodology can be applied to real data. Real data provide a much better measure than hypothetical cases do of how useful and adequate the method might be. For this report, we use the data collected in the RAND Aviation Accident Study to illustrate the steps involved in our methodology.14 The real data allowed us to test the methodology under some conditions that confront experts in actual litigation. Their use also illustrates the practical problems that arise and suggests some solutions to them.

This study used two distinct kinds of data. The first was specific to the airline decedents and derived from the RAND survey of the files of insurance carriers and defense lawyers for the 25 major accidents involving U.S. airlines between 1970 and 1984. These accidents resulted in 2228 passenger and ground deaths, or 88 percent of all the deaths resulting from U.S. airline accidents during that period. The RAND survey excluded accidents that involved aircraft with fewer than

14The bottom-line numbers resulting from this methodology are available in our companion volume, Economic Loss and Compensation in Aviation Accidents.
60 seats or that resulted in fewer than five deaths. Our analysis in this report is limited to those 2113 passenger deaths for which it was possible to compute economic loss. Table 2.1 lists for each of the 25 accidents the number of decedents for whom we were able to calculate economic loss.

Table 2.1

MAJOR ACCIDENT LIST FOR U.S. AIRLINES: 1970-1984

<table>
<thead>
<tr>
<th>Accident No.</th>
<th>Date</th>
<th>Airline</th>
<th>Location</th>
<th>Dead</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>11-14-70</td>
<td>Southern</td>
<td>Kenova, WV</td>
<td>59</td>
</tr>
<tr>
<td>2.</td>
<td>11-27-70</td>
<td>Capitol</td>
<td>Anchorage, AK</td>
<td>46</td>
</tr>
<tr>
<td>3.</td>
<td>6-6-71</td>
<td>Air West</td>
<td>Duarte, CA</td>
<td>44</td>
</tr>
<tr>
<td>4.</td>
<td>9-4-71</td>
<td>Alaska</td>
<td>Juneau, AK</td>
<td>104</td>
</tr>
<tr>
<td>5.</td>
<td>12-8-72</td>
<td>United</td>
<td>Chicago, IL</td>
<td>19</td>
</tr>
<tr>
<td>6.</td>
<td>12-20-72</td>
<td>No. Central</td>
<td>Chicago, IL</td>
<td>10</td>
</tr>
<tr>
<td>7.</td>
<td>12-29-72</td>
<td>Eastern</td>
<td>Miami, FL</td>
<td>93</td>
</tr>
<tr>
<td>8.</td>
<td>7-31-73</td>
<td>Pan Am</td>
<td>Tahiti</td>
<td>68</td>
</tr>
<tr>
<td>9.</td>
<td>7-31-73</td>
<td>Delta</td>
<td>Boston, MA</td>
<td>82</td>
</tr>
<tr>
<td>10.</td>
<td>12-17-73</td>
<td>Pan Am</td>
<td>Rome</td>
<td>20</td>
</tr>
<tr>
<td>11.</td>
<td>1-31-74</td>
<td>Pan Am</td>
<td>Pago Pago</td>
<td>83</td>
</tr>
<tr>
<td>12.</td>
<td>4-22-74</td>
<td>Pan Am</td>
<td>Bali</td>
<td>91</td>
</tr>
<tr>
<td>13.</td>
<td>9-8-74</td>
<td>TWA</td>
<td>Ionian Sea</td>
<td>76</td>
</tr>
<tr>
<td>14.</td>
<td>9-11-74</td>
<td>Eastern</td>
<td>Charlotte, NC</td>
<td>70</td>
</tr>
<tr>
<td>15.</td>
<td>12-1-74</td>
<td>TWA</td>
<td>Mt. Weather, VA</td>
<td>65</td>
</tr>
<tr>
<td>16.</td>
<td>6-24-75</td>
<td>Eastern</td>
<td>New York, NY</td>
<td>109</td>
</tr>
<tr>
<td>17.</td>
<td>4-27-76</td>
<td>American</td>
<td>St. Thomas, V.I.</td>
<td>35</td>
</tr>
<tr>
<td>18.</td>
<td>3-27-77</td>
<td>Pan Am</td>
<td>Tenerife</td>
<td>324</td>
</tr>
<tr>
<td>19.</td>
<td>4-4-77</td>
<td>Southern</td>
<td>New Hope, GA</td>
<td>69</td>
</tr>
<tr>
<td>20.</td>
<td>9-25-78</td>
<td>PSA</td>
<td>San Diego, CA</td>
<td>135</td>
</tr>
<tr>
<td>21.</td>
<td>12-28-78</td>
<td>United</td>
<td>Portland, OR</td>
<td>7</td>
</tr>
<tr>
<td>22.</td>
<td>5-25-79</td>
<td>American</td>
<td>Chicago, IL</td>
<td>258</td>
</tr>
<tr>
<td>23.</td>
<td>10-31-79</td>
<td>Western</td>
<td>Mexico City</td>
<td>61</td>
</tr>
<tr>
<td>24.</td>
<td>1-13-82</td>
<td>Air Florida</td>
<td>Washington, DC</td>
<td>74</td>
</tr>
<tr>
<td>25.</td>
<td>7-9-82</td>
<td>Pan Am</td>
<td>New Orleans, LA</td>
<td>114</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>2113</td>
</tr>
</tbody>
</table>

We did not include accidents prior to 1970 because of problems with data availability. We excluded accidents after 1985 because many of the resulting cases are still under litigation and could not provide us with information on compensation awards and litigation costs.

Thirty cases were excluded because these cases were not closed when data collection stopped in May 1986. Eighty cases were excluded because we did not have information on either sex or age, two variables that we judged as the minimum requirement before an economic loss calculation could be made. Finally, five cases were excluded because the decedents were residents of foreign countries for which we felt we had no basis for estimating their income.
The RAND claims data include detailed information on the characteristics of the decedents, the compensation paid, and the litigation history. These data can be divided into three categories: accident-level information, decedent information, and lawsuit information. The major variables in each of these categories are listed in Table 2.2.

The second distinct kind of data came from external sources. These data were needed because the claims files contained no direct information concerning certain critical components of economic loss: decedents' time spent in household services, fringe rates, taxes paid, personal consumption of the decedent, etc. Indeed, for many decedents, we lacked such basic data as their salaries at the time of death. To impute the value of these components, we had to rely on information from other external sources.

We used a simple criterion to select external data sources for this information. In each case, after searching among the alternatives available, we selected the external source that would allow us to estimate most accurately the missing data for these decedents. That criterion made us reject some data sources that may often have been employed in litigation. We discovered that some of these frequently used external sources provided biased and inaccurate predictions about the missing information. Our study suggests some new external data sources for economic experts to consider in litigation.¹⁷

¹⁷The precise statistical information used to make our economic loss estimates also came from various sources, including the Census and Bureau of Labor Statistics data, mortality and work probability data, fringe-benefit data, household time budget survey data, etc. The specific sources are identified throughout our discussion of the methodology.
Table 2.2
SUMMARY OF VARIABLES IN RAND ACCIDENT SURVEY

<table>
<thead>
<tr>
<th>Accident Level Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date and location of the accident</td>
</tr>
<tr>
<td>Number of deaths and injuries</td>
</tr>
<tr>
<td>Identity of defendants and insurers</td>
</tr>
<tr>
<td>Number of defendants who paid compensation</td>
</tr>
<tr>
<td>Defense expenditures</td>
</tr>
<tr>
<td>Whether defendants contacted plaintiffs early</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Decedent Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Sex</td>
</tr>
<tr>
<td>Country or state of residence</td>
</tr>
<tr>
<td>Citizenship</td>
</tr>
<tr>
<td>Race</td>
</tr>
<tr>
<td>Marital status</td>
</tr>
<tr>
<td>Health status</td>
</tr>
<tr>
<td>Length of time survived after accident</td>
</tr>
<tr>
<td>Whether multiple members of the same family were killed</td>
</tr>
<tr>
<td>Number and age of juvenile children of decedent surviving</td>
</tr>
<tr>
<td>Number of adult children of decedent surviving</td>
</tr>
<tr>
<td>Total number of dependents and degree of dependency of each</td>
</tr>
<tr>
<td>Total number of claimants</td>
</tr>
<tr>
<td>Employment status</td>
</tr>
<tr>
<td>Occupation</td>
</tr>
<tr>
<td>Military or not</td>
</tr>
<tr>
<td>Income (for decedent if adult, for parents if juvenile)</td>
</tr>
<tr>
<td>Fringe-benefit rate</td>
</tr>
<tr>
<td>Education (for decedent if adult, for parents if juvenile)</td>
</tr>
<tr>
<td>Anticipated education (if juvenile)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Claim and Lawsuit Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of plaintiff attorney</td>
</tr>
<tr>
<td>Whether a lawsuit was filed</td>
</tr>
<tr>
<td>Whether it was filed in a federal, state, or foreign court</td>
</tr>
<tr>
<td>Whether a trial was held</td>
</tr>
<tr>
<td>The length of trial</td>
</tr>
<tr>
<td>The total compensation received</td>
</tr>
<tr>
<td>The length of time to close the case</td>
</tr>
<tr>
<td>The presence of an international treaty limitation</td>
</tr>
<tr>
<td>The presence of a state limitation on compensation</td>
</tr>
<tr>
<td>Plaintiff's litigation expenditures as a percentage of compensation</td>
</tr>
</tbody>
</table>
III. BASE-YEAR INCOMES

A decedent's base-year income is a key variable in calculating full economic loss and loss to survivors. Base-year income represents the decedent's regular salary and fringe benefits at the time of death, as well as any earned or anticipated bonuses, commissions, income from second jobs, etc., for that year.\(^1\) For full economic loss, the base-year income indexes the value of the initial output that the decedent contributed to the economy.\(^2\) For loss to survivors, base-year income is a major component in determining the surviving dependents' standard of living.

ISSUES FOR CALCULATING BASE-YEAR INCOME

Because of its crucial role in loss calculations, base-year income must be measured as accurately as possible. Three major issues complicate such measurement: the concept of income, the sources of income, and the accuracy of imputing income where information on base-year income is missing.

Concepts of Income

This study makes a distinction between two concepts of base-year income: potential and expected income. Potential income represents what decedents could have earned if they had worked full time in the labor market. This potential concept is important because it indicates their ability to earn income in the labor market. However, most people do not choose to realize their full earning capacity. For example, many women work less, or not at all, when they have preschool children. Further, most people retire from the labor market between ages 62 and 65, after which their earnings are well below their potential income. Because of these labor-supply decisions, people's actual earnings will not equal potential earnings.

\(^1\)Our calculations of base-year income did not include such things as earnings on stocks and bonds, which continue after a person dies. We use "income" and "earnings" as synonymous terms in this report, but our usage refers only to those income sources that terminated with the death.

\(^2\)Throughout our methodology, all dollar values are expressed in real dollar equivalents to account for inflation. In our airline sample application, all nominal values are expressed in March 1986 dollars.
Expected income is the income decedents would actually have earned in the year of the accident. Consequently, for our calculations, expected income equals potential earnings multiplied by the fraction of the year that decedents would have worked.\footnote{We explain the construction of our measure of the fraction of a year worked in the section on worklife discounts below.}

Sources of Income

People’s basic salaries do not reflect their full pay from employment. Part of the pay comes in the form of health, insurance, and other fringe benefits. Many people also have supplemental incomes from, e.g., second jobs, bonuses, and commissions. Supplemental incomes may be less stable, and less representative of consistent earning power, than income from the principal job. All these components of income must be considered in calculating base-year income. These considerations are further complicated in cases involving self-employment and family-owned businesses where isolating the decedent’s unique income can be difficult.

Imputing Income

Base-year income is difficult to calculate even when information on basic salary and other sources of income are available. Without this information, the calculations become particularly demanding. This is often the case for the “unemployed,” women, the elderly, and juveniles in wrongful death litigation.\footnote{Children and foreign nationals create special problems for the calculation of economic loss. Thus, we treat them separately in the final section of this report.} Although many decedents are not employed in the labor market at the time of the accident, they may have worked in the future. In order to calculate the market economic loss resulting from their death, their incomes must be imputed. Moreover, sometimes, as in the case of our study sample, even when people were employed when the accident occurred, information about their incomes was not available.

In such cases, the standard procedure is to impute base-year incomes using statistics on the average earnings of “similar” workers. Similarity is determined by demographic attributes such as sex, age, race, education, occupation status, and citizenship. However, this imputation is correct only if the decedents represent a random sample of the population of people with “similar” demographic attributes. If they do not, the imputation may be biased by income selectivity—that is,
it may over- or underestimate the loss roughly in proportion to how the sample differs from the “average” in expected income.

For the sample of decedents in this study, we were concerned that income selectivity would be a problem. Many people who travel by plane (especially those who fly frequently) do so for business and professional reasons and are often among the economic elite. As a result, there was concern that they would not be a random sample of the population. We found significant income selectivity in our sample, and this selectivity affects the accuracy of the base-year incomes imputed to those decedents whose files lacked income information. However, because we had this information for the rest of the sample, we were able to gauge the possible magnitude of the bias involved. At a minimum, our results suggest how crucial it is to have accurate salary histories in wrongful death actions.

ESTIMATING BASE-YEAR INCOMES FOR THE AIR-DEATH SAMPLE

The files used in the airline accident study contained income information for about 55 percent of the decedents. For the other 45 percent, it was necessary to impute incomes from external sources. It is no surprise that the presence of income data was closely associated with the decedents' employment status. Table 3.1 shows the distribution of decedents by reporting and work status.

In most cases, when decedents were not working, no income information was available from the claims file.\(^5\) However, income data were also missing for almost one-fourth of the decedents who were employed when the accident occurred. In all, income data were missing more frequently for women than for men, largely because women are less likely

<table>
<thead>
<tr>
<th>Table 3.1</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Group</th>
<th>All</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>45.1</td>
<td>35.8</td>
<td>59.4</td>
</tr>
<tr>
<td>Working</td>
<td>23.0</td>
<td>21.6</td>
<td>27.7</td>
</tr>
<tr>
<td>Not Working</td>
<td>38.4</td>
<td>85.4</td>
<td>90.3</td>
</tr>
</tbody>
</table>

\(^5\)In about 200 cases with data on income, the data were not for the accident year but for income in at least one year prior. To compute income at the time of the accident, we let past income grow, as discussed in the next section on growth rate for income.
to be in the labor force. It is important to remember that the problems
raised by missing data confronted the plaintiffs and defendants in their
attempts to estimate damages. In the cases where the decedent was
not working, income data are not missing because our files are incom-
plete; instead, they are missing because there is no observable income
for these cases. The data were missing in only 16 percent of all cases
for which there were incomes and they were not recorded. No matter
what the cause of the missing data, incomes of these decedents had to
be imputed.

The methods we used for calculating base-year income with reported
income differ considerably from the methods used when that informa-
tion is missing. Thus, we describe them separately.

Computing Base-Year Incomes with Income Information

Even when we had income information for decedents, computing
their base-year incomes was not straightforward. As mentioned above
base-year incomes must include not only the basic salary amount, but
also fringe benefits and any regular second-job incomes, bonuses, or
commissions that decedents may earn. Further, many decedents were
self-employed or involved in family businesses, making their individual
incomes difficult to establish. Finally, the incomes in claim files were
expressed over different time intervals—yearly, weekly, monthly, and
hourly. For consistency's sake, all incomes were converted to an
annualized basis.

Fringe Benefits

The basic salary decedents earned does not reflect their full
pecuniary income loss. In addition to this basic salary, most workers
receive valuable fringe packages that provide for their health insurance,
retirement, and other benefits. Such benefits must also be replaced
when the passenger dies.

For 5 percent of decedents with income data, the ratio of fringe
benefits to basic salaries was known.\(^6\) For cases where fringe-benefit
information was lacking, we used industry-specific data (published
yearly by the Department of Commerce).

In considering fringe benefits, care must be taken not to double-
count the components that also appear in yearly salaries. For example,

\(^6\)In another 1 percent of these cases, the income in the claims file reportedly includes
fringe benefits, but a salary-fringe breakdown is not given. For these cases, we simply
assume that the reported salary-cum-fringe benefits include the full range of benefits on
the job.
reported salaries normally include paid vacation and sick leaves. We separated such components out of the total fringe-benefit package to avoid double-counting.\(^7\) These corrected fringe-benefit rates average about 22 percent of basic salary.\(^8\)

Two issues arise in assessing the accuracy of our fringe-benefit rates. First, we use average rates, implicitly assuming, for example, that fringe-benefits do not vary with income. There is a strong likelihood that fringe benefits rise more than proportionately with income. This point is telling because it is the nontaxed feature of fringe benefits that makes them more appealing to high-income individuals. Indeed, research has demonstrated that pensions, a large component of the fringe package, rise with salary levels.\(^9\) Unfortunately, there is no source for mapping a different fringe-benefit rate for alternate income levels. Because our airline sample consists of high-income decedents, we probably underestimate their true fringe rate, but the extent of the understatement is unknown.

The second issue that causes confusion is dividing fringes into those that would have benefited only the deceased and those that benefit the survivors. Some components of the fringe package may apply only to the deceased; i.e., life insurance and some health benefits. Some experts have argued that such decedent-directed fringe-benefits should not be included in calculating the fringe rate used to estimate loss to survivors.

The issues involved are actually far more subtle. First we offset (at a latter stage in the analysis) the decedent’s income, including the fringe component, by his unique proportion of family consumption. If the fringe package is divided into that received by its decedent and that received by his family, the consumption offset used below should not subsequently be applied to the fringe package. That would amount to

\(^7\) Fringes include the following components: employer’s shares of payments for the individual’s disability, dental, and health insurance, life insurance and pension plan premiums, profit-sharing payments, employer contribution to social security, and employee education expenditures; they do not include paid rest periods, paid vacations, and paid sick leaves.

\(^8\) For self-employed decedents with missing fringe-benefit data, the following assumptions were made: Decedents working without pay in the family’s business received a zero-fringe rate, while self-employed owners of businesses were decided on a case-by-case basis depending on their occupation. For example, self-employed physicians or lawyers are likely to set up fringe-benefits packages for themselves while domestic help and gardeners are not. Last we assigned to nonemployed individuals, for whom we imputed potential annual income, fringe-benefit ratios based on the average for all industries.

\(^9\) See Asch (1984). Some components of the fringe package, such as social security contributions, decline with income. The question is not the relation of individual components of the package but the correlation of the total package with income. The tax treatment of fringes makes it plausible that fringes as a whole rise as a fraction of wages as incomes increase.
subtracting the decedent’s share of fringe benefits twice and would incorrectly reduce damages. The general application of the consumption offset at a latter step in the methodology implies that the fringe package is implicitly divided between the decedent and his survivors. The only question is whether a different division should be used for the fringe component of income than for other income sources.

In general, the answer to that question is “no.” Consider a simple example where a worker receives no fringe benefits. From his normal wage income, he buys health insurance for himself and for his family. The cost of the insurance for himself is $1,000 and that for his family another $1,000. In fact, in general, assume this person splits all his income in half between himself and his family.

Now assume that his company offers this worker a fringe benefit of $1,000 that covers only his health insurance (i.e., no coverage for his family). A superficial treatment of the fringe package would argue that since the fringe package covers only the worker and not his family, the fringe package should not be counted at all in computing damages to survivors.

That reasoning is incorrect. Since the worker does not want $2,000 of health insurance for himself, he will simply cancel his private $1,000 health insurance policy but keep the policy he had for his family. The $1,000 that is saved will buy goods and services for himself and his family using the same fifty-fifty split he uses for all income.

This example demonstrates that the stated allocations of the fringe package between the decedent and his family are irrelevant as long as the worker can reallocate the rest of his income among family members. Since that will be the case as long as different income sources are fungible, the same personal consumption offset should be used for all types of income. Therefore, our methodology applies the same personal consumption offset to fringes as to other income sources.

Other Supplemental Earnings

Base-year earnings should also include supplemental incomes received from second jobs, bonuses, and commissions. While these supplemental sources of income are less stable than the principal job and less likely to consistently predict future earnings, they cannot be ignored. For some of the decedents, second-job incomes almost equaled

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10Income sources would not be fungible if workers were forced to consume more health care, etc., than they really desired.

11A total of 85 decedents were reported to have had second jobs.
income from their principal occupations. Bonuses, tips, and commissions are also a regular supplement to the basic salary in some cases. The danger here lies in over- or understating supplemental incomes based on one-year values only. To avoid this, we averaged these income amounts across all years for which income from that job was reported (including the years when decedents received zero amounts).

Of all employed decedents, 15 percent were self-employed. For these cases, it was necessary to separate decedents' incomes from the incomes of other family members and business partners. In most cases, incomes of the self-employed were reported as net incomes of the decedent and could be so used in the calculations. The more troublesome cases involved incomes that were jointly filed in tax returns, particularly joint spousal incomes. However, in these cases, RAND coders often indicated the comparative job involvement of the spouses, allowing us to divide self-employed or business incomes between them. Where such information was not available, the family's business income was split equally between the spouses.

Imputing Base-Year Income in the Absence of Earnings Information

Where the files contained no information on decedents' income, we assigned annual incomes using other known characteristics of the decedent. Incomes are imputed based on what workers similar to the decedents earn on average. Similarity is determined by such demographic attributes as sex, race, age, education, occupation status, and citizenship.

We estimated salary levels for decedents using the U.S. Current Population Surveys (CPS) for the years 1968–1985. For each CPS year, the data were arranged into age-specific cell means. The dependent variable in our regressions was the ln (natural log) of the arithmetic mean of full-time yearly earnings expressed in March 1986 constant dollars.¹² Within each race and sex group, separate regressions

¹²In addition to age, the explanatory variables in these regressions were the mean age-specific male education level and the natural log of the arithmetic mean of male income for each year. The yearly mean income of males was included to adjust for different average incomes across these CPS years. Because we wanted to isolate growth rate in wage rates, we restricted our sample to those who worked at least 48 weeks in the previous years and worked a minimum of 35 hours per week. Restricting the sample in this manner eliminates the effect of labor supply on the level, and hence growth, of earnings. In calculating economic loss, labor-supply variation is introduced through the worklife discount. An alternative specification would be to include a set of dummy variables for each year. We ran that specification as well. The coefficients of the other variables in the regression did not change. We include the variables for the ln of mean male income in the year to control for year effects, so that our estimated life-cycle profile
were run for nine occupation classes and six education groups.\textsuperscript{13} When
decedents’ occupations were reported, occupations were grouped into
nine occupation categories according to a taxonomy developed by
Welch and MacLennan (1976). This aggregation scheme reduces the
large number of census occupation codes to the most homogeneous
groups with respect to earnings and socioeconomic status. Separate
salary regressions were estimated within these occupation groups.
When occupation was not known, education-specific regressions were
used. Where neither was known, we used coefficients from the aggrega-
tion regressions for males.

Tables 3.2 and 3.3 illustrate salary levels\textsuperscript{14} assigned to men and
women, using the procedures just described.\textsuperscript{15} To illustrate some impor-
tant differences that emerged, Table 3.2 shows income imputations by
men’s occupation and schooling levels and women’s work status and
schooling. Table 3.3 shows the average imputed incomes for all de-
cedents without reported income.

The imputed salaries conform to well-established empirical regulari-
ties in the labor-market wage structure. Across all decedents with no
reported income, the mean imputed income (without fringe benefits)
was $21,565. Consistent with numerous labor-market studies, imputed
incomes for females were lower than those for male decedents. On
average, the calculations assigned women full-time earnings that are
only 70 percent of male levels.

In the calculations, imputed incomes increase with age for both
sexes but at a more rapid rate for men than for women. Male incomes

\textit{net} of calendar-year economic growth. We did this in part to isolate pure life-cycle
salary growth, an issue we discuss in the next section.

We considered the problem of retransforming the imputed log income values to dollar
amounts when the distribution of income values is highly skewed. We computed the log
of arithmetic means within each cell. Most variation in income values is within each
cell; the variation between cells is very small.

\textsuperscript{13}The occupation groups are shown in Table 3.7. The years of education categories
were: 0–7 years, 8–11 years, 12 years, 13–15 years, 16 years, and 17+ years.

\textsuperscript{14}CPS data contain an open-ended income class at the upper end. Using a Pareto
distribution, we estimated the mean income within the open-ended category. For the
years 1968–1981, we assigned $80,000 to the $50,000-and-over category; in the years
1962–1984, $115,000 to the $75,000-and-over category; and in 1985, $156,000 to the
$100,000-and-over category.

\textsuperscript{15}Our salary regressions for women differed in some important respect from those
estimated for men. To impute women’s salaries, accumulated work experience is used
instead of age as a predictor variable. Because these experience variables are measured
across all women, the salary regressions for women were not stratified by education or
occupation. The reasons for this difference are discussed in the section on salary growth
below. This procedure admittedly underestimates the income of women with high levels
of education who have greater attachment to the labor force. We were constrained by a
small sample problem at high levels of education.
Table 3.2

ASSIGNED EARNINGS
(March 1986 dollars)

<table>
<thead>
<tr>
<th>Education/Occupation</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Men</td>
<td></td>
</tr>
<tr>
<td>College undergraduate</td>
<td>23,178</td>
</tr>
<tr>
<td>College graduate</td>
<td>26,382</td>
</tr>
<tr>
<td>Doctors, lawyers, pilots, natural scientists</td>
<td>26,361</td>
</tr>
<tr>
<td>Engineers, professors, and kindred</td>
<td>26,368</td>
</tr>
<tr>
<td>Women</td>
<td></td>
</tr>
<tr>
<td>High school graduate</td>
<td></td>
</tr>
<tr>
<td>Working</td>
<td>13,391</td>
</tr>
<tr>
<td>Not working</td>
<td>10,923</td>
</tr>
<tr>
<td>College graduate</td>
<td></td>
</tr>
<tr>
<td>Working</td>
<td>19,075</td>
</tr>
<tr>
<td>Not working</td>
<td>15,560</td>
</tr>
</tbody>
</table>

Table 3.3

AVERAGE IMPUTED BASE-YEAR INCOMES
FOR DECEDEES WITHOUT REPORTED INCOME
(March 1986 dollars)

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean Imputed</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>21,565</td>
</tr>
<tr>
<td>Men</td>
<td>29,608</td>
</tr>
<tr>
<td>Women</td>
<td>17,848</td>
</tr>
</tbody>
</table>

also rise with schooling levels especially at older ages. As Table 3.2 shows, skill level is associated with wages in the stratification for male occupation. Decedents in the most skilled occupational category—doctors, lawyers, pilots, and natural scientists—were assigned incomes exceeding $45,000. For determining women's wages, prior accumulated work experience is a critical determinant. Based on our assignment
algorithm, women who have worked less in the past earn significantly less than those currently employed.

**Estimates of Base-Year Earnings**

For each decedent, we estimated a potential and an expected base-year income. This estimation is based on actual salary data if available. Table 3.4 lists the estimated mean values of both. Across all decedents, the mean expected base-year income is $40,389, while the mean potential income is $46,776. Women's expected incomes are only one-fourth as high as men's, partly reflecting women's lower rates of labor-force participation. However, even when we control for differential labor supply by comparing potential incomes, the estimated wages for female decedents are only 37 percent of male wages.

While it is convenient to have a single number describing incomes of decedents, exclusive reliance on one summary statistic can be misleading—particularly with a group as heterogenous as the air-crash decedents. Their incomes were extremely varied, and a much larger fraction than in the U.S. population had very high earnings. Tables 3.5 and 3.6 illustrate this diversity by listing incomes at selected percentiles of the expected and potential income distribution. These percentiles rank the population of decedents from lowest to highest in terms of their incomes. For example, using Table 3.5, the bottom 5 percent of decedents had expected incomes of $472 or less, while the bottom 30 percent had incomes of $10,863 or less.

The first sign of a highly skewed income distribution is a disparity between the mean and the median (the fiftieth percentile) income. Such a disparity characterizes our study sample. The median expected

<table>
<thead>
<tr>
<th>Table 3.4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MEAN BASE-YEAR INCOMES, POTENTIAL AND EXPECTED</strong></td>
</tr>
<tr>
<td>(March 1986 dollars)</td>
</tr>
<tr>
<td>Group</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>All</td>
</tr>
<tr>
<td>Men</td>
</tr>
<tr>
<td>Women</td>
</tr>
</tbody>
</table>

n = 2113.

16We compare decedents' incomes with those of U.S. workers in Table 3.8.
Table 3.5

DISTRIBUTION OF EXPECTED FIRST-YEAR EARNINGS
(March 1986 dollars)

<table>
<thead>
<tr>
<th>Percentile</th>
<th>All</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>472</td>
<td>899</td>
<td>14</td>
</tr>
<tr>
<td>10</td>
<td>958</td>
<td>8,799</td>
<td>606</td>
</tr>
<tr>
<td>20</td>
<td>4,227</td>
<td>15,703</td>
<td>1,056</td>
</tr>
<tr>
<td>30</td>
<td>10,863</td>
<td>20,823</td>
<td>1,883</td>
</tr>
<tr>
<td>40</td>
<td>16,360</td>
<td>28,522</td>
<td>5,185</td>
</tr>
<tr>
<td>50</td>
<td>21,315</td>
<td>35,088</td>
<td>19,378</td>
</tr>
<tr>
<td>60</td>
<td>30,230</td>
<td>47,249</td>
<td>13,157</td>
</tr>
<tr>
<td>70</td>
<td>42,548</td>
<td>58,587</td>
<td>17,070</td>
</tr>
<tr>
<td>80</td>
<td>56,721</td>
<td>76,657</td>
<td>21,452</td>
</tr>
<tr>
<td>90</td>
<td>85,715</td>
<td>114,839</td>
<td>33,572</td>
</tr>
<tr>
<td>95</td>
<td>125,096</td>
<td>178,452</td>
<td>46,531</td>
</tr>
<tr>
<td>99</td>
<td>308,141</td>
<td>343,618</td>
<td>82,168</td>
</tr>
</tbody>
</table>

Table 3.6

DISTRIBUTION OF POTENTIAL BASE-YEAR EARNINGS
(March 1986 dollars)

<table>
<thead>
<tr>
<th>Percentile</th>
<th>All</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>9,946</td>
<td>13,104</td>
<td>6,686</td>
</tr>
<tr>
<td>10</td>
<td>13,741</td>
<td>16,615</td>
<td>11,112</td>
</tr>
<tr>
<td>20</td>
<td>17,211</td>
<td>20,464</td>
<td>14,805</td>
</tr>
<tr>
<td>30</td>
<td>19,246</td>
<td>24,890</td>
<td>16,705</td>
</tr>
<tr>
<td>40</td>
<td>21,017</td>
<td>32,118</td>
<td>18,310</td>
</tr>
<tr>
<td>50</td>
<td>26,447</td>
<td>49,738</td>
<td>19,235</td>
</tr>
<tr>
<td>60</td>
<td>35,766</td>
<td>49,041</td>
<td>20,299</td>
</tr>
<tr>
<td>70</td>
<td>45,055</td>
<td>60,473</td>
<td>22,096</td>
</tr>
<tr>
<td>80</td>
<td>59,823</td>
<td>77,548</td>
<td>25,094</td>
</tr>
<tr>
<td>90</td>
<td>86,955</td>
<td>120,340</td>
<td>39,989</td>
</tr>
<tr>
<td>95</td>
<td>133,118</td>
<td>186,694</td>
<td>56,145</td>
</tr>
<tr>
<td>99</td>
<td>313,262</td>
<td>366,891</td>
<td>88,026</td>
</tr>
</tbody>
</table>

income among all decedents was $21,315 compared with its mean value (shown in Table 3.4) of $40,389. Similarly, the median potential income was $26,447, well below its mean of $46,776. This discrepancy between median and mean incomes is more pronounced among men.
The discrepancies are caused by the significant fraction of decedents who had very high incomes. As Table 3.5 indicates, the top 5 percent of all decedents had yearly earnings exceeding $125,000 a year, and the top 1 percent earned more than $300,000 a year. Among male decedents, the highest one in twenty earned more than $175,000 a year. However, the income diversity is not limited to decedents with very high incomes. Of our sample, 30 percent have expected incomes less than $10,000 per year, mostly because they would not have not worked.

Incomes Selectivity of Air-Crash Victims

Relative to the typical American worker during these years, our results indicate that the victims of airline crashes represent a highly selective group of high-income earners. Compared to the average American, many victims of airline accidents are among the economic elite. They are often flying to carry out critical tasks or to close important business deals for the firms they represent. In this section, we document the extent to which incomes of airline passengers are not representative of the U.S. population.

This income selectivity, however, raises some additional questions about the accuracy of our assignment of income to those decedents with unreported incomes in the claims files. Our assignment procedure is similar in spirit to most income assignment procedures conducted in litigation. Based on the observed attributes of decedents (age, education, occupation, sex), incomes are predicted based on what similar workers in the United States earn. Our evidence suggests that this procedure may systematically understate the true incomes of airline decedents. Because our procedure is similar to those typically used in the litigation process, it is important to recognize how much and how systematically results may be biased by income selectivity. In this section, we perform an experiment to assess the extent of the bias in the air-crash sample.

Occupation and Income Distributions of Employed Individuals

The possible income selectivity of the airline sample is suggested by comparing, first, the occupational distribution of those who were employed at the time of death with those for U.S. workers in general and, second, the incomes of both groups.

As Table 3.7 indicates, compared with the sample of U.S. workers (over the years covered by our study), the decedents in our sample are
among the socioeconomic elite. For example, 72 percent of the American male decedents who reported an occupation were employed in the three professional categories at the time of death, compared with 22 percent and 21 percent of the U.S. male population in 1970 and 1980. The disparity between the women in our sample and the U.S. female population is almost as striking.

These occupational disparities are reflected in the considerable income differences shown in Table 3.8. To provide a reference group for the U.S. decedents, the table compares mean base-year potential incomes for them with the most comparable income measure from published sources—incomes of full-time American workers.\textsuperscript{17}

Potential incomes of our U.S. air-crash decedents exceed those of the 1976 U.S. population of workers by 86 percent. If we further restrict our comparison to decedents with incomes reported in the claims file, the mean potential income of our decedent sample is more than double the U.S. average. The selective nature of the decedent sample is especially pronounced among men. Potential incomes among all American male air-crash victims are 95 percent higher than the working male population. This comparison includes our imputed incomes. Among male crash victims with reported incomes only, incomes are 2.27 times larger than those of the average male worker. While this income selectivity is smaller among female decedents, it is not trivial. Female working decedents earn 35 percent more than the average female full-time worker.

Assessing the Magnitude of Bias

Taken together, Tables 3.7 and 3.8 raise a suspicion that our assignment algorithm may systematically understate the actual incomes of air-crash decedents.\textsuperscript{18} This suspicion is strengthened when we compare in Table 3.9 the potential earnings of decedents with imputed incomes to the potential earnings of the decedents for whom we had income information. Although we consider reported occupation or education in

\textsuperscript{17}These published earnings were augmented by the average fringe rate in our sample (22 percent). In Table 3.8, we used 1976 figures because that year is roughly midway into our airline sample. Since potential incomes are incomes for full-time work, the appropriate comparison is the incomes of full-time workers. Full-time workers are those who worked 50–52 weeks.

\textsuperscript{18}Strategic behavior of the lawsuit participants would also enter into an assessment of the size of the income selectivity. For example, one could argue that plaintiffs of higher-income decedents have more incentive to report their income. If so, incomes of reporting decedents would overstate those of similar nonreporting decedents. However, it is equally true that defendants have an incentive to check and validate incomes when they are reported high. The fact that both parties participate in this reporting process diminishes somewhat the importance of this problem.
### Table 3.7

**COMPARISON OF DISTRIBUTIONS OF DECEDEXTS EMPLOYED AT TIME OF DEATH AND CENSUS SAMPLES BY OCCUPATION GROUP**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Doctors, lawyers, pilots, natural scientists</td>
<td>8.4</td>
<td>1.6</td>
<td>1.7</td>
<td>1.8</td>
<td>0.1</td>
<td>0.4</td>
</tr>
<tr>
<td>2 Engineers, professors, and kindred</td>
<td>48.8</td>
<td>12.6</td>
<td>13.9</td>
<td>21.0</td>
<td>4.5</td>
<td>8.4</td>
</tr>
<tr>
<td>3 Scientists, high craftsmen, managers</td>
<td>14.3</td>
<td>7.6</td>
<td>5.8</td>
<td>26.0</td>
<td>13.8</td>
<td>14.5</td>
</tr>
<tr>
<td>4 Foremen, para-professionals</td>
<td>13.2</td>
<td>14.4</td>
<td>13.7</td>
<td>11.8</td>
<td>14.5</td>
<td>13.3</td>
</tr>
<tr>
<td>5 Middle-level clerical, mechanics</td>
<td>5.3</td>
<td>9.7</td>
<td>9.2</td>
<td>11.2</td>
<td>9.9</td>
<td>12.0</td>
</tr>
<tr>
<td>6 High operatives, middle-level craftsmen</td>
<td>3.6</td>
<td>10.1</td>
<td>10.6</td>
<td>13.9</td>
<td>12.3</td>
<td>11.8</td>
</tr>
<tr>
<td>7 Low-level clerical, craftsmen</td>
<td>3.8</td>
<td>23.3</td>
<td>27.5</td>
<td>7.1</td>
<td>19.2</td>
<td>19.0</td>
</tr>
<tr>
<td>8 Operatives, service workers</td>
<td>1.9</td>
<td>15.1</td>
<td>13.8</td>
<td>5.3</td>
<td>18.9</td>
<td>16.2</td>
</tr>
<tr>
<td>9 Laborers</td>
<td>0.5</td>
<td>5.6</td>
<td>3.7</td>
<td>1.8</td>
<td>6.8</td>
<td>4.5</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Observations</td>
<td>7,10</td>
<td>49,844</td>
<td>38,012</td>
<td>338</td>
<td>33,277</td>
<td>47,132</td>
</tr>
</tbody>
</table>

²Grouping is based on Welch and MacLennan (1976). See their paper for a list of specific occupations that fall under each category.
Table 3.8

INCOME COMPARISON OF AIRLINE DECEDEHTS AND U.S. WORKERS IN 1976
(March 1986 dollars)

<table>
<thead>
<tr>
<th></th>
<th>Potential Earnings of Airline Decedents (full-time)</th>
<th>Potential Earnings of Airline Decedents with Income (full-time)</th>
<th>1976 Earnings of Full-Time Workers in U.S.</th>
<th>Ratio Column 1/3</th>
<th>Ratio Column 2/3</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>56,814</td>
<td>68,818</td>
<td>31,557</td>
<td>1.86</td>
<td>2.19</td>
</tr>
<tr>
<td>Men</td>
<td>71,644</td>
<td>83,144</td>
<td>36,617</td>
<td>1.95</td>
<td>2.27</td>
</tr>
<tr>
<td>Women</td>
<td>28,172</td>
<td>31,787</td>
<td>20,886</td>
<td>1.35</td>
<td>1.52</td>
</tr>
</tbody>
</table>

our imputations, Table 3.9 shows that our algorithm consistently imputed incomes much lower than the reported incomes of the rest of our sample. Assigned incomes are only 32 percent of reported incomes for the decedents. The problem of assigning base-year incomes is particularly troublesome for high-income decedents. Regression imputations inherently compress income variance—that is, they understate the degree to which income distribution may be skewed.

Without income information on the decedents, it is not possible to know the exact magnitude of the selectivity bias. However, we conducted an experiment that gives some sense of how great the bias might be. This experiment treated the decedents with income information as though that information were missing and used the assignment algorithm to “impute” incomes for them.

Table 3.9

AVERAGE REPORTED AND IMPUTED POTENTIAL BASE-YEAR EARNINGS
(March 1986 dollars)

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean Reported</th>
<th>Mean Imputed</th>
<th>% of Sample with Imputed Incomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>67,537</td>
<td>21,565</td>
<td>45.1</td>
</tr>
<tr>
<td>Men</td>
<td>82,738</td>
<td>25,608</td>
<td>35.8</td>
</tr>
<tr>
<td>Women</td>
<td>30,733</td>
<td>17,848</td>
<td>59.4</td>
</tr>
</tbody>
</table>
Table 3.10 shows the results. The second column in the table lists actual mean incomes of those decedents with reported incomes. The third column shows mean incomes assigned to these decedents using the same imputation algorithm we used for decedents who had no reported incomes. On average, actual incomes of these decedents are 80 percent larger than their assigned incomes. This income selectivity bias is concentrated among male decedents, for whom reported incomes are 89 percent greater than their assigned incomes. While the difference is much smaller for women, the 35-percent differential is still cause for concern.

The main objective of this experiment is not so much to demonstrate the income selectivity bias for our sample as it is to provide a cautionary example. The results suggest how important it is to have accurate salary histories for wrongful death actions, and, where that is not possible, to recognize that imputations based on “similar” workers’ incomes may be biased.

In the companion volume, we assess the possible implications of this problem by recomputing full economic loss and loss to survivors to gauge the extent of this bias.

Table 3.10
INCOME SELECTIVITY OF DECEDE NT SAMPLE
(March 1986 dollars)

<table>
<thead>
<tr>
<th>Sample Size</th>
<th>Reported Incomes$^b$</th>
<th>Imputed Incomes$^b$</th>
<th>Ratio Column 2/3</th>
</tr>
</thead>
<tbody>
<tr>
<td>All$^a$</td>
<td>1,154</td>
<td>55,922</td>
<td>31,104</td>
</tr>
<tr>
<td>Men$^a$</td>
<td>820</td>
<td>68,538</td>
<td>36,207</td>
</tr>
<tr>
<td>Women$^a$</td>
<td>339</td>
<td>25,405</td>
<td>18,760</td>
</tr>
</tbody>
</table>

$^a$The sample consists of working decedents whose incomes were reported.

$^b$Incomes without fringe.
IV. SALARY GROWTH

Salary growth is the second component in our methodology for estimating full economic loss and loss to survivors. Estimates of future loss must reflect the salary increases that decedents could reasonably have anticipated over their working lives. The amount of this increase depends on three factors: economy-wide wage growth, how earnings typically change as workers age and become more experienced, and the individual's ability relative to the average.¹ Our methodology models future salary growth for the decedents as the sum of these components.

ECONOMY-WIDE WAGE GROWTH

Wages of American workers have risen throughout the 20th century, reflecting the American economy's increased productivity. Even controlling for age and education, workers are paid substantially more today than they were twenty years ago. Twenty years hence, salaries will certainly be higher than they are now. To estimate the effect of economy-wide wage growth, one must first estimate how much salaries will rise as the American economy expands overall.

This estimation is, necessarily, based on the past performance of the economy. On what basis should one project the long-term wage growth of the economy? As for many aspects of the methodology, the answer to that question depends on the specifics of the particular application. If we want to project wage-growth only for the next year or two, then the current conditions of the economy should be given great weight in forming our projection. However, if we want to forecast wages over the next thirty years, then we should use the long-term economic growth rate toward which the economy gravitates, ignoring temporary swings about the long-run average. Because our typical decedent would

¹The growth in nominal earnings also depends on the inflation rate. We adjust for inflation by calculating growth rates of real earnings, that is, earnings expressed in constant 1986 dollars. The CPI price deflator was used. Many economists have argued that the CPI index overstates the extent of inflation in the 1970s and early 1980s (and therefore understates real income growth). The substantial housing price inflation during those years is a source of income (in capital gains) as well as a cost, a factor not incorporated into the CPI. A better price index for the 1970s and early 1980s would be the GNP price deflator. Since our growth period extended over a 40-year period, it is less affected by the choice of a price deflator. However, if projections are made based on data from the 1970s and early 1980s alone, we too would recommend the use of a GNP price deflator.
experience wage growth for twenty or thirty years, our application suggests that we should base our forecasts of expected future wages on the prior economic growth in the United States economy over as long a period as possible.

Most important, a consistent perspective should underline the forecasts of all elements of the methodology. If the damages extend far into the future, as they do in our applications, then long-run projections based on many years in the past should be used to select all numerical assumptions—salary growth, interest rates, worklife discounts, etc. One cannot emphasize the importance of short-run conditions in selecting one element of the methodology—i.e., salary growth—while opting for long-run values of other measures—i.e., interest rates.²

Because of the sharp swings in U.S. economic performance, future projections over a long period should not be based on the experience of a few years. For example, the rapid income growth of the 1960s was immediately followed by the stagnant economic conditions of the 1970s. By the same reasons, the below-average economic performance of the 1970s should not be used to forecast wages into the next century. Consequently, the viewpoint we adopt is a long-term one. We use the growth rates in white-male incomes across the years 1940 to 1980 as indicators of economy-wide U.S. income growth. Over these 40 years, those incomes have expanded by 2.4057 percent per year.³

Even if the economy does expand at that rate in the future, not all of this income growth would have accrued to the decedents in our sample who were in the labor market in the 1970s. An adjustment was necessary because some of the long-term economic growth reflects rising education levels of each new generation of workers. These rising levels of schooling do not enhance the future income prospects of workers who are already in the labor market and have fixed education

²This point is particularly relevant for the air-crash sample. The 1970s were a below-average period in terms of economic growth. Some argue that this no-growth decade should be the basis of the projection of wage rates over the next thirty years. However, that period also was characterized by negative real interest rates, so a consistent treatment should also argue for a negative discount rate. Such consistency rarely characterizes vested interest selection of numerical assumptions. Our main argument is that we should consistently adopt long-run parameters in applications where forecasts are made many decades into the future.

³Incomes for full-time workers in the 1940 and 1980 decennial Censuses were used. Data were obtained from the decennial Census tapes of those years. We did not use women's incomes to compute this growth rate because their incomes were strongly affected by the growth in rates of labor-force participation. See Smith and Ward (1984) for a detailed discussion of the complexity of the time-series trends in women's wages. We chose the period 1940–1980 because this is the longest period for which such data are available. Including women and blacks would have led to a higher estimate of long-term salary growth rate.
levels—a situation that characterizes most decedents in the sample. Consequently, it is necessary to subtract the effects of rising education levels over time from the overall secular income growth. We estimate that 21 percent of the 1940–1980 growth resulted from education increases. After taking out this schooling effect, we use a long-term income growth of 1.9029 percent per year to project future salaries of decedents.

LIFE-CYCLE SALARY GROWTH

Overall economic growth is only one reason workers’ salaries grow. They also grow as workers gain experience in the marketplace and years of seniority on the job. This salary growth is uneven over work careers. The typical pattern has an inverted “u” shape: Salary raises are largest in the younger years, slow down in the middle of careers, and often become negative (in inflation-adjusted dollars) as workers approach retirement. Many empirical studies have found that this life-cycle wage profile holds for most subgroups of workers, here and internationally. Nevertheless, the magnitude of effects varies for certain sub-groups, most notably for women. Research has consistently demonstrated that men and women face very different rates of wage growth. Less dramatic but still important distinctions exist among workers in different occupations and across individuals with different levels of education. To calculate this component of salary growth, we estimated separate life-cycle earnings profiles for several subgroups with different combinations of sex, race, education, and occupation. Because the procedures differ for men and women, we discuss the methodology for each separately.

Life-Cycle Salary Growth for Men

For men, we calculated typical life-cycle wage increases using Current Population Surveys (CPS) over a period (1968–1985) roughly corresponding to the years of the airline crashes. In each CPS year, the data were arranged into age-specific cell means.

---

4 Between 1940 and 1980, the education levels of whites in the United States increased by 3.09 years. According to Smith and Welch (1986), a one-year increase in schooling raised income by 6.5 percent. Using these numbers, 21 percent of economic growth was due to schooling. This estimate is quite similar to those used by Denison (1962) in accounting for long-term American economic growth.

5 For some prominent examples, see Becker, 1973; Hause, 1971; Lillard, 1977; Rosen, 1976.

6 See, for example, Mincer and Polachek, 1974; or Smith and Ward, 1984.
The dependent variable in our regression was the \( \ln \) (natural log) of the arithmetic mean of full-time male earnings expressed in March 1986 dollars.\(^7\) Within each race group, we ran separate regressions for the nine occupation classes and six education groups, described in Sec. III.\(^8\) In this context, the purpose of the regressions was to assign the salary growth for an individual at all his subsequent ages. To estimate the exact curvature of the life-cycle wage profile as precisely as possible, the age variable was specified by a detailed set of age splines.\(^9\)

To illustrate, Table 4.1 lists our estimates of life-cycle salary growth for white male workers.\(^10\) The table shows yearly percentage increases in earnings for different age groups in different education classes. The results replicate well-documented trends. Wage increases are especially high (about 30 percent per year) for male teenagers as they leave the informal “teenage” labor market and enter the more highly paid, career-oriented labor market for adults. For the rest of the life cycle, male salary increases become progressively smaller. Between ages 40 and 60, the pure life-cycle-wage profile is basically flat, indicating that middle-aged men receive small life-cycle salary increases. After age 60, male salaries actually decline for the remaining career.

Also reflecting recognized trends, the size of salary increases tends to rise with schooling levels, especially for men in their thirties. During this age span, men who have postgraduate schooling (category 17+ in Table 4.1) enjoy raises of 4.5 percent per year compared to 1.3 percent for male high school graduates. After forty, the profiles are uniformly flat for all education groups. Similarly, although we do not show our results in Table 4.1, salary increases are larger among men in the professional and managerial categories.

---

\(^7\)In addition to age, the explanatory variables in these regressions were the mean age-specific male education level and the \( \ln \) of the arithmetic mean of male income for each year. The education variable was included to net out the effect of changes in education levels across age cells.

\(^8\)In assigning the appropriate life-cycle salary growth rates, we used the following rules: First, if the occupation of the decedent at the time of the accident was known, we used the occupation-specific regressions. If occupation was not known, education-specific regressions were used. Finally, if both occupation and education of the decedent were missing, the coefficients from the aggregate male regressions were used. All regressions were weighted by the number of observations making up the age-specific cell means.

\(^9\)By age splines, we mean defining age segments across which the relationships between age and wage may be different. Table 4.1 lists the segments we use in the analysis. To illustrate, the age spline 16–19 takes a value of (Age-16) for a decedent aged 16–19 at the time of death or a value of three for a decedent older than 19 at the time of death.

\(^10\)For lack of data on life-cycle wage growth in other countries, we assume that for comparable education and occupation groups, the life-cycle earnings profiles of foreign males resemble those of U.S. males.
Table 4.1

LIFE-CYCLE EARNINGS GROWTH FOR WHITE MALES
(Earning increases with an additional year if age is in percentages)

<table>
<thead>
<tr>
<th>Age</th>
<th>Aggregate</th>
<th>0–8</th>
<th>9–11</th>
<th>12</th>
<th>13–15</th>
<th>16</th>
<th>17+</th>
</tr>
</thead>
<tbody>
<tr>
<td>16–19</td>
<td>30.7</td>
<td>23.5a</td>
<td>32.4b</td>
<td>36.5b</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>20–29</td>
<td>6.25</td>
<td>4.00</td>
<td>5.22</td>
<td>5.89</td>
<td>6.80</td>
<td>6.83b</td>
<td>7.52c</td>
</tr>
<tr>
<td>30–39</td>
<td>2.37</td>
<td>1.71</td>
<td>1.02</td>
<td>1.30</td>
<td>2.25</td>
<td>3.57</td>
<td>4.53</td>
</tr>
<tr>
<td>40–49</td>
<td>0.11</td>
<td>0.42</td>
<td>0.36</td>
<td>0.32</td>
<td>0.39</td>
<td>1.13</td>
<td>0.30</td>
</tr>
<tr>
<td>50–59</td>
<td>-0.31</td>
<td>-0.31</td>
<td>-0.39</td>
<td>-0.31</td>
<td>-0.12</td>
<td>-0.49</td>
<td>0.51</td>
</tr>
<tr>
<td>60+</td>
<td>-2.31</td>
<td>-3.33</td>
<td>-3.53</td>
<td>-2.15</td>
<td>-2.52</td>
<td>-2.70</td>
<td>-2.43</td>
</tr>
</tbody>
</table>

aAges 17–19.
bAges 22–29.
cAges 25–29.

Life-Cycle Salary Growth for Women

Because women and men have very different labor-force experiences, we compute women’s life-cycle salary increases differently. The salary-age relationship we estimated for men equated another year of age with another year in the labor market, because most men have continuous and uninterrupted work careers. However, many women do not. While women’s labor-force participation rates have risen rapidly in recent decades, women are still far more likely than men to postpone their work careers to care for their children. Thus, for women, a year of age does not necessarily equal another year in the work force.

To calculate women’s salary growth correctly, one must know how much additional labor-force experience they typically accumulate for each year of age. For this purpose, we used a model that Smith and Ward (1984) developed to calculate women’s average work experience at each age for the years 1968–1985. Besides these age-specific experience values, we derived all other variables from the 1968–1985 CPS surveys. The dependent variable was the ln (natural log) of the arithmetic mean of full-time female earnings expressed in constant March 1986 dollars. To capture life-cycle curvature, we included a detailed spline specification for the experience variable.

We included as covariates average education levels of female workers and the ln of the arithmetic mean of male workers for each year. The interpretation of these covariates was identical to those we used in the male salary regressions.
Table 4.2 depicts our estimate of women’s life-cycle salary growth.\textsuperscript{12} Like men’s wages, women’s wages grew most rapidly in the early phases of the career. During the first three years, women realized a 10-percent salary increase. This fell to 3.5 percent between years 5 and 10, after which the life-cycle wage profile is flat.\textsuperscript{13}

Before we could estimate life-cycle salary growth for the women in the sample of airline decedents, we had to "situate" them in the appropriate experience slot. The claims files did not contain information on their actual experience. Consequently, we imputed to each female decedent the average labor-force experience of women of her age and employment status in the accident year. These experience values were obtained using the methodology outlined for calculating worklife discounts in Sec. V. This imputed labor-force experience tells us which coefficient in Table 4.2 to use.

Future increments to each female decedent’s experience are obtained from the future period worklife discounts. We established the correct life-cycle salary growth for women by multiplying these worklife discounts by the relevant wage coefficient in Table 4.2. Because we multiply wage coefficients by individual-year worklife discounts, in

\begin{table}[h]
\centering
\caption{Life-Cycle Salary Growth for Women}
\begin{tabular}{ll}
\hline
Years of Experience & Percentage Increase in Salary \\
\hline
0–3 & 10.05 \\
3–5 & 8.63 \\
5–10 & 3.65 \\
10–15 & 0.60 \\
15–20 & 0.42 \\
21–25 & 0.07 \\
25+ & 0.06 \\
\hline
\end{tabular}
\end{table}

\textsuperscript{12} The Smith and Ward estimates of experience are available for all women only. Thus, they are not stratified by race, education, or occupation. Because of this, our estimates of women’s salary growth are independent of schooling and occupation. Because the women in the aviation sample have higher-than-average educational levels, we probably underestimate the true salary growth for women in our companion study.

\textsuperscript{13} It is important to remember in interpreting women’s salary growth that a year of work experience typically takes far more than a year of age to accumulate. If we translate these experience wage increments into wage increases with age, the standard result would emerge. Women’s wages increase less rapidly with age than male wages.
every year working women will realize greater salary growth than non-working women. This is appropriate because working women should increase their job-related skills (and thus their salary) by accumulating more experience in a given year.

INDIVIDUAL-SPECIFIC WAGE GROWTH

The Rationale

Not all people with the same education, age, or experience will have the same life-cycle salary growth. Other, less quantifiable, characteristics evidently make some people more successful than others: They not only have higher current salaries but are likely to continue out-earning other workers. While this consideration applies for the population at large, it is especially important for the passengers in airline accidents. As we saw in our earlier discussion of income selectivity in the sample, compared to the "average" American, many victims of airline crashes are among the economic elite. Thus, we cannot assume that they would have had the same life-cycle salary growth as the average worker.

A Summary of the Approach

The difficult question is how to estimate the extent to which these decedents would have had salary increases different from the average. Salary growth assumptions probably present the most alluring opportunities for mischief in litigation. The assumptions invoked are often ad hoc, with the end result of extrapolating far into the future some very temporary and unrepresentative salary actions. On the other hand, completely ignoring the fact that these decedents would likely enjoy higher salary increases than average is not acceptable either.

Computing individually determined wage growth requires more than one year of salary information. Otherwise, some very temporary and unrepresentative salary actions may be extrapolated far into the future. The data available in this study offer a unique opportunity to estimate this component of salary growth because we had at least two years of usable salary history for 648 (30 percent) of the decedents.14 For this subset, we are able to compute salary growth unique to each decedent. Appendix A presents the specifics of the statistical model we developed to make the computations. Here, we outline the highlights of the approach.

14The modal value is four salary changes; histories with six or more changes are relatively rare.
We had two criteria for the calculations of individually determined salary growth. First, the model was to measure how much of the observed salary change in the claims file signified permanent differences in the decedents' salary prospects and how much was only statistical noise. An inspection of the individual salary histories indicated that there was considerable noise in the data—that is, large positive salary increases were immediately offset by equally large salary reductions. Such patterns typically indicate that the underlying data contain considerable measurement error.

Second, we wanted the model to place greater confidence on the decedents' projected salary growth when we had data on their salary history for many years. If a decedent had a 5-percent salary increase for each of the last seven years before his death, it is more reasonable to assume that these increases would have persisted than it would be if a decedent had that increase for only one year.

The individual-specific salary growth assigned to each of these 648 decedents is equal to $\Delta y \cdot \gamma$. $\Delta y$ is the mean salary growth for individual decedents in our air-crash data.\textsuperscript{16} $\gamma$ is the parameter estimated from our statistical model that tells us how "seriously" to treat each computed average salary growth. $\gamma$ takes one of two values, depending on whether it is the first year after the accident or any subsequent year (the "permanent" salary growth). $\gamma$ is defined as

$$\gamma = \frac{\sigma_t^2 - \sigma_u^2}{\sigma_t^2 + \frac{2\sigma_u^2}{N^2}}$$  \textit{first-year salary growth}  \\
$$\gamma = \frac{\sigma_t^2}{\sigma_t^2 + \frac{2\sigma_u^2}{N^2}}$$  \textit{permanent-year salary growth}

In these equations, the term $\sigma_t^2$ captures permanent differences in salary growth among decedents, while $\sigma_u^2$ represents the purely random statistical noise. The permanent differences subsumed in $\sigma_t^2$ are the basis of forecasting decedents' future salary growth. In contrast, salary

\textsuperscript{16}To compute this mean, we subtracted from each decedent's salary the "normal" life-cycle salary growth that we estimated using the methods described above and the calendar-year economic growth that actually occurred over these CPS years. Because we did not know prior work experience for the decedents, we estimated CPS salary growth regression for women using age instead of experience as a covariate. These regressions were specified similarly to those of males. Separate regressions were estimated for race, education, and occupation groups. Covariates included a detailed age spline, average male income (in logs), and education (except for the education-specific regressions).
growth variation represented by $\sigma^2$ should not be used to project future salary growth. The value of $\gamma$ lies between zero and one, with values closer to one indicating that we should assign greater weight to the mean individual growth. For example, if all salary change variation were permanent, $\gamma$ would equal 1, and we would accept fully the mean salary growth for projecting to the future. Alternatively, if $\sigma^2$ were zero, $\gamma$ would also equal 0 and there would be no individual-specific salary growth.

The two values of $\gamma$ depend on the distinction between the first and subsequent years that result from the random component. For example, assume the salary in the accident year was inaccurately measured so that value is much too high. The consequence is not only a positive salary growth in the accident year but an offsetting negative salary decrease in the first year after the accident. This negative serial correlation results in a different value for the first year after the accident, compared with all subsequent years.

Table 4.3 lists the values of $\gamma$ we obtained for each number of observed salary changes. The parameter values in this table indicate that our model meets the dual criteria of separating statistical noise from permanent change and of placing more confidence in longer salary histories. As an example of the first, when we observe only one salary growth for a decedent, $\gamma$ equals .13 for the permanent effect. That value implies that for a decedent who had only one raise that was 10 percent above the average salary increase, we would assign a 1.3-percent permanent salary increase above the norm. The magnitude of our assigned value when we only have one salary change indicates that there was indeed considerable noise in the salary histories. As a result, the salary history in the claims file cannot be taken at face value in forecasting future salary growth.

Because the size of $\gamma$ increases as the salary history becomes larger, the model meets the second criterion. For example, when seven or more salary changes are observed, 88 percent of the decedent’s mean salary change over that period is assigned to forecast his future salary growth.

Results

Among these 648 decedents, the mean individual-specific salary growth for men was 1.55 percent per year above the norm and 1.44 for women.\textsuperscript{16} These results confirm the hypothesis that passengers of

\textsuperscript{16}In assigning the individually determined specific salary growth for women, we multiplied our model estimated by the worklife discount. Our argument here is that the airline data measured salary growth to full-time female workers.
Table 4.3
VALUES OF $\gamma$

<table>
<thead>
<tr>
<th>Number of Salary Changes</th>
<th>Number of Cases</th>
<th>Period 1</th>
<th>Permanent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>127</td>
<td>-.31</td>
<td>.13</td>
</tr>
<tr>
<td>2</td>
<td>110</td>
<td>-.26</td>
<td>.37</td>
</tr>
<tr>
<td>3</td>
<td>110</td>
<td>-.07</td>
<td>.57</td>
</tr>
<tr>
<td>4</td>
<td>174</td>
<td>.11</td>
<td>.70</td>
</tr>
<tr>
<td>5</td>
<td>99</td>
<td>.25</td>
<td>.79</td>
</tr>
<tr>
<td>6</td>
<td>13</td>
<td>.37</td>
<td>.84</td>
</tr>
<tr>
<td>7 or more</td>
<td>15</td>
<td>.45</td>
<td>.88</td>
</tr>
<tr>
<td>Total</td>
<td>648</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Airline accidents would have anticipated larger salary increases than the population at large.\(^{17}\)

Table 4.4 shows the distribution of the individual growth rates for these 648 decedents. The numbers in the column labeled "raw data" represent the actual distribution of mean salary growth. The column labeled "transformed data" shows the distribution of the predicted permanent growth rates we assigned. There is considerable dispersion in growth rates with a decided tilt toward positive values. To illustrate, approximately 62 percent of the raw and transformed salary increases are positive. One in nine decedents had an adjusted salary growth larger than 15 percent per year, and almost one in three experienced an average unadjusted salary increase in excess of 5 percent. While positive values were more common, one-third of decedents had negative actual salary growth.

The transformed data demonstrate the shrinkage property of our statistical model in that the dispersion in the transformed data is much smaller than for the raw data. The reason for this shrinkage is that the transformed data seek to isolate permanent differences in salary growth by removing the significant dispersion that is due to measurement error. For example, more than half the transformed salary growth rates lie between plus or minus 2.5 percent. Positive salary growth remains far more common, but the extreme values are much

\(^{17}\)Because we do not have data on their salary histories, it was necessary to assume that the individual-specific component of salary growth for all decedents other than those 648 was zero.
Table 4.4

DISPERSION OF INDIVIDUAL-SPECIFIC SALARY GROWTH

<table>
<thead>
<tr>
<th>Salary Growth Interval</th>
<th>Raw Data</th>
<th>Transformed Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;15</td>
<td>3.2</td>
<td>0</td>
</tr>
<tr>
<td>5-15</td>
<td>11.1</td>
<td>5.0</td>
</tr>
<tr>
<td>2.5-5</td>
<td>8.6</td>
<td>9.0</td>
</tr>
<tr>
<td>0-2.5</td>
<td>14.4</td>
<td>23.5</td>
</tr>
<tr>
<td>Positive growth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-2.5</td>
<td>18.2</td>
<td>31.0</td>
</tr>
<tr>
<td>2.5-5</td>
<td>13.3</td>
<td>15.3</td>
</tr>
<tr>
<td>5-15</td>
<td>19.8</td>
<td>14.7</td>
</tr>
<tr>
<td>&gt;15</td>
<td>11.4</td>
<td>1.7</td>
</tr>
</tbody>
</table>

diminished. In the transformed data, less than 2 percent of the observations have average salary growth larger than 15 percent.\footnote{However, even after the shrinkage of the unadjusted salary data it remains true that a nontrivial subset of decedents had large positive individually determined salary growths. For example, 14.7 percent of our 648 decedents had salary increases within the 5-15 percent range. If salary increases of this magnitude really persisted into the indefinite future, the size of discounted future earnings would be unbelievably large. Because of this, we used the individually determined growth rates for only the number of years corresponding to the actual air-crash data used to estimate this model, which is six years.}

MEAN SALARY GROWTH AS THE SUM OF ALL THREE COMPONENTS

Table 4.5 lists the mean salary growth projected for all decedents in the second year following the accident. This total salary growth is the sum of our three components: calendar-year, life-cycle, and individually determined salary growth.\footnote{There is no unique salary growth for an additional year of age. First, the size of the normal life-cycle components varies with age or experience. Second, our model predicts that the individually determined component differs in the first year from subsequent years. Moreover, we assign the individually determined components for only six years. The salary growths in Table 4.5 include the permanent individually determined component and the life-cycle growth in the second year after the accident. We used the second year instead of the first because the salary growth from our individually determined growth model is unrepresentative of the actual growth rates we assign.} The average salary growth in the second year after the accident was almost 4 percent. In interpreting this number, it is important to remember that this is the largest salary growth we will obtain for these decedents. Salary growth in all
subsequent years would decline because individual decedents would have aged and moved into stages of the life cycle where salary growth diminishes.\textsuperscript{20} Further, the individually determined component will last only six years. Beyond six years, we assume that each worker resembles the average worker.

To illustrate the consequences of our modeling, we stratify by two key demographic variables in Table 4.5, sex and work status. On average, men have a 1 percent higher expected salary growth than women do. Since both sexes are assigned a common calendar-year growth, this sex difference is due entirely to the other two components, with the average life-cycle growth component playing the dominant role. If we subtract out the effect of calendar-year and individually determined growth, life-cycle growth rates for men are almost twice those of women. On the life-cycle effect alone, men would experience an initial 2-percent salary growth while women would realize only 1 percent.

Salary growth rates are almost 2 percent larger for those who were currently working in the year of the accident than for those who were not.\textsuperscript{21} In fact, if we subtract calendar-year growth, salary raises for currently nonworking men and women when they were working are essentially zero. This disparity by work status is a desirable

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>Working\textsuperscript{a}</th>
<th>Not Working\textsuperscript{a}</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>3.99</td>
<td>3.90</td>
<td>2.48</td>
</tr>
<tr>
<td>Men</td>
<td>4.37</td>
<td>4.10</td>
<td>2.22</td>
</tr>
<tr>
<td>Women</td>
<td>3.42</td>
<td>3.42</td>
<td>2.86</td>
</tr>
</tbody>
</table>

\textsuperscript{a}In our working/not working categories, we exclude those decedents for whom we do not know work status. Many of these decedents are juveniles.

\textsuperscript{20}This 4-percent wage growth is much higher than the average salary growth for a typical worker, because it is heavily influenced by the much higher initial life-cycle growth rates of young workers at the beginning of their careers. For example, male high school graduates are initially assigned a salary growth rate of 36.5 percent on the life-cycle component (see Table 4.1).

\textsuperscript{21}In this stratification, the difference for men overstates the expected disparity between currently working and not-working men. In the increment-decrement models used to compute male worklife discounts, the difference between current workers and nonworkers in their worklife discounts are largest in the first few years and converge quickly after that. Because these salary growths depend on worklife discounts, they will be much different for working and nonworking men in the first years after the accident.
consequence of the modeling. Individuals who work less (i.e., with less commitment to the labor market) should be expected to receive smaller salary increases in the future.
V. WORKLIFE DISCOUNTS

Future earnings depend not only on base-year incomes and salary growth but also on how much people actually work now and in the future. Thus, to calculate economic loss in wrongful death cases, one must forecast a decedent’s likelihood of working in all future years. In most instances, economic experts know for certain only whether decedents were working for pay when they died. Estimating how long the decedent would have worked is therefore a source of contention, and the conventional approach is seriously flawed, particularly in its treatment of women. We predict the air-crash decedents’ most likely labor-force behavior in the future, based on what the data report about their labor-force status when the accident occurred. Because the relationship between current labor-force status and probable future behavior differs so fundamentally for men and women, we developed different models for calculating male and female worklife discounts.

MALE WORKLIFE DISCOUNTS:
INCREMENT-DECREMENT MODELS

A considerable body of evidence suggests that men who are working at the time of accidental death would have been more likely to work in subsequent years than men who were out of the labor market. However, this correlation is by no means perfect. Some men not now working will get jobs, while some of the current workers will leave the job market. Our model for male worklife discounts explicitly incorporates the relation between future work probabilities and current work status.

We rely on the standard demographic increment-decrement model to forecast future male labor-force behavior. The essential feature of the increment-decrement model is that it is a “two-state, one-period” Markov. In this model, people can occupy one of two mutually exclusive “states”: (a) being a labor-force participant or (b) being out of the labor market. Although an individual can occupy only one of these states during a given period, he can move between them from period to period. The critical assumption of the “one-period” designation is this: The probability of working this year depends only on whether or not a person worked last year. The probability is not affected by labor-force history prior to that year. To illustrate, in the increment-decrement framework, two workers of the same age who worked last year are equally likely to work this year. This will be the case even though one
of the workers may have worked for twenty consecutive years while the other may never have worked before last year.

Using this increment-decrement approach, the model is built up from four age-specific labor-force transitions: \( P_{mn}, P_{nm}, P_{mn}, P_{nn} \), (where \( m \) is the labor force, and \( n \) indicates out of labor force).\(^3\) Using these symbols, \( P_{mn} \) is the probability of a current worker of a given age being in the labor force next period, while \( P_{nm} \) is the probability of a current nonworker transiting into the labor force in the next period.

The equation that links the labor force between periods is

\[
M_t = P_{mn} M_{t-1} + P_{nm} (1 - M_{t-1})
\]  

(1)

The labor-force participation rate next year \( (M_t) \) will consist of two groups of workers. From the current workforce \( (M_{t-1}) \), a fraction \( P_{mn} \) will remain in the labor force for another year. From the current nonworkforce \( (1 - M_{t-1}) \), a fraction \( P_{nm} \) will transit into the workforce during this year.

These one-year transition probabilities between the workforce and nonworkforce determine the amount of work experience accumulated during any given year. The increment to experience in any year is

\[
exp_m = (P_{mn} + P_{nn}) \text{ for labor force}
\]  

(2)

\[
exp_{nm} = P_{nm} \text{ for non-labor force}
\]  

(3)

\[
exp = M_{t-1} (P_{mn} + P_{nn})
\]

\[
+ (1 - M_{t-1}) \ P_{nn} \text{ for population}
\]  

(4)

\( exp_m \) is the yearly increment of experience for current period workers. During the year, the fraction \( P_{mn} \) of the current workforce will remain in the labor force and add one more year of work experience. The remaining fraction of the original labor force, \( P_{nn} \) will leave the labor force uniformly over the year. On average, that subset of workers will add one-half year of additional work experience. Similarly, the nonworkforce will accumulate \( exp_{nm} \) of a year of experience as the fraction \( P_{nm} \) transits uniformly into the workforce during the year. Finally, the experience accumulated for the population \( (exp) \) is a weighted average of the workforce and nonworkforce accumulations, with the weights representing the current fraction of the population in the labor force.

---

\(^3\)For expository convenience the age subscript is suppressed in the text.
Equation (4) is the basis of our forecast of the future worklife discounts of decedents. Equation (4) can be translated into a future worklife discount by conditioning on an individual's current age and current labor-force status. In doing so, the labor-force participation rates in (4) are those future labor-force participation rates conditioned on current work status. For example, for current workers, $M_{t-1}$ in equation (1) is equal to one and $M_t$ equals $P_{nm}$. By repeated use of equation (1), all future labor-force participation rates for a group of original labor-force members can be calculated. Similarly for current nonworkers, $M_{t-1}$ in equation (1) is equal to zero and $M_t$ equals $P_{nm}$. Once again, all future labor-force rates for nonworkers flow from this initial value. Therefore, the amount of work experience in some future periods conditional on work status at period $t$ can be written as

$$\exp_t = (M_{t-1}/M_t = 1) (P_{nm} + P_{mn})$$

$$+ ((1 - M_{t-1})/M_t = 1) P_{nm}$$

$$\exp_t = (M_{t-1}/M_t = 0) (P_{nm} + P_{mn})$$

$$+ ((1 - M_{t-1})/M_t = 0) P_{nm}$$

In each future period, equations (5) and (6) define the worklife discounts we apply in our calculation of economic loss.

To calculate worklife discounts, we must know the four labor-force transitions ($P_{nm}, P_{mn}, P_{nn}, P_{en}$) and the labor-force participation rates at each age. For these parameters, we used the published estimates provided by the Bureau of Labor Statistics. Estimates of these parameters are available for three education groups (less than 12, 12-14, and 15 or more years of school). Whenever possible, we used the education-specific worklife discounts for men.

In litigation, a common practice is to use a summary statistic that measures the number of remaining years a worker can expect to work. This "worklife expectancy" can be obtained by simply summing all future worklife discounts, which is equivalent to assuming a constant worklife discount in all future periods. However, we know that current

---


3If we knew the decedent's education, we used the education-specific tables directly. If we did not know education but did know the decedent's occupation, we first assigned an education based on the mean education by age in our nine occupation groups. If we knew neither education nor occupation, we used race-specific tables aggregated over all schooling schools. Finally, if we also did not have the decedent's race, we used the BLS table for all men.
workers are more likely to work next year than they are five years hence. Consequently, remaining years in the workforce will generally understate market economic loss of workers and overstate market economic loss of nonworkers.

For these reasons, we believe that our year-by-year worklife discounts for individuals provide a measure of economic loss preferable to worklife expectancies. However, worklife expectancies are a useful statistic for illustrating the implications that worklife discounts have for economic loss calculations. Table 5.1 lists remaining years of male worklife for two illustrative cases: those with 15 or more years of schooling and those with 12–14 years of schooling. (The expected years in the labor market in Table 5.1 include the effect of mortality.)

Starting with age 20 and at five-year age intervals, this table lists remaining years in the labor force for all men of that age, as well as for working men (labor force) and nonworking men (the nonlabor force). For example, a 20-year-old male with 15 or more years of education could expect to spend an additional 39.2 years in the workforce. If that 20-year-old man is working, his expected worklife increases to 39.6 years; if he is not working, his expected worklife is 38.5 years. Over the periods shown, current workers have longer remaining worklives than current nonworkers—a difference that becomes more pronounced with age.

Table 5.1

WORKLIFE EXPECTANCIES FOR MEN

<table>
<thead>
<tr>
<th>Age</th>
<th>15 Years of Schooling or More</th>
<th>12–14 Years of Schooling</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Labor Force</td>
<td>Nonlabor Force</td>
</tr>
<tr>
<td>20</td>
<td>30.2</td>
<td>30.6</td>
</tr>
<tr>
<td>25</td>
<td>35.8</td>
<td>36.0</td>
</tr>
<tr>
<td>30</td>
<td>31.6</td>
<td>31.6</td>
</tr>
<tr>
<td>35</td>
<td>27.1</td>
<td>27.1</td>
</tr>
<tr>
<td>40</td>
<td>22.5</td>
<td>22.5</td>
</tr>
<tr>
<td>45</td>
<td>18.0</td>
<td>18.1</td>
</tr>
<tr>
<td>50</td>
<td>13.7</td>
<td>13.9</td>
</tr>
<tr>
<td>55</td>
<td>9.6</td>
<td>10.1</td>
</tr>
<tr>
<td>60</td>
<td>5.9</td>
<td>6.7</td>
</tr>
<tr>
<td>65</td>
<td>3.1</td>
<td>4.5</td>
</tr>
</tbody>
</table>
Remaining years of worklife decline for older men. This reflects both rising rates of mortality with age and labor-force retirement, a lifestyle change that looms closer for older men. Finally, remaining years of worklife are greater among more highly educated men. Various economic studies have demonstrated that additional schooling has the very real benefit of significantly reducing the risks of unemployment (see Ashenfelter and Ham, 1979). This schooling benefit shows up in the longer worklives of the more educated. For example, at age 40, men with at least 15 years of education (roughly the college-educated) will work 2.2 years more than men with 12–14 years of schooling. The high education levels of air-crash decedents argue for our use of education-specific tables to compute male worklife discounts.

FEMALE WORKLIFE DISCOUNTS: SMITH-WARD MODEL

The standard practice has been to develop women's worklife discounts analogously to men's. However, increment-decrement models are poor predictors of women's future labor-force behavior because they are incapable of replicating women's actual accumulation of labor-force experience.

Applying conventional increment-decrement models to women is problematic for two reasons: First, the labor-force transition rates are based on cross-sectional data for a single year. Basing the rates on such data implies that a woman who is 30 years old in 1979 can expect, twenty years later, to have the labor-force participation rate of a woman who is 50 years old in 1979. This implication is untenable—given the rapid, sustained secular increases in rates of women's labor-force participation. As a result, the calculation of worklife discounts should accommodate the reality that a contemporary 30-year-old woman will work more when she is 50 than does today's 50-year-old woman.

Second, conventional increment-decrement models do not distinguish sufficiently between the probable accumulated experience of current workers and nonworkers. Labor-market studies have demon-

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4As we discuss below for women, secular changes in participation rates for women imply that cross-sectional labor-force transition rates will understate worklife expectancies. Although not as critical, a similar issue may arise for men for whom there exists a secular decline in the retirement age. However, extrapolation in the future is more problematic in this case. Changes in the policy environment, elimination of mandatory retirement ages, etc., are acting to offset long-run trends. Whether future retirement ages continue to decline is an open question.
strated that female workers and nonworkers are quite different. Women who are working tend to stay in the labor force for extended periods of time, while housewives persistently remain out of the labor force. In explaining the one-period assumption in the increment-decrement model, we noted that the probability of moving out of the labor force depended only on the current labor-force state and not on any prior labor-force history. The one-period assumption causes a great deal of labor-force turnover in the increment-decrement model, making the expected worklives of workers and nonworkers closer than they are in reality.

That consequence for all males can be seen in Table 5.1, above. To illustrate, the model predicts that among 30-year-old men with 15-plus years of schooling, those currently working will work an additional 31.6 years while nonworking men will work 30.4 years. Increment-decrement models produce similar small disparities in expected worklives for working and nonworking women. This may not be a serious problem for calculating men’s worklife discounts because 95 percent of men will actually be in the labor market. Consequently, the differences in expected worklives between the currently working or nonworking men are actually rather small. However, that does not hold for women. In reality, currently working women have much longer expected worklives than nonworking women have.

Because increment-decrement models do not correctly predict women’s worklife discounts, we developed an alternative approach based on the work of Smith and Ward (1984). Here, we simply highlight its principal distinguishing features. The essential innovation of the Smith-Ward model is that it incorporates population heterogeneity. The increment-decrement model cannot capture the reality that large numbers of women remain in a labor-force state for extended periods of time. Smith and Ward incorporate that reality for currently working women in their model by allowing for a fraction $S_w$ of women who are “stayers” in the working state. Nonworking women also have a stayer fraction, $S_n$, with a zero probability of leaving the nonwork state. The remaining proportions of the population, $(1 - S_w) M_{n-1}$ and $(1 - M_{n-1}) (1 - S_n)$ are “movers” who transit between the work and

---


6However, one could question whether working and nonworking men are not more different in their labor-force behavior than the standard increment-decrement model implies. If they are, then the increment-decrement models used for men will understate worklife expectations and economic loss for current male workers but at the same time overstate worklife expectations and economic loss for currently nonworking men. There are no models at present that capture more permanent differences in worklife expectancies for men.
nonwork states according to the simple two-state Markov increment-decrement model. Movers who are currently working have a probability $P_w$ of working the next period while nonworkers have a probability $q_n$ of remaining out of the labor force the succeeding period.

Using the labeling conventions we adopted for men, we can derive the four transition rates for women between the two labor-force states.\footnote{As was the case for men, age-specific transition rates are used in the modeling. These are suppressed in the text for expository ease.}

\[
P_{mm} = Sw + (1 - Sw) P_w
\]
\[
P_{mn} = (1 - Sw) (1 - P_w)
\]
\[
P_{nm} = (1 - q_n) (1 - Sn)
\]
\[
P_{nn} = Sn + (1 - Sn) q_n
\]

and

\[
M_t = P_{mm} M_{t-1} + P_{nm} (1 - M_{t-1})
\]

The probability of moving between states is now a weighted average of the certain probability that a stayer remains in her current state and of the transition probability of movers. For example, the probability that workers will remain in the labor force ($P_{mm}$) is made up of two groups of workers. The fraction of workers who are stayers ($Sw$) will all remain in the labor force and accumulate one year of experience. Of the workers who are not stayers ($1 - Sw$), a fraction $P_w$ will remain in the labor force for another year.\footnote{See Smith and Ward (1984) for the details involved in estimating the stayer fractions $Sw$, $Sn$ and the Markov transition probabilities $P_w$, $q_n$.} If the fraction of stayers are constant over time, the accumulated work experiences of working and non-working women will differ significantly. In the extreme, a large fraction of women will always work accumulating many years of work experience, while a corresponding fraction of women will never work, accumulating zero years of work experience. It is this possibility that allows the Smith-Ward numbers to distinguish between the workforce and nonworkforce.

Table 5.2 compares the expected worklives obtained from the Smith-Ward model with those derived from a conventional increment-decrement model. Compared with Smith-Ward, the increment-decrement model understates the remaining years of worklife for women under age 40. That underestimation results from the latter's
use of cross-sectional transition rates between labor-force states. As we suggested in explaining the need for a new model, use of cross-sectional rates does not capture the reality of women's sustained, increasing rates of labor-force participation. This argument is supported by the fact that the models exhibit little difference for all women after age 45, where this bias is small.

For calculating worklife discounts, the critical difference between the two models is not the disparity between their estimates for all women but the disparity between their estimates for women who are or are not in the labor force. As Table 5.2 shows, the BLS tables predict that at age 30, a currently working woman would work 21.7 more years while a currently nonworking woman would work 19.1 years (a difference of only 2.6 years). In contrast, the numbers from Smith-Ward for 30-year-olds are 28.2 and 17.3 (a difference of 10.9 years). The Markov model that underlies the BLS worklife tables simply does not allow for sufficient distinction between current workers and nonworkers.

We can establish the relative merits of the two models by calculating retrospective experience of women. Both models imply a past worklife as well as a future one. As a result, we can calculate the retrospective years of experience for current workers and nonworkers, using each model. Then, we can compare the measures with work experience actually accumulated by women in the National Longitudinal Survey (NLS Parnes) data. Table 5.3 presents the results of this exercise.

Table 5.2

<table>
<thead>
<tr>
<th>Age</th>
<th>Increment-Decrement Model</th>
<th>Smith-Ward Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In Labor Force</td>
<td>Not in Labor Force</td>
</tr>
<tr>
<td></td>
<td>All Women</td>
<td>All Women</td>
</tr>
<tr>
<td>20</td>
<td>27.2</td>
<td>27.9</td>
</tr>
<tr>
<td>25</td>
<td>24.0</td>
<td>24.8</td>
</tr>
<tr>
<td>30</td>
<td>20.8</td>
<td>21.7</td>
</tr>
<tr>
<td>35</td>
<td>17.6</td>
<td>18.6</td>
</tr>
<tr>
<td>40</td>
<td>14.3</td>
<td>15.5</td>
</tr>
<tr>
<td>45</td>
<td>11.1</td>
<td>12.5</td>
</tr>
<tr>
<td>50</td>
<td>8.0</td>
<td>9.8</td>
</tr>
<tr>
<td>55</td>
<td>5.2</td>
<td>7.2</td>
</tr>
<tr>
<td>60</td>
<td>3.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>
Table 5.3

COMPARISON OF ACTUAL AND ESTIMATED WORK EXPERIENCE

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>35-39</td>
<td>8.9</td>
<td>12.1</td>
<td>4.8</td>
<td>8.7</td>
<td>12.2</td>
<td>4.8</td>
</tr>
<tr>
<td>40-44</td>
<td>11.7</td>
<td>14.9</td>
<td>6.6</td>
<td>11.5</td>
<td>14.8</td>
<td>6.2</td>
</tr>
<tr>
<td>45-49</td>
<td>13.9</td>
<td>17.9</td>
<td>8.7</td>
<td>13.6</td>
<td>18.5</td>
<td>7.3</td>
</tr>
</tbody>
</table>

How do the models compare? Smith-Ward is able to replicate the past work experience of current working women and current nonworking women. For example, among 45- to 49-year-old women, Smith-Ward predicts a mean prior work experience of 18.5 years for current women workers and 7.3 years for women who are currently out of the labor force. These model-simulated predictions are quite close to the actual values of 17.9 years for the labor force and 8.7 years for the non-labor force.

Smith-Ward predictions are even closer to the mark for younger women. Among women 35–39 years old, Smith-Ward actually matches the actual nonlabor force mean (4.8 years) and misses the labor-force mean by only one-tenth of a year (12.1 compared to 12.2).

MORTALITY

Adjustment for mortality is a standard component of economic loss calculations. For both market and nonmarket components of loss, one should discount the loss in each future age by the probability that the decedent (if he had not died in the crash) would have survived to that age. Thus, for example, we might calculate that a 20-year-old would have earned $40,000 at age 60. However, if the probability of surviving to that age were .7, the expected loss would be only $28,000, not the entire $40,000.

Our method incorporates a conventional mortality adjustment. The National Center for Health Statistics publishes lifetables that indicate...

---

\footnote{Losses are also discounted for the probability that the beneficiary would have died before the victim. This issue is discussed in Sec. VII below.}
the number of remaining survivors from a base population. For each age, these tables tell us the conditional probability of living for another year \((1 - m_i)\). These age-specific survivor rates can be linked across ages to calculate the probability of living to some future year. To illustrate, the probability of living to year \(s\) evaluated at age \(t\) is equal \((1 - m_i)\). These survival probabilities to each future year are the basis of our mortality adjustment for economic loss.

It has been well-documented that mortality rates differ by race and sex, and such differences appear in our mortality discounts as well. A useful summary statistic for mortality is life expectancy. Table 5.4 illustrates life expectancies at five-year age intervals separately by race and sex.

**Table 5.4**

<table>
<thead>
<tr>
<th>Age</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>White</td>
<td>Black and Other Races</td>
</tr>
<tr>
<td>20</td>
<td>52.4</td>
<td>47.5</td>
</tr>
<tr>
<td>25</td>
<td>47.9</td>
<td>42.4</td>
</tr>
<tr>
<td>30</td>
<td>43.3</td>
<td>38.9</td>
</tr>
<tr>
<td>35</td>
<td>38.6</td>
<td>34.7</td>
</tr>
<tr>
<td>40</td>
<td>34.0</td>
<td>30.5</td>
</tr>
<tr>
<td>45</td>
<td>29.5</td>
<td>26.5</td>
</tr>
<tr>
<td>50</td>
<td>25.2</td>
<td>22.8</td>
</tr>
<tr>
<td>55</td>
<td>21.3</td>
<td>19.5</td>
</tr>
<tr>
<td>60</td>
<td>17.6</td>
<td>16.5</td>
</tr>
<tr>
<td>65</td>
<td>14.3</td>
<td>13.9</td>
</tr>
<tr>
<td>70</td>
<td>11.4</td>
<td>11.4</td>
</tr>
<tr>
<td>75</td>
<td>8.9</td>
<td>9.2</td>
</tr>
</tbody>
</table>


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10See U.S. National Center for Health Statistics, *Vital Statistics of the United States: 1979, Vol. II, Mortality.* These survival probabilities are based on current-year mortality rates. Implicitly, they assume that a 20-year-old will face in 40 years the current mortality prospects of a 60-year-old. Secular improvements in health argue, however, that by the time our 20-year-old is 60, his life expectancy would be higher than today's 60-year-old. Unfortunately, tables are not readily available that calculate life expectancies, correcting for this bias.

11Higher age-adjusted death rates for blacks are related to their lower average income and education. Since airplane passengers tend to have higher incomes than the average black, using race-specific mortality rates may underestimate the life expectancy of black descendants in our sample.
As the table indicates, for each sex, whites will live longer than blacks. For example, at age 40, a white man is likely to live 3.5 years longer than a black man. The racial discrepancy for women at age 40 is 3.2 years. However, the largest demographic difference in life expectancy is between the sexes. Once again for age 40, white women will live 6.3 years longer than white men, while black women will live 6.5 years longer than black men. These differences in life expectancies have straightforward implications for our calculation of economic loss. All other things equal, economic loss should be much higher for the young than for the elderly and somewhat higher for whites and women.
VI. NONMARKET LOSS

The lost future earnings of the decedent represent only a partial measure of the full economic loss attributed to his death. Market earnings capture the forgone output that a decedent would have produced in the workplace now and in the future. But market-produced goods are only a part, and very often only a small part, of the total sum of useful things produced by the decedent lost because of his death.

Individuals engage in a range of productive activities outside the formal labor market. Such activities include caring for children, fixing meals, shopping, and making household repairs. Although the resulting goods and services are not exchanged in a formal market, they are, in principle, no different from the labor that produces a car on the assembly line. Consequently, they should be counted equally with the decedent’s forgone earnings in calculating full economic loss. The following problem illustrates why.

A woman can provide care for her children by (a) getting a job and earning the money to pay others for child care or (b) caring for the children herself. If she earns $15,000 on her job, and it costs her the full $15,000 to pay someone else for child care, the value of that care is $15,000. Because she earned the money to buy it, this $15,000 used to purchase child care is counted correctly as part of economic loss.

Suppose that she stays home and takes care of the children. In a compensation system that excluded nonmarket loss, this care would not be considered. Yet, the cost (and value) of that child care would still be $15,000, her forgone market earnings. The two scenarios are identical—child care worth $15,000 must be replaced (either the lost earnings that were used to pay for it, or the lost time used for the care itself).¹

Failing to count nonmarket losses equally with market losses is inequitable and logically indefensible in calculating economic loss. It is inequitable because it would undercompensate women who stay home to care for their children compared to women who went to work and purchased child care. However, computing nonmarket loss is more complicated. Earnings are available to measure market loss, but more indirect measures are required to calculate nonmarket economic loss.

Our procedures for calculating nonmarket loss involve three steps—(1) calculating the total number of hours each decedent would have

¹This example obviously oversimplifies the actual calculations that would be involved. As we shall see below, fringe benefits and taxes complicate the calculation of opportunity cost of nonmarket loss.
spent in nonmarket activities during the accident year, (2) projecting these hours into future periods, and (3) placing a value on each hour.

**IMPUTING NONMARKET HOURS**

**Bases for Imputation**

In almost any wrongful death action, it would be necessary to impute the decedent's time spent in nonmarket activities, since few people leave records of such things. Calculations are typically based on data about what "similar" people do. We imputed the nonmarket activities for the airline sample using the best dataset available for such calculations: the 1975–1976 Time Allocation Study conducted by researchers at the University of Michigan. This study is widely regarded as the most methodologically sound data source for estimating nonmarket hours. Furthermore, it is the only nationally representative sample of American adults that records time-use data. All other available time-budget surveys are limited to very specialized and nonrandom samples.

The Michigan survey group obtained time-use data from diaries in which the respondents chronologically recorded their detailed activities for the day. To adjust for seasonality, respondents were interviewed four times during the year. In addition, respondents were interviewed on weekdays and weekends so that total yearly hours would reflect the very different weekday and weekend uses of home time.

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2 Time-use data are notoriously difficult to collect. To do so accurately requires considerable resources as well as a dedicated and skilled survey staff. For the collection of time-use information, the Michigan survey group is regarded as the most experienced in the United States.

3 An excellent example of a nonrandom sample frequently used in litigation is the 1967–1968 Cornell Survey. See Walker and Gauger (1973) for some results of this survey about the value of household time. In addition to sampling a single geographical area, this Cornell Survey oversamples suburban housewives. For an estimate of the bias involved in using the Cornell sample, see our companion volume, *Economic Loss, Litigant Behavior, and Compensation in Aviation Accidents*.

4 The original Michigan sample consisted of 1519 respondents and 887 spouses. In our analysis, we used only respondents for whom "synthetic week variables" were calculated. [The synthetic week is a "typical" week derived from the diaries and the interviews, across seasons. Thus the variables are available only for respondents who answered all four interviews.] There were 1448 observations with synthetic week variables but 78 had a missing value for age and were deleted from our analysis. As a result, our final sample was 1370. For a detailed description see Juster and Stafford, 1984.
Which Nonmarket Activities Should Be Included?

There are no hard and fast rules governing which activities should be counted in imputing nonmarket loss. We have adopted what amounts to a very narrow definition of nonmarket time. Table 6.1 illustrates the range of possible activities, divided into those we chose and those we excluded. Our definition includes only those activities traditionally associated with housework—the time spent preparing meals, cleaning the house, laundry, shopping, home repairs, and child care. Even if we exclude sleep time, only half of total nonmarket time is included in our definition.

In setting a benchmark for deterrence (the full economic loss), it is especially questionable to exclude many of the activities in the right-hand column. The decedent’s time spent in voluntary charitable or religious work or on his own education could be viewed on a par with home work time because this time spent yielded satisfaction to the decedent and contributed valuable time to society. The same is true for the decedent’s passive and active leisure time, which also may have produced only self-satisfaction but is part of the real cost incurred by the death.

We have used the narrower definition here for two reasons: First, even in states where full economic loss is the mandated principle, most litigation focuses on the activities we included. While we believe that this limited focus should be reconsidered, it remains the overwhelming norm in litigation practice. Second, loss to survivors is the dominant

<table>
<thead>
<tr>
<th>ACTIVITIES SELECTED FROM TOTAL NONMARKET TIME</th>
<th>Included</th>
<th>Excluded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meal preparation, household cleaning, laundry</td>
<td>Sleep</td>
<td>Travel</td>
</tr>
<tr>
<td>Shopping and household repairs</td>
<td></td>
<td>Education</td>
</tr>
<tr>
<td>Child care</td>
<td></td>
<td>Entertainment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Political Activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Religious Activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Voluntary organizations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hobbies, sports</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Passive leisure</td>
</tr>
</tbody>
</table>

\[^5\]In our companion volume, Economic Loss and Compensation in Aviation Accidents, we provide simulations of the estimates of full economic loss using the more inclusive definition of nonmarket time.
objective in most states; thus, most courts consider only activities from which survivors would have benefited directly.

The Results

Using the more narrow definition, we obtained predicted values of total nonmarket hours for each decedent from regressions estimated with the Michigan Time Budget Study. The regression variables were those that significantly affected total nonmarket time: indicator variables for two marital status groups (married and divorced or separated), the number of children less than 18 years old, and the age of the youngest child. In addition, a detailed age spline was included to capture the life-cycle path in nonmarket time. Because sex and work status are such critical determinants of nonmarket hours, separate regressions were estimated by sex and by current work status (currently working or not).6

Table 6.2 illustrates the annual levels of nonmarket hours obtained from the Michigan Time Budget Survey and the values of initial nonmarket time imputed for our decedents.7 This table stratifies our estimates by three demographic characteristics strongly associated with levels of nonmarket time: sex, marital status, and employment status. In spite of the rapid increases in women’s labor-force participation, the traditional division of labor in the American household persists. According to our estimates, on average, women’s yearly hours of household work are more than twice those of men. However, contrary to the view that replacement of household services only applies to housewives, Table 6.2 indicates that working women and men spend a significant amount of time in nonmarket work.

For both sexes, time spent in household tasks is strongly affected by whether individuals are currently married and whether they have a job. Marriage concentrates activities more and more inside the home. As a result, hours of home work increase for married people of both sexes, but the effect of marriage is more pronounced for women. In the Michigan sample, married women spend 615 more hours each year in

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6The specification of the age spline was 18-25, 26-39, 40-54, 55+ years old. Because of values missing for subsets of the covariates in the claims file, additional regressions were run deleting variables from the full specification. We first dropped the children variables, and then the marital status variables. Finally, some respondents did not fully account for their weekly time use. To correct for this problem, we included a variable that measured total time not accounted for. This variable was set equal to zero when we predicted hours for decedents.

7To preserve comparability between the Michigan and our decedent imputations, we restricted our calculations in Table 6.2 to decedents who were at least 18 years old. How we treat younger decedents is discussed in Sec. X.
Table 6.2
TOTAL NONMARKET ANNUAL HOURS

<table>
<thead>
<tr>
<th></th>
<th>All Marital Status</th>
<th>Married</th>
<th>Not Currently Married</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Michigan Tapes*</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Work Status</td>
<td>1694</td>
<td>1987</td>
<td>1252</td>
</tr>
<tr>
<td>Working</td>
<td>1334</td>
<td>1443</td>
<td>1075</td>
</tr>
<tr>
<td>Not Working</td>
<td>2002</td>
<td>2232</td>
<td>1459</td>
</tr>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Work Status</td>
<td>806</td>
<td>770</td>
<td>627</td>
</tr>
<tr>
<td>Working</td>
<td>758</td>
<td>701</td>
<td>543</td>
</tr>
<tr>
<td>Not Working</td>
<td>940</td>
<td>1070</td>
<td>755</td>
</tr>
<tr>
<td><strong>B. RAND Decedent File</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Work Status</td>
<td>1526</td>
<td>1783</td>
<td>1113</td>
</tr>
<tr>
<td>Working*</td>
<td>1245</td>
<td>1440</td>
<td>969</td>
</tr>
<tr>
<td>Not Working</td>
<td>1960</td>
<td>2155</td>
<td>1490</td>
</tr>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Work Status</td>
<td>707</td>
<td>766</td>
<td>557</td>
</tr>
<tr>
<td>Working</td>
<td>686</td>
<td>729</td>
<td>555</td>
</tr>
<tr>
<td>Not Working</td>
<td>1032</td>
<td>1146</td>
<td>696</td>
</tr>
</tbody>
</table>


*Work status unknown is not included in the stratification by work status.

home-related activities than women who are not currently married do. In contrast, having a job reduces home time, an effect that once again is much greater among women. Mean hours for nonworking women exceed those of women in the labor force by 656 hours in the Michigan sample. The largest entry in Table 6.2 occurs for nonworking married women who spend more than 2200 hours in home-based, nonmarket activities.

Although the initial values we imputed for decedents parallel the structure and levels described within the Michigan study, they differ quantitatively. Comparing initial male hours, we find that the airline

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*Our estimates of nonmarket time for men are probably biased upwards. We have seen that male decedents are strongly positively selective in their market incomes—i.e., they earn much more than the typical male worker in the United States. Because of their higher earning power, they also most likely spend less time than the norm in household activities. Thus, we suspect that we underestimate male market losses but overstate
decedents had 100 fewer hours than the Michigan sample (i.e., 707 hours compared with 806). Similarly, the mean yearly home hours for female decedents was 172 fewer than for the Michigan females (i.e., 1526 compared with 1694). Given our imputation procedure, these disparities must emerge from the demographic differences between the two samples. The differences are concentrated in the nonmarried subsets of the samples. The patterns of nonmarket hours exhibited for the nonmarried in Table 6.2 indicate that our nonmarried decedents were younger and more likely to be working than the similar subset in the Michigan sample.

CALCULATING FUTURE VALUES OF NONMARKET HOURS

The initial values indicate only nonmarket time during the first year after the accident. Thus, imputing these initial values is just the first step in computing nonmarket loss. To calculate full nonmarket economic loss, we must also know levels of nonmarket activity at all subsequent ages. For this projection, total hours of household time at any future age are a weighted average of the household hours of a worker and those of a nonworker, where the weight reflects the probability that a decedent will be a worker during that future age. More formally:

\[
\text{Total time} = q_t (bX_t) + (1 - q_t) (b'X_t')
\]

where \( q_t \) is the expected future labor-force participation rate of the decedent, \( bX_t \) is the regression prediction for nonmarket hours at age \( t \) for workers, \( (1 - q_t) \) the probability of being out of the labor force at age \( t \), and \( b'X_t' \) the nonmarket hours forecasted for nonworkers.

Table 6.3 illustrates life-cycle predictions of total nonmarket hours for two prototypical families—married couples with two children, the youngest of whom is 2 years old, and never-married individuals without children. This table demonstrates once again the close association of marriage and labor-force participation with time spent in home

their nonmarket loss. While we can assess the magnitude of the bias in market loss, there is no way of gauging any bias on male nonmarket loss. Neither of the offsetting sources of bias is included in our estimates.

\(^9\)For this projection, we increase the decedent’s age by a year in each future period. Similarly, the values of the number of children under age 18 and the age of the youngest child move along their predicted life-cycle path (i.e., the youngest child ages a year, and number of children is reduced when a child becomes 18). For these projections, decedents retain their original values for marital status throughout the remainder of their life.
activities. For example, a 30-year-old housewife with 2 children spends 2400 hours in household tasks while a 30-year-old, single-career woman spends only 815 hours.

The patterns in Table 6.3 implicitly describe the standard life-cycle pattern of nonmarket work. As women marry, have children, and leave the job market temporarily, their time in household activities increases substantially. As their children age and go to school, women return to the job market and nonmarket hours decline. Finally, as men and women both start to retire at age 60, their nonmarket activities expand once again as their productive activities are increasingly focused in the home.10

### Table 6.3

<table>
<thead>
<tr>
<th>Age</th>
<th>Married, Two Children</th>
<th></th>
<th>Never Married, 0 Children</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Working</td>
<td>Nonworking</td>
<td>Working</td>
<td>Nonworking</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>1472</td>
<td>1994</td>
<td>722</td>
<td>814</td>
</tr>
<tr>
<td>25</td>
<td>1669</td>
<td>2339</td>
<td>918</td>
<td>1159</td>
</tr>
<tr>
<td>30</td>
<td>1566</td>
<td>2400</td>
<td>815</td>
<td>1220</td>
</tr>
<tr>
<td>40</td>
<td>1407</td>
<td>2502</td>
<td>656</td>
<td>1322</td>
</tr>
<tr>
<td>50</td>
<td>1871</td>
<td>2433</td>
<td>920</td>
<td>1253</td>
</tr>
<tr>
<td>60</td>
<td>1860</td>
<td>2287</td>
<td>1049</td>
<td>1087</td>
</tr>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>637</td>
<td>783</td>
<td>512</td>
<td>312</td>
</tr>
<tr>
<td>25</td>
<td>716</td>
<td>670</td>
<td>591</td>
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<td>30</td>
<td>696</td>
<td>837</td>
<td>571</td>
<td>416</td>
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<tr>
<td>40</td>
<td>670</td>
<td>1149</td>
<td>545</td>
<td>728</td>
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<td>50</td>
<td>777</td>
<td>1462</td>
<td>652</td>
<td>1041</td>
</tr>
<tr>
<td>60</td>
<td>842</td>
<td>1516</td>
<td>717</td>
<td>1095</td>
</tr>
</tbody>
</table>

10There are two unexpected patterns for single individuals. First, among working women, nonmarket time peaks first at 25 before declining during their later career years. This may be due to a large increase in the formation of own households by women at that age. Since income levels are lower than at later ages, they are not yet able to substitute purchased goods for home production, which becomes more affordable later in their worklife. Second, nonworking men have much smaller nonmarket hours up to age 30 than working men, suggesting a different lifestyle than working men. These men could possibly be sharing their household with others who did most of the home work.
VALUING EACH HOUR OF NONMARKET TIME

Placing a value on each nonmarket hour is the final step in computing nonmarket loss. Because goods and services produced in the home are not exchanged in a formal market, one cannot directly observe a nonmarket time value. Explicit prices are not attached to these household-produced goods or to the time used to produce them.

A method occasionally used to value household services is estimating what the "replacement cost" would be—that is, how much would it cost to purchase a replacement for services previously performed by the decedent? Replacement cost has considerable intuitive appeal, as witnessed by how often the popular press uses it to value the housewife's contribution. However, this approach entails methodological problems far more imposing than its simple application in the press (and unfortunately by some economic experts) would suggest.

In the simple application, the mean number of hours spent in each household task is multiplied by the market wages of a substitute laborer. For example, the number of hours the average housewife reports in cooking is multiplied by a cook's wages, the hours in laundering by a launderer's wages, the hours in child care by a babysitter's wage, and so on. These hours-wage products are then summed across all household activities. While seemingly straightforward, this simple method fails to reflect how hours are typically reported in time-budget studies. Consequently, the cost calculation is analytically incorrect and systematically understates the true replacement cost of household services.

To illustrate, the Michigan Time Budget Study lists the mean annual hours that nonworking married women with one child reported spending in child care. The annual mean for mothers of preschool children (less than five years old) was 437 hours, or only 1.2 hours a day. Obviously, no "average" mother leaves her toddler unattended for the rest of the day. These reported hours are so incredibly low because time-budget surveys have characteristically asked respondents to classify their time use by the major activity they are performing at the time. Although child care goes on continually while a woman is doing almost all other household tasks, she will report the "major" use of her time as household cleaning, meal preparation, doing laundry, but not child care.

The substantial economies of scale in household time use make reported hours in given activities an inadequate measure of the market hours that must be purchased as a replacement. If the wife in our example above dies, the husband does not face the problem of replacing 1.2 hours of child care per day (or 437 a year). For the preschool child,
he must purchase child care for, at least, all the hours he is at work—perhaps more on the order of 2000 hours (50 weeks a year, 5 days a week, 8 hours a day). While this problem may be less severe for other household tasks, much smaller levels of scale economies will still produce a large bias in the calculation of replacement cost.

While it is conceptually possible to account for these problems and correctly measure replacement costs, the methodology would have to enable case-by-case analysis and would require exhaustively detailed information on the specifics facing each decedent. Such a methodology is not yet available, and developing it is beyond the scope of this project. In actual litigation, it is important to obtain such information. In the absence of such information, economic theory offers a framework for developing a measure of time value that correctly measures the value of the lost nonmarket output.\footnote{We do try to account for replacement costs in the sensitivity analysis reported in the companion volume, \textit{Economic Loss and Compensation in Aviation Accidents}.}

We value an hour of home time at its opportunity cost: The individual faces a tradeoff in deciding whether to spend another hour in the job market or another hour in home activities. The value of another hour of homework is the market income the individual gives up by spending another hour in nonmarket activities.\footnote{The ability to take market and nonmarket hours on the margin is often questionable. One view of the labor market is that workers are offered jobs that consist of wage-hour pairs. The marginal wage in this case is the wage that is available if the worker quits his job and works one more hour on another job. It is not clear whether the average wage we used would be greater or less than this marginal wage. Unfortunately, the empirical literature in labor economics on this subject does not as yet offer much insight into the relationship between these two wage concepts. This discussion benefited from comments of Sherwin Rosen.} To illustrate the point, consider an individual with an hourly wage of $10, and a fringe package worth $3 per hour, who faces a marginal tax rate of 50 percent. In this case, the cost of spending another hour in home activities is the $8 forgone from an hour of work ($5 in after-tax pay and $3 in fringes). More generally, the value of the marginal hour of home work ($w^h$) is equal to $w_m + w_m (f - t)$ where $w_m$ is the before-tax hourly wage, $f$ is the value of the fringe package as a fraction of the market wage,\footnote{The appropriate fringe rate to use is the marginal rather than the average rate, but we have no data on this.} and $t$ is the marginal tax rate. In this project, we value each hour of household time at this home wage $w^h$.\footnote{For housewives, the value of their home time exceeds the wage they would be offered on the job. That inequality is the reason they do not work. We did not follow that approach here because in all time periods but the first, our worklife discounts imply that everyone was partly a worker and partly a nonworker. Therefore, the distinction between workers and nonworkers breaks down in all future periods.}
Another way of thinking about the value of nonmarket time is the choice between doing the homework oneself or purchasing a substitute in the market. Using child care as an example again, suppose that instead of either parent spending an hour in child care, parents can purchase the equivalent of that hour directly (e.g., from a day-care center or babysitter). For any given level of quality, individuals will choose the child-care method that is least expensive.

Using the numerical example above, a family will purchase child care if the full cost is less than $8 per hour, but provide it themselves if the cost is more than $8. The important point is that, for each hour of child care that the family does provide themselves, the value of an hour remains $8 (the forgone market wage). Thus, even though the choice is between market-purchased goods and home time, the opportunity cost is still the correct measurement of the home time for families who provided home child care.

To compute the value of the home time, the first step is converting salaries into before-tax hourly wages (i.e., dividing yearly incomes by annual hours worked). In the section on taxes below, we describe the

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15One argument often made against the opportunity cost approach is that it doesn't apply when loss to survivors is the death-damage principle. The reasoning is that some of the value is unique to the decedent. However, there is no difference between market and nonmarket loss in this regard. We apply to nonmarket loss the same consumption offset as we do to market income, so the total value of the nonmarket activity is not assigned to the survivors in our methodology either. On this issue, special interests in the litigation will often argue that certain nonmarket activities only gave utility to the decedent. These arguments can be very misleading. Other uses of nonmarket time (such as home repairs) are almost like public goods. In such cases, there should be no personal consumption offset at all. Remember as well that our limited definition of household time gives no value to survivors from many nonmarket uses of time. This is a very extreme assumption. If anything, on this issue our assumptions probably underestimate loss to survivors.

16We view this opportunity cost approach as an accurate measure of the valuation of nonmarket time for the typical decedent in our sample. As such, it should provide an accurate measure on average for the nonmarket losses in the air-crash sample. However, it is not equally appropriate for all situations. For example, the $50-an-hour executive certainly may not provide the same hourly value for his nonmarket work. In actual litigation, experts should take into account all the specifics associated with the case (including the true cost of replacing the time in the market). In this regard, it should be noted that these high-price executives typically spent far more on replacement than a lower-income person. We believe that our opportunity cost approach gives an accurate assessment of the average loss, but it probably understates the variation in loss, especially overstating loss among high-wage men. In contrast, our simulation of the alternative replacement cost measure severely understates the true variability in loss.

17If information on weekly hours or annual weeks worked were available from the claims file, we used those data in our computation of hourly wages. If this information were missing, we used sex-age group cell means for full-time and part-time workers covered by the U.S. Current Population Surveys. Thus, if the decedent was a full-time male worker in a certain age group, he was assigned the CPS mean for a full-time worker.
assumptions necessary to derive effective or average tax rates. To compute the value of household time, however, it is the marginal tax that is relevant. Each year, the IRS publishes data that associate each adjustable family income with a federal marginal tax rate.¹⁸ We use the combined federal and state marginal tax rates to calculate the value of household time.

Table 6.4 lists the mean levels of household time values that we computed for this study. These mean values are the marginal time values for the first year after the accident. On average, we assign the value of a nonmarket hour at $14.51. Given their substantial differences in earning capacity, we impute an hour value of $18.31 for men and $8.72 for women. These large differences in tax-adjusted hourly earnings are almost entirely offset by the sex differences in average home hours. Indeed, when we multiply our initial hour values by initial home hours, both sexes receive a total value of approximately $13,000 of nonmarket time a year. The average value of home time of $13,000 a year does not seem an excessive value to place on the total nonmarket value.

In future periods, these base-year household-time values will grow at a rate dictated by our combined salary growth for the decedent, offset by the effect of rising marginal tax rates.

Table 6.4
VALUE OF NONMARKET HOURS FOR THE AIRLINE DECEDENTS

<table>
<thead>
<tr>
<th>Group</th>
<th>Value in Dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>14.51</td>
</tr>
<tr>
<td>Men</td>
<td>18.31</td>
</tr>
<tr>
<td>Women</td>
<td>8.72</td>
</tr>
<tr>
<td>U.S. Citizen</td>
<td>15.37</td>
</tr>
<tr>
<td>Foreigner</td>
<td>9.82</td>
</tr>
</tbody>
</table>

¹⁸The total marginal tax rate equals \( t' + t' (1 - t') \). Where \( t' \) is the federal marginal rate and \( t' \) is the state marginal rate. Although state marginal tax rates are progressive, this progressivity is offset by the higher value that the state tax deduction has to a high marginal-tax federal taxpayer. Because of this, we assumed a constant flat state tax of 3 percent. See state tax rates in Table B.2.
VII. PERSONAL CONSUMPTION OFFSET

The methodology we have developed for base-year incomes, salary growth, and nonmarket loss is not limited to compensation calculations for wrongful death alone. For example, our methodology for these components applies equally as well to personal injury cases. However, in one respect—the personal consumption offset—our methodology is unique to wrongful death applications.

Wrongful death statutes in most states are aimed at compensating survivors rather than making defendants liable for full economic loss. Many loss-to-survivor statutes require that the decedent’s personal consumption be subtracted from full economic loss in estimating compensation to survivors.

However, economists have been plagued for decades by the problems of isolating the unique consumption of a single individual within a family. Their goal in identifying an individual’s unique consumption was to make welfare comparisons across different types of families. The question was: How much income do families of different sizes and different composition need to be equally well-off? If we could pinpoint the unique consumption of an individual, we would know how much income the decedent’s survivors need to maintain their overall level of well-being.

THE INDIVIDUAL’S PROPORTION OF FAMILY CONSUMPTION

Although larger families clearly require more resources than smaller families do to achieve a given standard of living, there are substantial economies of scale with family size. For example, a house for six people does not have to be twice the size of a house for three, and a given number of refrigerators and washing machines can serve larger families almost as well as smaller ones. Budgetary studies have consistently found that because of these “scale” economies, the income needed rises with family size, but does so at a declining rate.

The numbers indexing the consumption levels that make families of different sizes and compositions equally well-off are called equivalence scales. Because these scales have many important applications, economists have been working on their development for decades. For example, these scales are the basis of the widely used poverty lines. Poverty thresholds also increase with family size but at a less than
proportionate rate. Unfortunately, despite the substantial literature on this subject, research has reached no consensus about the single best methodology for creating these equivalence scales.

In this study, we have not advanced a new methodology for this problem. After reviewing the literature, we were unable to select a methodology that we felt was clearly superior to the others. Because of this, we simply averaged three of the more prominent methodologies available: Orchansky, U.S. Bureau of Labor Statistics, and Lazear and Michael.¹

Table 7.1 presents the resulting equivalence scales that we used in this project. These scales are stratified by the age of the household head and the size of the family. All values are normalized against a one-person family with a head of household less than 35 years old. These scales reveal two major patterns. First, the scales decline when the head of household reaches age 55. Second, they expand as family size increases, but at a less than proportionate rate. For example, a two-person family headed by a 35- to 54-year-old individual “needs” only 31 percent more income than a one-person family of that age (134.2/102.8). Similarly, a five-person family in that age bracket does not require five times as many resources as a one-person family; it needs only 2.42 as much.

The rate of increase is not proportionate to family size because some consumption is shared among family members. To illustrate, if all members of a four-person family consumed equally, each would consume 25 percent. However, we estimate that the unique consumption of one person is only 17.7 percent. The difference between the equal share of 25 percent and our 17.7 percent estimate results from the

<table>
<thead>
<tr>
<th>Size of Family</th>
<th>Age of Household Head</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Under 35</td>
</tr>
<tr>
<td>One Person</td>
<td></td>
</tr>
<tr>
<td>Two Persons</td>
<td></td>
</tr>
<tr>
<td>Three Persons</td>
<td></td>
</tr>
<tr>
<td>Four Persons</td>
<td></td>
</tr>
<tr>
<td>Five Persons</td>
<td></td>
</tr>
<tr>
<td>Six Persons</td>
<td></td>
</tr>
</tbody>
</table>

¹We discuss the characteristics and limitations of these methodologies in the “Note on Equivalence Methodologies” at the end of this section.
substantial shared consumption that takes place among family members. To establish the consumption requirements of the rest of the family, we should subtract only the consumption that is unique to the decedent.

As a proportion of total family consumption, joint consumption is relatively more important the smaller the original family size. This result should not be surprising since many of the shared goods in the household are required even if there is only one person present. If one family member dies, the rest of the family still needs a house and a refrigerator.

Table 7.2 illustrates how these equivalence scales can be transformed to deduce what fraction of total family consumption is unique to each individual (in this case, the decedent). Here, we reproduce the equivalence scales for families headed by 35- to 54-year-old individuals and the decedent’s share of family consumption.

Assume that a family of three spent $17,150 on consumption. Using the scales in Table 7.2, that family is as well-off as a family of two with a total consumption of $13,420. To put the comparison in a more revealing way, the other two members of the family of three must have been consuming at the $13,420 level to be as well-off in terms of their consumption between a family of two and a family of three. As a result, the unique consumption of a decedent is $3,730 (the difference between family size 3 and 2 consumption), which is about 22 percent of the original total family consumption.

Table 7.2

ILLUSTRATION OF EQUIVALENCE SCALES
(Head Aged 35-54)

<table>
<thead>
<tr>
<th>Family Size</th>
<th>Equivalence</th>
<th>Decedent's Share of Family Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>102.8</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>134.2</td>
<td>23.4</td>
</tr>
<tr>
<td>3</td>
<td>171.5</td>
<td>21.7</td>
</tr>
<tr>
<td>4</td>
<td>208.2</td>
<td>17.7</td>
</tr>
<tr>
<td>5</td>
<td>249.1</td>
<td>16.4</td>
</tr>
<tr>
<td>6</td>
<td>288.7</td>
<td>13.7</td>
</tr>
</tbody>
</table>
CALCULATING DEPENDENCY

To calculate the consumption offset, we must also know whether and how much reported family members actually share in family consumption. The individuals who would have been actually consumption-dependent on the decedent, in each period, constitute the “effective” family.²

To establish the “effective” family size, we relied on information provided in the claims files about family composition and the degree of dependency for each dependent. Based on their stated dependency, each claimant was assigned a value between zero and one to index their extent of consumption dependency.³ Dependents with values of one were counted as full family members while those with dependency values of zero were not counted as family members at all. Those with dependency values between zero and one were treated as partial family members.

These dependency amounts were enforced over the dependent’s life expectancy.⁴ We did so because many dependents have life expectancies that are less than the decedent. For example, consider the case of

²The “effective” family sizes are the ones we use for the equivalence scales in Table 7.1.

³For cases with data, there was information for each claimant indicating his/her degree of dependency in five categories: no dependency, 100-percent dependent, partially dependent-extent not specified, partially dependent-extent specified, and not-reported. For the initial value of dependency, no dependency cases were assigned a zero and full dependency cases were assigned a one. The partial dependent-extent specified category generally listed a dollar amount of dependency. To calculate the fraction of dependency, we divided this amount by the age sex-specific incomes computed from the Current Population Surveys. For example, if the reported amount of dependency was $4,000 and average income was $20,000 among people of the same age and sex as the dependent, our computed dependency would be .2. Within each relationship code between the decedent and dependent, unspecified partial dependencies were assigned the mean of the specified partial dependencies, and missing values were assigned the mean across all reported values.

⁴In cases where the dependent was younger than the decedent, our standard decedent mortality assumptions were applied. Because of the substantial number of missing values for dependent’s age, we had to impute many age values for dependents. Since husbands typically do not live as long as their wives, we limited husband’s dependency on a deceased wife based on his life expectancy. If the spouse’s age was missing, we imputed that age based on the decedent’s age. We assumed a two-year difference between spouses’ ages, with men being the older of the two spouses. For intergenerational dependencies, we assumed a 25-year generational lag. For example, adult children’s ages were imputed to be 25-years younger than their decedent parent, but the imputed age was truncated at age 25. Similarly, parents were assigned ages 25-years older than their decedent children and grandparents 50-years older. Siblings were given the same age as the decedent. There were also many cases when the ages of juvenile children were missing. Since our computation of dependency depends on children’s ages, we had to impute these missing ages. These ages were imputed using data from the 1980 Census.
a 60-year-old dependent mother of a 30-year-old air-crash victim. The consumption dependency of the mother would obviously not last the full life expectancy of the deceased. It is instead limited to her own life expectancy. For dependents whose life expectancies are less than the decedent, we cut off the consumption dependency based on the life expectancy of the dependent.

The most straightforward cases involved spouses and juvenile children. For the purposes of equivalence scales, all spouses and juvenile children under 19 years old count as full family members. The more problematic issue concerns how dependent these children are after they reach age 19. There is no single age where children go from full dependence on their parents to independence. While some children move away from home immediately after high school to live alone and eventually marry, many others stay at home for a number of years. Others go off to college, with expenses paid by their parents. Moreover, parents often help their children financially throughout their lives, especially for costly life events such as the purchase of a home, the birth of children, and emergencies.

We could find no satisfactory source for this consumption dependency as children become adults. In the absence of other data, we used information from the claims files on dependency amounts for adult children. To explicate our method, we first describe the calculation of consumption-dependency among these adult children. Most adult children, especially older ones, reported that they were not dependent on their parents. Their dependencies were recorded as zero on our scale. A few, especially those younger than 22 years old, reported that they were fully dependent. They were counted in the first postaccident year as "ones" on our scale. All other adult children received a partial dependency fraction between zero and one.⁵

At each adult child's age, we averaged these dependencies across all adult children in the airline crash data. These mean values, stratified by age, estimate the evolving life-cycle trajectory of mean dependencies as children pass through adulthood. Table 7.3 lists the computed dependencies we assigned to young children when they become adults. These dependencies exhibit a sharply declining life-cycle pattern, especially in the years immediately following adolescence.

The rationality of our estimates is implied by the sharp break at age 22 in Table 7.3. Before age 22, many children are still at home, while

⁵For those adult children who listed a specific dependency amount, their partial dependency was computed by dividing that amount by the sex age-specific personal incomes from the Current Population Surveys. Unspecified partial dependencies were equated to the mean of these specified partial dependencies at that age. The numbers in Table 7.4 are derived from the means across all these computed values.
Table 7.3

COMPUTED DEPENDENCY RATES AMONG ADULT CHILDREN

<table>
<thead>
<tr>
<th>Age of Child</th>
<th>Dependency</th>
<th>Age of Child</th>
<th>Dependency</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>.825</td>
<td>26</td>
<td>.149</td>
</tr>
<tr>
<td>20</td>
<td>.719</td>
<td>27</td>
<td>.106</td>
</tr>
<tr>
<td>21</td>
<td>.729</td>
<td>28</td>
<td>.109</td>
</tr>
<tr>
<td>22</td>
<td>.490</td>
<td>29</td>
<td>.121</td>
</tr>
<tr>
<td>23</td>
<td>.293</td>
<td>30</td>
<td>.106</td>
</tr>
<tr>
<td>24</td>
<td>.228</td>
<td>31−39</td>
<td>.062</td>
</tr>
<tr>
<td>25</td>
<td>.168</td>
<td>40+</td>
<td>.041</td>
</tr>
</tbody>
</table>

others are getting large financial payments from their parents for college expenses. With college graduation and marriage, adult children's dependencies drop sharply and continue to decline rapidly during the early twenties.

Table 7.4 summarizes our work in constructing these family dependencies. We started out with the 6210 live relatives of decedents who appeared on the claims data. In the first column of Table 7.4, we list the original number within each type of relationship. Under the "effective" column, we list the effective number of family members in the first year after the accident. As we mentioned earlier, spouses and juvenile children count as full dependents. However, in all other categories the number of effective family members is far less than the actual number of relatives.

Table 7.4

REPORTED AND EFFECTIVE NUMBER OF DEPENDENTS

<table>
<thead>
<tr>
<th>Relation</th>
<th>Reported</th>
<th>Effective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spouse</td>
<td>719</td>
<td>719</td>
</tr>
<tr>
<td>Juvenile Child</td>
<td>1610</td>
<td>1610</td>
</tr>
<tr>
<td>Adult Child</td>
<td>1235</td>
<td>149</td>
</tr>
<tr>
<td>Parent</td>
<td>1205</td>
<td>155</td>
</tr>
<tr>
<td>Sibling</td>
<td>789</td>
<td>23</td>
</tr>
<tr>
<td>Grandparent</td>
<td>120</td>
<td>2</td>
</tr>
<tr>
<td>Grandchild</td>
<td>48</td>
<td>10</td>
</tr>
<tr>
<td>Separated Divorced Spouse</td>
<td>213</td>
<td>15</td>
</tr>
<tr>
<td>Other</td>
<td>271</td>
<td>63</td>
</tr>
<tr>
<td>Total</td>
<td>6210</td>
<td>2726</td>
</tr>
</tbody>
</table>
If we exclude spouses and children for purposes of consumption dependencies, our effective family sizes are only 10 percent as large as the actual family sizes. The ratio of effective to actual number of family members varies with relationship type in the expected manner. For example, the smallest ratios of effective to actual family members occur among siblings (2.9 percent) and grandparents (1.63 percent). In contrast, the effective number of parents is 11.2 percent and of adult children 9.2 percent. Most of the parents are elderly and claim partial support from their children.

ADJUSTING FOR THE EFFECTS OF SAVINGS

The objective in compensation to survivors in most states is to leave the dependents as economically well-off as they were before the accident. To accomplish that objective, we must replace all ongoing and future transfers that would have passed between the decedent and each dependent. Thus, the methodology must also account for the simple fact that people do save and leave bequests to their heirs. Death not only deprives survivors of the present consumption benefits but also denies them access to probable accumulations of wealth through decedents’ savings. A methodology that fails to recognize this savings component would fail to compensate survivors for their full loss.

This treatment of savings has been endorsed by two leading authorities on wrongful deaths. To quote Speiser, “Nevertheless, loss of inheritance has long been recognized as recoverable in death cases.” Tiffany, in the second edition of his pioneer wrongful death treatise, stated that:

Where the evidence shows that it is probable that decedent but for his death would have accumulated property, which if he had died intestate, would have been inherited by the beneficiaries of the action, these facts constitute such a reasonable expectation of pecuniary benefit as to authorize a recovery of damages for its loss.

Similarly, in the landmark case, O’Toole v the United States, Justice Goodrich wrote:

A widow is entitled to a share of her husband’s estate if she outlives him. If he is a man who is accumulating an estate as the years of his life go by, the widow suffers from his untimely death with regard to what she might inherit as well as what she might have from the

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6Note that the initial ratio of effective to actual number is the highest we will obtain for adult children. Since adult children will be passed through the life-cycle adult child dependency ratios in Table 7.3, their effective number drops over the years.
husband for support. The only argument against allowing such recovery that we can see is that whether there will be growth of the husband’s estate is a matter of speculation. But in this area exact calculations are impossible to make at best. . . . Although there are decisions to the contrary, there is substantial authority in support of the proposition that a beneficiary’s loss of an expected inheritance, or of prospective accumulations, caused by a decedent’s wrongful death, is recoverable as an element of damages under a wrongful death statute and this rule is equally applicable to federal and state wrongful death statutes.

In each period, the loss to dependents from market and nonmarket loss is equal to

\[ c_{ij} Y^{**}_{ij} + Y_{ij} (1 - t_{ij}) + Y^{**}_{ij}. \]

The term \( c_{ij} \) is the proportion of decedent’s after-tax income that goes to dependents. It is equal to \( (S_i) + (1 - S_i) (1 - d_{ij}) \), where \( d_{ij} \) is the decedent’s consumption at age \( j \), and \( S_i \) is the family’s saving rate.\(^7\) \( Y^{**}_{ij} \) is the fringe component of market economic loss, \( Y_{ij} \) is the non-fringe component of market loss, and \( Y^{**}_{ij} \) is nonmarket loss.\(^8\) We separate out the three components of income because only the decedent’s market earnings \( (Y_{ij}) \) are taxed. The expression in parentheses therefore represents the after-tax income of the decedent.

In computing resource flows to decedents, nonmarket and market sources of income are treated equivalently. Just as individuals do not themselves consume all of their incomes, people do not personally consume all the nonmarket income they produce. The care of children, shopping, and cleaning the home are activities that produce consumption benefits to other members of the family besides the one performing the task. Analogously, many of the home activities that absorb time are made for investment purposes rather than current consumption. For example, a significant proportion of the time spent with children is an investment in their future human capital. The time spent on home repairs is for future consumption rather than the present. Investment in home repair will increase the future value of my house to my dependents.

Because we do not have good estimates of how the parameters may differ between nonmarket and market components of income, we

\(^7\)The derivation of the effective tax rate is explained in the next section. Using the estimates of Smith and Ward (1984), we assume a savings rate of .1062.

\(^8\)The decedent’s dependents also share in fringe benefits, such as a health plan. Even if the health plan does not explicitly provide for the health care of dependents, the income gain to the decedent for not having to buy a health plan is shared by dependents. This argument may not apply to all components of the fringe-benefit package, but we are not able to separate all components.
assume that the personal consumption component of nonmarket income is the same as that for market incomes, and families save at the same rate from nonmarket income as they do for market income.

A Note on Equivalence Methodologies

The Orchansky scale is derived from estimating the costs of purchasing nutritionally adequate diets for families of different sizes. Given these "objectively" determined minimally adequate diets, these standards were multiplied by three (since the share of food in total family consumption was approximately one-third when the index was developed). The Orchansky scale is the basis of the creation of the widely used poverty lines. The main disadvantage of the Orchansky scales is that they were derived mainly for comparisons among poorer families.

The BLS Scale was derived from a functional relationship between food expenditure and income. Use of this scale is based on the notion that families spending the same proportion of their disposable income on food act as if they have the same amount of total consumption. One of the oldest empirical findings in economics is that the fraction of food's share in total consumption declines as income rises. This monotonic relationship is the basis of the match between food share and income. For example, if at the same family-income level an additional child increases the food share, we must give the family enough additional income to drive down the food share to its original value. The BLS scale values are percentages to be applied to the total cost of consumption of the base family, which consists of four persons, that is, a husband of age 35–54, a wife, and two children where the older is between 6–15 years. See "Revised Equivalence Scale for Estimating Equivalent Incomes or Budget Costs of Family Types: Bulletin No. 1570–2," U.S. Department of Labor, Bureau of Labor Statistics.

A limitation of the Orchansky and BLS equivalence scales is that they are based on food consumption alone. In contrast, Lazear and Michael (1980) is based on a broader set of commodities. In the Lazear-Michael framework, different family sizes and composition are treated as "average price" differences to the family, i.e., it costs less per person to consume a unit of a shared good in a family of three than a family of two. Given estimated price and income elasticities, differences in expenditures associated with different family types and consumption can be translated into price differences across families. These cost-of-living differences are converted into real income differences across families. See Lazear-Michael (1980) for details.
VIII. TAXES

WHEN AND WHY TAXES SHOULD BE INCLUDED

The literature on computing economic loss shows considerable confusion on the issue of taxes. This confusion has various sources, including the different aims of the tort system; a failure to consider the role that taxes should play in calculating compensation; and a misunderstanding about their effect on income generated by the award. In part, the confusion stems from a failure to distinguish between taxes on the award itself and taxes on the income the award generates. In litigation, parties with an interest in the outcome often add to this confusion because they perceive that a particular solution will either increase or decrease the size of the award. In this section, we discuss the relationship between aims of the tort system and the role of taxes in calculating awards and present a method for incorporating taxes in those calculations.

Taxes enter our calculation of economic loss and compensation in a number of ways. First, a person is able to allocate support to his dependents only from his after-tax income. Only part of the decedent’s market and nonmarket income, however, is subject to tax. Taxes are paid on wages and salaries; but fringe benefits and all nonmarket income escape taxation.

Taxes must also be considered because the future incomes beneficiaries receive from compensation will be taxed. Sufficient compensation must be given to beneficiaries not only to replace their lost consumption but also to finance future tax liabilities that accrue from the compensation award.

Viewed from the perspective of estimating full value necessary to produce deterrence, taxes should not be part of the economic loss calculation. However, if the objective is compensating loss to survivors, taxes must be taken into account to fully and fairly compensate the decedent’s survivors. It is simply impossible to achieve the latter goal without examining tax implications.

For evaluating the contribution of the tort system to the deterrence objective, we need to estimate the full economic cost of a death. This full economic cost is correctly measured by the total before-tax market and nonmarket economic loss. This point can be demonstrated with market loss alone. Consider a decedent with $20,000 in earnings, from which he pays $6,000 in taxes. The firm employing this worker
presumably felt that this worker produced something worth $20,000. Given this, what is the societal loss when the death occurs? Obviously, society loses the $14,000 in take-home pay the decedent used to purchase goods and services for himself and his family. However, the $6,000 in taxes is equally a part of the social loss associated with this death. This $6,000 helped to pay for, among other things, schools, highways, and national defense. Thus, the real loss to society incurred by the death is the $20,000 this worker received at his firm, and that is the cost that should be imposed on the tortfeasor by whatever combination of legal, regulatory, and market forces to achieve full deterrence.

Matters are more complicated when we turn to the second objective—compensation, of loss to survivors. The goal of compensation is to leave the survivors as well-off as they would have been in terms of their lifetime consumption. Taxes enter this calculation in a variety of ways. First, the decedent provided consumption benefits to survivors only from his after-tax income. However, care must be taken in computing this after-tax income: Some parts of decedent’s market and nonmarket incomes are taxed, but others are not. Job-related salaries are subject to tax, but the fringe-benefit package is not. In our economy, for example, workers do not pay any taxes on their health and retirement benefits. In addition, because it does not flow through the formal labor market, none of the decedent’s nonmarket income can be taxed.

Second, taxes are a part of the calculation of compensation because the beneficiary will have to pay taxes on the future income generated by the compensation. Some people argue that because the compensation award itself is not taxed, taxes are irrelevant to the issue of compensation. That is a flawed argument because, even though the compensation award (principal) is not taxed, the income flow from it will be. Indeed, taxing both the award and the award-income flow would amount to double taxation.

Table 8.1 illustrates how far off the mark compensation can be when the effect of taxes is not calculated in loss to survivors. Because the miscalculations depend on how much of economic loss was originally taxed and how long into the future the economic loss endures, we highlighted those extremes in Table 8.1.

The numbers under the “One-Year Loss” column correspond to a one-year economic loss (for, say, an elderly person), while the numbers under the “Perennial” column represent an income loss that continues for each year into the future (for, say, a young person). The columns under each duration describe extremes: In one case, the decedent’s income was all market earnings (and thus fully taxed). In the other case, the income was all fringe and nonmarket income (and thus
Table 8.1
COMPENSATION IS INADEQUATE WHEN TAXES ARE IGNORED

<table>
<thead>
<tr>
<th></th>
<th>One-Year Loss</th>
<th>Perennial</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All Market</td>
<td>All Fringe and Nonmarket</td>
</tr>
<tr>
<td>Loss income per year</td>
<td>100,000</td>
<td>100,000</td>
</tr>
<tr>
<td>After-tax loss income</td>
<td>50,000</td>
<td>100,000</td>
</tr>
<tr>
<td>per year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumption to survivor</td>
<td>25,000</td>
<td>50,000</td>
</tr>
<tr>
<td>(1/2 of line 2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Award ignoring taxes</td>
<td>45,454</td>
<td>45,454</td>
</tr>
<tr>
<td>Award with correct</td>
<td>23,810</td>
<td>47,619</td>
</tr>
<tr>
<td>effect of taxation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incorrect compensation</td>
<td>+21,644</td>
<td>-2,165</td>
</tr>
</tbody>
</table>

untaxed). For our numerical examples, we assume that the discount rate is 10 percent, the tax rate is .50 percent, and the decedent gave half his after-tax income to his survivors.¹

For the one-year lost income, a decedent would have had a full income of $100,000. If that income was all market earnings, the after-tax income would be $50,000, of which the survivors would have received $25,000. If we ignore taxes in computing compensation, we would give half the decedent’s before-tax income to the survivor ($50,000). The compensation award would be $45,454 ($50,000 discounted at 10 percent). This award would overcompensate the survivor by $21,644.

Why does this overcompensation occur? It occurs because ignoring the taxes paid on the lost earnings of the decedent has a much larger impact than ignoring the taxes to be paid on the income generated by the award. When the economic loss occurs only in one period, most of the total compensation payment is principal (calculated on the basis of the untaxed market earnings) and not income generated by the principal. This “untaxed” principal produces the substantial overcompensation. To compensate the survivor for the actual loss of $25,000, the correct award is only $23,810. This award would generate an income of $2,381. If half of this is taxed, $1,191 remains in after-tax income from.

¹We assume for purposes of our example that the income is received at the end of the year.
the award. This $1,191 and the principal of $23,810 makes up the $25,000 required to compensate the survivor correctly.

The situation is quite different if a decedent’s income consisted entirely of untaxed fringe and nonmarket income. The survivor is now entitled to $50,000 (half the untaxed income of $100,000). The present value of the award ignoring taxes is $45,454. This is $2,165 less than the amount necessary to correctly compensate the survivor because the survivor must pay taxes of 50 percent on the $4,545 of income the compensation generated in the first year. We undercompensated in this case because, although none of the decedent’s income was originally taxed, the interest income from the award will be taxed.2

Table 8.1 illustrates that the chances of undercompensation increase significantly for younger decedents. If all the decedent’s income consisted of fringe benefits and nonmarket income, and thus untaxed, the survivor is entitled to $5,000 a year. If we ignore the tax implications, the compensation award is $50,000, which provides a before-tax income stream of $5,000. But the survivor will pay tax on this income leaving him only $2,500 to replace the decedent’s original $5,000 contribution. Hence, the correct compensation is actually $100,000. Ignoring taxes on the award-generated income makes the compensation half as large as it should have been.3

These examples indicate that the effect of taxes must be included in calculating compensation to survivors. Not doing so is analytically incorrect in that it fails to correctly compensate survivors. It is also inequitable because beneficiaries regarded by the law as equally deserving would not, in fact, be treated equally.

Our tax treatment addresses three issues: the computation of family income, the selection of effective tax rates, and the computation of future tax liabilities.4

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2The correct award would be $47,619, which generates an after-tax income of $23,810. With the principal of $47,619, this equals $50,000.

3If the decedent’s income consisted entirely of market earnings and the tax rate is 0.50 in the perennial case, the two tax effects wash out. Ignoring the taxes on the award results in twice the value of the loss, but ignoring the taxes paid on the income generated by the award yields one-half of the compensation.

4One possible way to incorporate taxes is to use a single after-tax discount rate. For example, if the pre-tax discount rate is 3 percent and the tax rate was 50 percent, an after-tax discount rate of 1.5 percent could be used. The difficulty is that some components of loss were originally not taxed (fringes and nonmarket loss), so that these must be discounted at a different rate. In addition, because of rising income levels over time, the discount rate would vary from period to period. While appealing, the simplification of using a single after-tax rate would not, in general, give the right answer.
COMPUTATION OF FAMILY INCOME

Taxes are a function of family income and not simply the income of the decedent. Thus, we must know family income in order to apply the correct tax rate to the decedent's income, and to estimate the tax liability of his beneficiaries and the taxes on award-generated income. Because one calculation refers to events before the accident and the second to postaccident realities, two different family incomes must be derived to obtain correct tax rates.

Family incomes represent the sum of a number of distinct income types, including the labor-market earnings of each individual family member as well as a diverse set of nonearnings income components (i.e., interest, dividends, and pensions). Because the claims files contain very little data on incomes other than decedents' incomes, we were limited in our ability to directly assign family incomes. Only 294 decedents reported nonsalaried family income, and the claims data allowed us to retrieve only 130 useful cases of spousal incomes. Thus, we were forced to rely on more indirect methods to impute family incomes in most cases.

Because our imputation assumptions are so different, we discuss our procedures for pre- and postfamily incomes separately. However, Table 8.2 indicates the sources we used to impute family incomes for both procedures.\(^4\)

Preaccident Family Incomes

For simplicity, we assume that preaccident family income is the sum of the decedent's income, the income of a spouse, and the nonsalaried income of the family (i.e., income from stocks, bonds, pensions, etc). Once we account for the decedent's income, the largest remaining component of preaccident family income is spousal income. For married decedents, we used three sources to estimate spousal incomes: information in the claims file, estimations already made for full economic loss, and 1980 Census estimates. The most accurate measurement involved those married couples who were both killed in the crash (566 of the decedents). Since each spouse appears separately in our files as a decedent, we assigned spousal income values by merging the corresponding

\(^4\)All subcases in Table 8.2 have one element in common. If they contain one of the 294 cases who reported nonsalaried family incomes, this income was assigned from the claims file. For this subset of decedents, this present and future nonsalaried income was added to total family income in both its pre- and postaccident manifestation. As we did for salary growth, we assumed that nonsalaried income would grow at the economy-wide income growth rate of 1.9 percent.
Table 8.2

SOURCES USED TO ASSIGN OTHER FAMILY INCOME

<table>
<thead>
<tr>
<th>Preaccident Other Family Income</th>
<th>Postaccident Other Family Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Married, spouse dies in accident</td>
<td>Spouse's income already estimated*</td>
</tr>
<tr>
<td>Married, with spousal income on claims file</td>
<td>Spouse's income on file</td>
</tr>
<tr>
<td>Married, no income on claims file</td>
<td>1980 Census estimates</td>
</tr>
<tr>
<td>Single</td>
<td>N.A.</td>
</tr>
</tbody>
</table>

*Because spouse also died, income was already calculated for full economic loss.

income streams computed for decedents. The sum of lost incomes of the two dead spouses determines which effective tax rate to apply.

For another 130 decedents, the claims files contained incomes in the accident year for the surviving spouse. To calculate future spousal incomes, we employed the same rules used to project decedent’s income into the future. Accident-year spousal incomes were updated using our standard life-cycle and calendar-year salary growth assumptions. In addition, our standard worklife discounts were applied to these projected spousal incomes.6

For the remaining married decedents, the files contained no information on spousal incomes. Family incomes were estimated for these cases using the 1980 U.S. Decennial Census. The 1980 Census sample of married couples was stratified by age, education, and current work status of each spouse. For example, when the decedent was a woman, the Census stratification was based on the age, education, and labor-force participation of the wife. When the decedent was a man, the Census stratification was based on the husband's attributes. Within each age, education, and work-status cell, we calculated arithmetic means of other family income—family income minus the income of the spouse on whose attributes we stratified. Based on the decedent’s age, education, and work status, we assigned values of other family income for the accident year. Future annual spousal incomes were derived by applying our calendar-year income growth rate to this base-year spousal income. Future values of spousal incomes are

6For example, if the decedent was male, we applied the worklife discounts for women to the spousal income.
\[ FY'_{t} = \rho'_{t} FY + (1 - \rho)_{t} FY' (1 + g)^{-t} \]

where \( \rho'_{t} \) is the probability that the decedent will be working in year \( t \), given his work status at the time of the accident. \( FY' \) and \( FY \) are the other family incomes of workers and nonworkers, respectively, in year \( t \), and \( g \) is calendar-year income growth.\(^7\)

Postaccident Family Income

In calculating the correct compensation, we are attempting to give beneficiaries sufficient income to maintain the same consumption level they would have received from the decedent. Although the award is not taxed, the income from the award will be taxed. To determine if the income from the awarded compensation is sufficient to replace the lost consumption, it is necessary to compute the future tax obligations that will be incurred. Postaccident family income is the sum of the family income of the primary beneficiary, the income from the award, and any reported nonlabor income of the family.

Table 8.2 lists the sources we used to estimate postaccident family incomes. If a spouse was still alive after the accident, the beneficiary's income is equal to the preaccident spousal income. Such cases correspond to the second and third rows of the table. We had to compute a beneficiary family income when both spouses died or when the decedent was unmarried. To compute beneficiary family income, we once again used the 1980 Decennial U.S. Census files. At each age, mean family incomes of married couples were calculated. Given the age of the primary beneficiary, we assigned them this age-specific family income. Future-year values were obtained by applying our calendar-year income growth to this base-year beneficiary income.

Decedents usually have more than one beneficiary, and the total compensation award must be divided among the beneficiaries. In principle, a separate income of each beneficiary should be computed, with a different tax rate applied to each beneficiary. We simplified this process by "assigning" a primary beneficiary to each decedent. For the purposes of computing the relevant tax rate only, we assumed that the award was received entirely by the primary beneficiary. Table 8.3 indicates the order of relationship we used to select the primary beneficiary: surviving spouse, juvenile child, adult child, etc.

\(^{7}\)This formula implicitly includes normal life-cycle salary growth and worklife discounts of the spouse. Life-cycle and labor-supply variation are built into the age-specific means.
Table 8.3
ORDER FOR DETERMINING PRIMARY BENEFICIARY

<table>
<thead>
<tr>
<th>Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spouse</td>
</tr>
<tr>
<td>Juvenile child</td>
</tr>
<tr>
<td>Adult child</td>
</tr>
<tr>
<td>Parent</td>
</tr>
<tr>
<td>Juvenile sibling</td>
</tr>
<tr>
<td>Adult sibling</td>
</tr>
<tr>
<td>Grandchild</td>
</tr>
<tr>
<td>Other relative</td>
</tr>
<tr>
<td>Separated or exspouse</td>
</tr>
<tr>
<td>Grandparent</td>
</tr>
</tbody>
</table>

CALCULATION OF TAX RATES

To calculate tax obligations, we must be able to map average tax rates onto family income levels. This is challenging because alternative sources of income are treated differently and allowances are made for many expenses and deductions. We obviously do not have access in this project to the kind of information required to calculate a decedent's actual tax liability. Our problem is complicated further because the tax system has gone through a number of significant alterations during the years spanned by the airline crash data. In the Reagan presidency alone, two radical changes in the federal tax code were legislated. Further, we also confront a system of 50 ever-evolving state tax codes.

We had to simplify this problem by relying on accurate average tax rates for individuals whose family incomes were similar to our decedents' incomes. Fortunately, each year, the IRS publishes effective tax-rate tables stratified by adjusted family incomes and the number of exemptions claimed. Effective tax rates are average tax payments divided by adjusted incomes.\(^8\)

Table 8.4 lists the effective tax rates for tax year 1974 for a family with four exemptions. Among such families with incomes of $10,000, taxes paid were roughly 8 percent of family income. Among families with $50—$100,000 incomes, tax rates rose to 25 percent, and those with incomes above $1 million paid rates over 50 percent. This pattern of rising effective tax rates characterized all yearly tax tables published

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\(^8\)The tables also list the total wage and salary income reported along with the number of taxpayers reporting wage and salary income. These two numbers allow us to calculate the mean wage and salary income within each total income bracket.
by the IRS during the 1970s. In fact, our inspection of these tables indicated that the average tax rate was reasonably stable as a function of inflation-adjusted family incomes. Using this stability as our justification, we relied on federal tax rate tables for a single year, 1974. This 1974 effective tax rate table was converted to 1986 dollars, the same nominal units in which all incomes are expressed.9

Because state rates are so much lower than federal rates, we simplified even further to compute the relevant effective state tax.10 The information available to us on state taxes was a summary description of the system operating in each state.11 Appendix Table B.2 describes the marginal tax rates associated with taxable income brackets, as well as the size of standard deduction and the allowance for personal

Table 8.4
EFFECTIVE FEDERAL TAX RATES FOR FOUR EXEMPTIONS
(Tax year 1974)

<table>
<thead>
<tr>
<th>Family Income</th>
<th>Mean Wage and Salary Income</th>
<th>Tax Rate</th>
<th>Family Income</th>
<th>Mean Wage and Salary Income</th>
<th>Tax Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-3</td>
<td>2,508</td>
<td>.03</td>
<td>13-14</td>
<td>13,279</td>
<td>9.72</td>
</tr>
<tr>
<td>3-4</td>
<td>3,778</td>
<td>.02</td>
<td>14-15</td>
<td>14,270</td>
<td>10.38</td>
</tr>
<tr>
<td>4-5</td>
<td>4,628</td>
<td>.72</td>
<td>15-20</td>
<td>16,795</td>
<td>11.62</td>
</tr>
<tr>
<td>5-6</td>
<td>5,498</td>
<td>2.29</td>
<td>20-25</td>
<td>21,168</td>
<td>13.55</td>
</tr>
<tr>
<td>6-7</td>
<td>6,521</td>
<td>3.95</td>
<td>25-30</td>
<td>25,197</td>
<td>15.03</td>
</tr>
<tr>
<td>7-8</td>
<td>7,492</td>
<td>5.33</td>
<td>30-50</td>
<td>32,296</td>
<td>18.09</td>
</tr>
<tr>
<td>8-9</td>
<td>8,562</td>
<td>6.51</td>
<td>50-100</td>
<td>47,490</td>
<td>25.50</td>
</tr>
<tr>
<td>9-10</td>
<td>9,337</td>
<td>7.49</td>
<td>100-200</td>
<td>80,882</td>
<td>33.82</td>
</tr>
<tr>
<td>10-11</td>
<td>10,399</td>
<td>7.99</td>
<td>200-500</td>
<td>123,976</td>
<td>39.60</td>
</tr>
<tr>
<td>11-12</td>
<td>11,271</td>
<td>8.54</td>
<td>500-1000</td>
<td>186,297</td>
<td>45.14</td>
</tr>
<tr>
<td>12-13</td>
<td>12,297</td>
<td>9.30</td>
<td>More than 1000</td>
<td>384,862</td>
<td>56.17</td>
</tr>
</tbody>
</table>

*Incomes expressed in thousand-dollar intervals.

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9We linearized between the brackets in Table 8.4 to associate each real family income with a specific federal tax rate.

10Descendants were assigned their state of residence at their death.

11To maintain comparability with our federal codes, we used the 1974 description of the state systems. Our inspection of these state tax tables in other years did not indicate the same stability (in real dollars) in these states codes. Most states did adjust their state codes to compensate for inflation. In these states, we followed our federal procedure by expressing the nominal values in Table A.2 in March 1986 dollars. Some states, however, maintain nominal rate stability over this period. When we computed tax rates for these states, we first adjusted income into the nominal dollars for that year. After 1986, however, we assumed that all states maintain an inflation-adjusted dollar tax code.
exemptions. We give the decedent the standard deduction, and because we knew his family composition from the claims files, we assigned the number of personal exemptions. After subtracting these allowances, we used the taxable income brackets and the marginal tax rates in the first two columns of Appendix Table B.2 to assign an effective average state tax rate.\textsuperscript{12}

**INCORPORATING TAXES IN CALCULATING COMPENSATION**

Because decedents allocated resources to their dependents from after-tax incomes, the first step involves computing the present discounted value of the after-tax income. From this income, a certain fraction $\delta_i$ is allocated in each period to the decedent's dependents. This fraction is the year-by-year value of the adjustment for personal consumption offset we described in the previous section. The present value of the lifetime allocation to dependents is

$$\text{equal to } PV^* + \sum_{i=1}^{N} \frac{Y^A_i (1-t^*) \delta_i}{(1+r)^i} + \sum_{i=1}^{N} \frac{Y^B_i \delta^i}{(1+r)^i}$$

where $Y^A_i$ is decedent's year $i$ income that was subject to tax, and $Y^B_i$ is decedent's income in year $i$ that was untaxed (i.e., fringe benefits and the full amount of nonmarket income). Using our imputed decedent's family incomes in each future period, the sum of the federal and state effective rates ($t^*$) relevant for that family income level is retrieved and applied only to the taxable part of the decedent's income.

The beneficiary's family income, including the income flow from the award, determines the effective tax to use for the tax obligations from the compensation award. Since we must know total compensation to obtain the award income flow, the solution for compensation must be determined interactively. In addition, we must make an assumption about the pattern by which beneficiaries consume from the award—a pattern that determines each period's remaining principal from the original award and therefore the age-specific award income.

For this sequence, we invoke the permanent income hypothesis. According to this theory, lifetime wealth (or permanent income) rather than current income is the determinant of family consumption. Thus, current income levels that exceed permanent income will be saved, while those that fall short will lead to dissaving. In the extreme,

\textsuperscript{12}We assumed that the marginal tax rates in column one and the taxable brackets were mapped by two linear functions.
individuals will smooth lifetime fluctuations in income by consuming a constant consumption flow. Since the present value of consumption expenditures equals the present value of after-tax wealth, we can solve for the beneficiaries' constant consumption flow per period \( (C_p) \).

\[
P V^* - \sum_{i=1}^{\infty} \frac{c_p m_i}{(1+r)^i}
\]

\[
c_p = \frac{P V^*}{N}
\]

where \( N = \sum_{i=1}^{\infty} \frac{m_i}{(1+r)^i} \)

where \((1 - m_i)\) is the probability of surviving to period \(i\) and \(r\) is the discount rate.

The compensation award must allow the beneficiaries to consume a constant flow of \( C_p \). To illustrate, let \( A \) be the compensation award (or, equivalently, the principal in period 0). At the end of the next period \( (P_1) \), the beneficiary will consume \( C_p \), earn \( r(P_0 - C_p/2) \) in before-tax income for the award, and pay \( t^*(r(P_0 - C_p/2)) \) in taxes.\(^{13}\)

The tax rate \( t^* \) is computed from the beneficiaries' total income in that period. Therefore, the principal remaining from the award at the end of the period is \( (P_0 - C_p) + r - t^*r(P_0 - C_p/2) \).

A similar process continues into the next and subsequent periods, as the beneficiaries draw down their original award. The constraint imposed is that the remaining principal in the last period is zero. That is, beneficiaries have nothing remaining from their awarded compensation after consuming \( C_p \) each period. The sequence of the remaining principal can be described as

\[
t = 0 \quad A \text{ (award)} = P_0
\]

\[
t = 1 \quad P_1 = (P_0 - C_p) + r(P_0 - C_p/2) - t_1^*(r(P_0 - C_p/2))
\]

\[
t = 2 \quad P_2 = (P_1 - C_p) + r(P_1 - C_p/2) - t_2^*(r(P_1 - C_p/2))
\]

\[^{13}\text{We assume that consumption is even over the course of the year.}\]
\[ t = N \quad P_N = (P_{N-1} - C_p) + r \left( P_{N-1} - C_p/2 \right) \]
\[- t_{N-1}^* (r(P_{N-1} - C_p/2)) = 0 \]

Because effective tax rates change with each award, we interact on alternative compensation amounts until the final period principal is zero.\(^{14}\)

\(^{14}\)We start with an initial award value equal to \(PV^*\). If that value yields a positive \(P_N\), we reduce the award in increments of \$100,000 until the final period value is negative. We then reverse directions, adding \$10,000 to the award until \(P_N\) is positive. We reverse once again in increments of \$1,000 until \(P_N\) becomes positive. This value is computed compensation. A reversed procedure is used if the initial value produced a negative \(P_N\).
IX. DISCOUNT RATE

Because a lump-sum compensation payment is typically made on the
day of the settlement or at the conclusion of litigation, a discount rate
must be selected to compute economic loss.\textsuperscript{1} Since a plaintiff can earn
interest on the award, he would effectively be overcompensated if he
were paid one dollar for every one dollar loss in the future.\textsuperscript{2} Discounting
expresses future-year economic losses in terms of their present
worth.

Although economists agree universally that discounting is necessary,
which actual discount rate to use has been controversial. In part, such
controversy is inevitable because economists have not reached a con-
sensus on the appropriate discount rate. The absence of consensus is
compounded by the myriad interest rates that exist at any given time.
Every day the financial pages of the \textit{Wall Street Journal} contain a
variety of interest rates that vary according to their maturity, tax
treatment, and degree of risk. The confusion is enhanced by interested
parties to the litigation who are fully aware of the impact that discount
rates have on the computed award. Fortunately, some of the debate
that centers around the choice of an interest rate can be resolved by
applying sound economic reasoning to the problem.

The role of inflation is one issue that has unnecessarily confused
some courts. The inflation issue arose with renewed force during the
1970s when double-digit inflation rates became commonplace. Along-
side such inflation rates one found, of course, interest rates in double
digits. Some courts refused to adjust discount rates based on expected
future inflation on the grounds that estimates of future inflation were
too "speculative." Unfortunately the same courts, often using the same
"speculative" argument, would disallow salary growth. Such a view was
based on incorrect scientific reasoning and would undercompensate
survivors.

To see this, one must recognize the basic distinction between nomi-
nal and real interest rates. Almost all interest rates quoted in news-
papers are nominal rates, promises to pay a specified number of dollars
in the future. In contrast, a real interest rate is a promise to pay a

\textsuperscript{1}Structured settlements were made in only 3 percent of our cases.
\textsuperscript{2}In \textit{Chesapeake \\& Ohio R. Co. v Kelly}, it was held that "in all cases where it is reason-
able to suppose that interest may safely be earned upon the amount that is awarded, the
ascertained future benefits ought to be discounted in the making up of the award" (96
return in inflation-adjusted dollars. The link between the nominal and real rates is the expected rate of inflation. For example, assume that in a zero-inflation environment, the nominal and real interest rates were 3 percent. If everyone expected inflation to rise 5 percent per year, the nominal rate would increase to 8 percent. At a 5-percent inflation rate, borrowers would now be willing to pay an 8-percent yield because the dollars they will have to pay back in the future are 5 percent less valuable. Similarly, because they realize that the future dollars they receive will be worth 5 percent less, lenders would demand an 8-percent nominal yield. As this simple numerical example illustrates, the nominal interest rate equals the real interest rate plus the expected rate of inflation.

Some courts failed to realize that existing nominal rates of interest already incorporate a "speculation" about the rate of inflation. Nominal rates of interest were high in the late 1970s because inflation rates were high. To use a nominal interest rate (which reflects inflation) and to simultaneously disallow the impact of inflation on salary growth is a simple error in logic.

Fortunately, the majority of courts did not make this error and insisted on a consistent treatment of inflation. There are two ways inflation can be entered into our computation of the interest rate. First, future earnings of the decedent can be calculated by adjusting base-year earnings by all expected salary increases, including those due to merit and inflation. These future nominal dollar losses can then be reduced to present value using a nominal market rate of interest. (This approach is consistent in that both salary growth and discount rates are expressed in nominal dollars.) Equivalently, one can, as we do in this study, express salary growth in inflation-adjusted dollars. To be consistent, it is then necessary to adjust the nominal interest rate downwards by expected rate of inflation in order to use a real interest rate to discount. This approach is also consistent in that both salary growth and discount rates are expressed in inflation-adjusted dollars.

---

3In O'Shea v Riverway Towing Co., the Court ruled that "inflation should be treated consistently in choosing a discount rate and in estimating future lost wages to be discounted to present value using that rate, since it is illogical and indefensible to build inflation into the discount rate yet ignore it in calculating the lost future wages desired to be discounted" (877 F.2d 1194, 1989).

4In O'Shea v Riverway Towing Co., the opinion of the Court was that the projection using this approach "would not require gazing into a crystal ball" since the expected rate of inflation can be "read off from the current long-term interest rate." It held that "if that rate is 12 percent, and if . . . the real or inflational free interest rate is only one to three percent, this implies that the market is anticipating 9-11 percent inflation over the next 10 years" (at 1190).

5The adjustment follows from the equation stating that nominal rates equal real rates plus the expected rate of inflation.
In this study, we follow this approach and discount future economic losses using a real rate.

In a landmark case (*Jones and Laughlin Steel Corp. v. Pfeifer*), the Supreme Court explicitly addressed the problem of incorporating inflation into a prospective damage award (103 S.Ct. 2541, 1983; George, et al., 1984; Maxwell, 1984). In the Pfeifer case, the Court approved the use of real interest rates, holding that it would not reverse a trial court’s decision if it adopts “a rate between one and three percent and explains its choice.” This approach may have originated in an earlier case (*Feldman v Allegheny Airlines, Inc.*, 1975), where the trial court used a 1.5 percent “inflation-adjusted” discount rate. In the O’Shea case (677 F.2d 1194, 1982), the Court also ruled that a real rate of interest between one and three percent “would not be outlandish even if there were no inflation.”

The next issue concerns interest rate maturity. For a variety of reasons (including expected rates of inflation), yield curves vary with the maturity of the bond. For example, at the present time, yields on thirty-year bonds are higher than rates on one-year bonds. Choosing the correct maturity to use depends on the specifics of the case. The maturity of the discount rate should reflect the time period over which we wish to compensate survivors. For more elderly decedents, that principle would argue for a relatively short-term bond reflecting their future life expectancy. For young decedents, the correct maturity could be as long as 50 to 70 years. Because we wanted to select a methodology common to all cases, these arguments suggest a long-term maturity of 30 years or more.\textsuperscript{6}

\textsuperscript{6}The Court recognized that since “inflation has been a permanent fixture in our economy for many decades” and that “inflation rates have not remained low,” inflationary trends should be considered in awarding damages. Three methods of adjusting for inflation were discussed in Pfeifer although the Court did not prescribe any one method by which the effects of inflation on awards must be considered. In addition to the two discussed in the text, the third method known as the Alaska method assumed that the market interest rate is completely offset by future inflation. Hence, discounting of future earnings was not necessary. A shortcoming of this method is that wages are assumed to increase at the same rate as the market interest rate, ignoring the fact that incomes in some occupations grow faster than the inflation rate, while in others they rise more slowly. It also ignores the fact that the earnings of certain individuals tend to grow faster than that of the average worker, while the earnings of other older workers grow slower.

\textsuperscript{7}This rate was arrived at by subtracting the average yearly price changes over the prior 18-year period from the annual interest to be derived from a safe, nonsophisticated investment (George et al., 1984; Maxwell, 1984).

\textsuperscript{8}The issue of what market interest rate to use also depends on how the plaintiff would invest the award. Greater difficulty in projecting productivity and inflation in the more distant future favors investing in safe short-term securities. However, this still means that future rates of reinvestment when they mature, transactions costs, and future market interest rates must be calculated too. It is believed that long-term securities
The final issue concerns the degree of risk. No investment, no matter what its form, is completely devoid of uncertainty, but some are riskier than others. As events of the last year aptly demonstrate, only those with a strong constitution should have a substantial part of their portfolio in stock market equities. Severe swings in the Dow-Jones Index take place not only year to year, but often on a daily basis.

Bonds are generally viewed as safer than stocks, but there are myriad bonds available at any one time. Some bonds carry a substantial risk premium to offset the possibility of default. The yield on bonds issued by major U.S. corporations is more certain, and U.S. government bonds are generally viewed as among the most secure. But all bonds, including those of the U.S. Treasury, carry some risk because they represent a promise to pay in nominal dollars. If inflation increases to levels above what people originally expected, nominal interest rates will rise and prices of previously issued bonds will decline. Thus, bondholders face the prospect of a capital loss even on the so-called safest bonds.

The issue of risk must also account for the uncertain income streams we are trying to replace in a wrongful death case. Very few of us have our salaries specified and guaranteed far into the future. In calculating damages, we have used expected future incomes, but these incomes were by no means certain. At a conceptual level, investments that have a similar degree of risk to the income stream we are replacing may be appropriate. The rate of return in stock market equity is carry a yield premium, given risk aversion to capital losses due to less-than-perfect forecasting. Interest rates return to their "normal" level in the long run, with yields being higher on long- relative to short-term securities when interest rates are relatively low, because long-term securities are then subject to capital losses. When interest rates are relatively high, the opposite would be true (Modigliani and Sutch, 1966).

In essence, if there was a truly safe financial investment, risk-averse plaintiffs would accept a certain stream of lower present value than the present value uncertain stream that is to be replaced.

Some experts have argued that these risk considerations imply that the rate of return to human capital investments (such as education) should be used to discount earnings losses in wrongful death cases. The essence of their argument is that human capital is a risky investment (far riskier than other physical investments). The excess of the estimated rate of return to education (6.5 percent based on Smith-Welch, 1984) over the long-term real interest rate terms in this view represents a premium to the more risky human capital investment. This line of reasoning is unpersuasive. First, there are many reasons the rate of return to human capital may be high, including omitted ability differentials associated with different years of schooling. Most important, the primary risk associated with human capital investments surely reflects how much human capital these prior investments (such as education) produced. But for a 40-year-old worker (the typical decedent in our sample), his human capital is already in place (as indexed by his income). Thus, any risk premium associated with prior education decisions are irrelevant to our problem. Because we condition on a largely in-place stock of human capital, the rate of return to education is simply not informative about the real risk faced
clearly not right because stock market variability significantly exceeds the salary variability of the average worker. But, again, even the so-called safest bonds contain elements of risks. It is not at all clear whether the income uncertainty faced by the typical worker is greater or less than that of the "safe" bonds (with their inflation risk). For this reason, we adopt the concept of the relatively risk-free interest rate.\textsuperscript{11}

Lending some support to our decision, the courts have spoken in virtually one voice on the issue of risk, also opting for the selection of a "risk-free" interest rate or as close to a risk-free investment as can be obtained. For example, in the landmark Jones and Laughlin case, the court wrote "the discount rate should be based on the rate of interest that would be earned on the best and safest investments," and that an injured worker "is entitled to a risk-free stream of future income to replace his lost wages; therefore, the discount rate should not reflect the market's premium for investors who are willing to accept some risk of default." With this in mind, the Supreme Court stated: "we do not believe a trial court adopting such an approach [real interest rate]... should be reversed if it adopts a [discount] rate between one and three percent and explains its choice."\textsuperscript{12}

Our discussion of the principles regarding discount rate suggests that we select a relatively safe long-term real interest rate appropriate to the period of the mid- and late 1970s, the time relevant to our air-crash sample. These are the considerations that also led the Supreme Court to suggest a rate between 1 and 3 percent. Unfortunately, our certainty about the principles is not matched by certainty in the empirical economics literature about the magnitude of the rate. In our calcula-

\textsuperscript{11}Our assumption is appropriate for the average decedent. Clearly, there are some people with widely variable income streams (a stockbroker on commission would be a good example). For these workers, the choice of the appropriate risk of the investment instrument is more problematic. In such cases, one could argue for a discount rate with some risk premium built in. Unfortunately, there do not appear to be any reliable estimates in the literature of what the size of the risk premium might be.

\textsuperscript{12}Similarly, the Second Circuit, in an aviation accident case, stated "this Court has suggested that a 1-1/2 to 2 percent [discount] rate would be appropriate." \textit{Woodbury v. Garrett Corp.}, 813 F.2nd 643, 558 (2d Cir. 1987).
tions, we use a long-term discount rate of 2.75 percent, which Feldstein and Summers (1978) estimated for the period 1954–1976.\(^\text{13}\)

\(^\text{13}\)Of the many studies we read on this subject, our judgment was that this study provided the soundest scientific basis for estimating the real interest rate at the time of the aviation crashes. Their long-term interest rate was an average of yields on new issues of high-grade corporate bonds, while the predicted inflation rate is the weighted average of ten years of quarterly forecasts, where the weights reflect discounting of future inflation. Their real interest rate was the difference between the average yield and average inflation.

Real interest rates in 1987 are somewhat higher than those at the time of these air crashes. Because we recognize that there is some legitimate dispute about the correct magnitude of the real discount rate, we perform a sensitivity analysis using rates 1 percent higher and 1 percent lower than our best estimate of 2.75 percent in our actual calculations for the airline crash sample. See the companion volume by King-Smith (R-3551-ICJ).
X. SPECIAL CASES

There were two groups of decedents in this study for whom some unique issues arise in computing total economic loss and compensation to survivors: foreign decedents and juvenile children. This section summarizes the differences in treatment that emerged for these cases.

FOREIGN DECEDENTS

Among the decedents in our sample, there were 327 foreign nationals, representing 15 percent of all cases. These foreign residents presented special problems because they come from 40 different countries. Table 10.1 indicates that almost two-thirds were citizens of the high-income industrial countries in Western Europe, Australia, Canada, Japan, and New Zealand, while the remaining one-third were from lower-income countries. It would have been impossible to develop a separate set of assumptions and to compile data specific to each of these 40 countries. For the most part, therefore, our computation method for foreign decedents is the same as for U.S. cases. However, the input data for our computations vary across these countries in three important respects: base-year incomes, calendar-year economic growth, and fringe rates.

Table 10.1

<table>
<thead>
<tr>
<th>Country Group</th>
<th>All</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>327</td>
<td>182</td>
<td>145</td>
</tr>
<tr>
<td>Developed countries</td>
<td>69.1</td>
<td>67.6</td>
<td>71.0</td>
</tr>
<tr>
<td>Less-developed countries</td>
<td>30.9</td>
<td>32.4</td>
<td>29.0</td>
</tr>
</tbody>
</table>

1*Developed countries* include Australia, Austria, Belgium, Canada, Denmark, France, West Germany, Great Britain, Greece, Israel, Italy, Japan, the Netherlands, New Zealand, Norway, Saudi Arabia, Sweden, and Switzerland. "Less-developed" countries include American Samoa, Argentina, the Bahamas, Brazil, Colombia, Costa Rica, Ecuador, Honduras, Hong Kong, India, Indonesia, Iran, Ireland, Jamaica, South Korea, Mexico, Nigeria, the Philippines, Portugal, Puerto Rico, Syria, Venezuela, Virgin Islands, Western Samoa, and Yugoslavia. How this classification was obtained is explained in footnote 3 below.
In assigning base-year incomes, our main difficulty in assigning base-year incomes was that 60 percent of foreign decedents did not have income reported in the claim files. For these cases, incomes had to be obtained from external sources. Our imputation of foreign citizens' base-year salaries was based on the same CPS estimated wage equations for U.S. residents described in the base-year income section earlier. However, the standard of living of many of these countries differs substantially from that in the United States. To account for these differences, our salary predictions were adjusted by the fraction of country-specific GNP per capita relative to U.S. GNP per capita.

The average base-year earnings for foreign decedents are presented in Table 10.2. These salaries are also listed separately for those foreign nationals who reported their incomes and for those whose incomes were imputed. On average, the earnings of foreign decedents are roughly 60 percent of those of U.S. decedents. However, the need to impute so many base-year incomes did create some problems. While the ratio of imputed to reported incomes is about a third for both foreign and U.S. citizens, the larger proportion of foreigners with imputed incomes implies that the imputation has a much greater effect on average foreign incomes. While 42 percent of U.S. citizens had their incomes imputed, 60 percent of all foreigners did.

The serious consequences of imputation are most apparent for residents of less-developed countries. The reported incomes of such male decedents were over $52,000 but we impute an income of only about $6,500. Even more than U.S. airline passengers do, airline passengers from less-developed countries represent a very select sample of their countrymen. These comparative results for reported and

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3 Many foreign decedents who did report their incomes did so in the currency of their home country. We used exchange rates for the calendar year at the time of the income to convert to U.S. dollars.

4 1962 GNP levels were used. The countries grouped as developed have a GNP per capita ratio from .5 to 1.3; the ratio for the less-developed countries range from .02 to .4 (World Bank, 1984). We chose this method of imputation because published data on wages and earnings in the 40 countries differ so much in the manner that they are reported that they are not consistent with each other (United Nations, 1984). For example, these salaries are expressed as monthly, weekly, or hourly wages, but the numbers of weeks or hours worked are not always available or consistent with the group for whom earnings are reported; salaries are usually reported for production workers in manufacturing industries, but not for other workers; sometimes the reported wages include men and women, but often they refer only to men. Finally, they were not available for seven countries included in our sample.

5 In spite of this bias, we probably understated the incomes of foreign residents of developed countries more than we understated the incomes of U.S. citizens. A much larger fraction of incomes are imputed for developed countries. As a consequence, the mean incomes of less-developed and developed foreign country citizens are not very different.
assigned incomes in Table 10.2 suggest once again the necessity of conducting a sensitivity analysis of our salary imputation procedure on our loss estimates.

The second difference in our treatment of foreign residents involved fringe-benefit rates. Many foreign countries, particularly those in Western Europe, appear to offer fringe-benefit packages that are much more generous than in the United States. For this project, fringe-benefit rates were based on unpublished tables obtained from the Bureau of Labor Statistics (BLS). These data represent manufacturing sectors of 34 countries for the period 1975–1985. In most countries, industry-specific data are also available. Over this period, these rates index the full range of fringe benefits of workers, including paid vacations and sick leaves. To make these rates comparable with our definition for the United States, the fraction attributable to paid vacations

Table 10.2

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean Reported</th>
<th>Mean Imputed</th>
<th>% Imputed</th>
<th>Total Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All U.S.</strong></td>
<td>69,921</td>
<td>22,570</td>
<td>42.4</td>
<td>49,851</td>
</tr>
<tr>
<td><strong>Men</strong></td>
<td>85,987</td>
<td>25,787</td>
<td>33.9</td>
<td>65,659</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td>81,785</td>
<td>19,286</td>
<td>24.9</td>
<td>57,902</td>
</tr>
<tr>
<td><strong>All Foreign</strong></td>
<td>48,578</td>
<td>17,704</td>
<td>60.2</td>
<td>29,978</td>
</tr>
<tr>
<td><strong>Men</strong></td>
<td>58,236</td>
<td>23,971</td>
<td>47.2</td>
<td>42,045</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td>21,309</td>
<td>12,848</td>
<td>76.6</td>
<td>14,532</td>
</tr>
<tr>
<td><strong>Developed</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Countries</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Men</strong></td>
<td>62,694</td>
<td>27,948</td>
<td>56.9</td>
<td>42,924</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td>19,492</td>
<td>15,718</td>
<td>79.6</td>
<td>16,488</td>
</tr>
<tr>
<td><strong>Less-Developed</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Countries</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Men</strong></td>
<td>52,742</td>
<td>6,588</td>
<td>27.1</td>
<td>40,233</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td>34,243</td>
<td>4,735</td>
<td>69.0</td>
<td>10,782</td>
</tr>
</tbody>
</table>
and paid leaves was eliminated from the total rate.\textsuperscript{5} Table 10.3 illustrates the range of adjusted fringe-benefit rates obtained for the included countries.\textsuperscript{6}

The third distinction made for foreign residents involved calendar-year salary growth. The countries in our data experienced very different rates of economic growth. Since 1950, while real wages in Hong Kong expanded by more than 6 percent per year, per capita income in India stagnated with an economic growth of 1 percent per year. Given this variability, it would be incorrect to assign citizens of these countries the U.S. calendar-year economic growth. Based on the country of residence, foreign decedents were assigned their own country-specific adjusted rate of growth.\textsuperscript{7} These adjusted growth rates are listed in Appendix B.

Table 10.3
FRINGE-BENEFIT RATES IN OTHER COUNTRIES FOR THE MANUFACTURING SECTOR IN 1982

<table>
<thead>
<tr>
<th>Country</th>
<th>Rate</th>
<th>Country</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>17.6</td>
<td>Italy</td>
<td>58.1</td>
</tr>
<tr>
<td>Austria</td>
<td>56.4</td>
<td>Japan</td>
<td>11.6</td>
</tr>
<tr>
<td>Belgium</td>
<td>49.1</td>
<td>Portugal</td>
<td>19.2</td>
</tr>
<tr>
<td>Brazil</td>
<td>25.5</td>
<td>South Korea</td>
<td>13.5</td>
</tr>
<tr>
<td>Canada</td>
<td>18.7</td>
<td>Mexico</td>
<td>28.4</td>
</tr>
<tr>
<td>Denmark</td>
<td>14.3</td>
<td>Netherlands</td>
<td>46.8</td>
</tr>
<tr>
<td>France</td>
<td>53.9</td>
<td>New Zealand</td>
<td>15.2</td>
</tr>
<tr>
<td>Germany</td>
<td>48.3</td>
<td>Norway</td>
<td>30.4</td>
</tr>
<tr>
<td>Greece</td>
<td>37.2</td>
<td>Sweden</td>
<td>41.9</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>7.4</td>
<td>Switzerland</td>
<td>22.3</td>
</tr>
<tr>
<td>India</td>
<td>8.5</td>
<td>United Kingdom</td>
<td>23.8</td>
</tr>
<tr>
<td>Israel</td>
<td>28.7</td>
<td>Venezuela</td>
<td>5.4</td>
</tr>
</tbody>
</table>

NOTES: Data derived from unpublished BLS tables have been adjusted by the fraction of fringe-benefit rates attributable to vacation leave sick days.

\textsuperscript{5}For this calculation, we assume that the proportion of paid vacations and sick leave to the total fringe package is similar to that in the United States since country-specific data is missing. This fraction ranges from 40.5 percent in 1970 to 32.4 percent in 1982.

\textsuperscript{6}For decedents from countries not included in the BLS study, we use U.S. data to impute fringe-benefit rates.

\textsuperscript{7}Productivity growth rates are based on the long-term growth of real gross domestic product per capita in each country. As we did for the United States, we adjusted for the fraction of this growth due to schooling. Incomes of foreign decedents also grew according to the individual-specific growth, and life-cycle salary growth. Given the lack of data to compute earnings profiles for each of these 40 countries, these countries were given the same age-experience profile in the other countries as in the United States.
These three elements—base-year salary differences, fringe-benefit rates, and calendar-year salary growth—constitute the only differentiation we made for foreign citizens. This decision was not based on a belief that the other elements involved in economic loss—worklife discounts, taxes, consumption offsets and life-cycle salary growth—did not differ across countries. In fact, there is considerable evidence that they do. However, building a full set of assumptions for each country would be a project in itself. Moreover, the three elements that we do differentiate across countries account for a significant part of our loss calculations.\footnote{With respect to nonmarket economic loss, our estimates for foreign decedents are based on hourly wage rates computed using base-year income, and time data based on the same numbers as we used for U.S. decedents. The validity of the assumption with regard to time allocation depends partly on differences in the labor-force participation rates of women and normal family size among countries. However, recall that our imputations of hours spent in household production controls for these two factors, thus accounting for some country differences in labor-force participation rates and fertility rates. Finally, with respect to personal consumption adjustments, we also apply the U.S. consumption equivalence scales to foreign decedents. We checked estimates for developing countries by Deaton and Muellbauer (1986) and found that the BLS scale values fall between the two alternative scales that the authors propose.}

\textbf{JUVENILE DECEDENTS}

The second group of special cases involved juvenile children. Decedents under 18 years of age are treated differently. Table 10.4 lists the principal demographic characteristics of the minor children in our sample. Children constitute almost 8 percent of all decedents; one-third of them were of preschool age. For the most part, these children have not entered the work force or completed their schooling at the time of their death. As a result, their future earnings potential as adults is not yet in place. Before they would be able to receive their eventual adult earnings, considerable additional investments in these children must be made. The costs of these investments must be accounted for before an accurate measure of the full economic cost associated with the death of these children can be obtained.

A second issue involves children's special dependency on their parents. Measured in purely monetary terms, children are net absorbers of financial resources vis-à-vis their parents. A mechanical application of the general procedures we have outlined could produce the discomforting conclusion that the net benefit of children to their parents is negative. Such a mechanical application would clearly be absurd. Numerous studies in economics and demography have studied
the child-related decisions of parents and estimated the costs and value of children to their parents.\textsuperscript{9} These studies and common sense argue that couples decide to have children and to allocate a considerable fraction of their resources to raising them because they value having children.

As we did for adults, we computed two measures of loss for these minor children. The first step in estimating gross economic loss involves predicting the future market earnings and value of household services of these juvenile children. From the present value of these nonmarket and market incomes (evaluated at the time of the child’s death), we subtract the present value of the projected cost of raising the child.\textsuperscript{10} The second value—compensation to survivors—is measured by the total value of the investments parents have made in the child.

In order to project future market earnings, these children’s eventual educational attainment and age of entry into the labor force were estimated.\textsuperscript{11} Although many young people will have accumulated some labor-market experience by age 18, age of entry is defined as the age when they would obtain their first full-time job. Based on this imputed

\begin{table}
\centering
\begin{tabular}{lrrr}
\hline
\textbf{Age} & \textbf{All (No.)} & \textbf{Boys (Percent)} & \textbf{Girls (Percent)} \\
\hline
All & 161 & 95 & 66 \\
0-6 & 31.0 & 32.6 & 28.8 \\
7-11 & 29.0 & 29.5 & 25.8 \\
12-17 & 41.0 & 37.9 & 45.4 \\
\hline
\end{tabular}
\caption{Distribution of Juvenile Decedents by Age and Sex}
\end{table}

\textsuperscript{9}See, for example, Becker and Lewis, 1973.

\textsuperscript{10}There were 70 decedents aged 18–24 who were full-time students at the time of death. We calculate economic loss for them as we would for adult decedents, except for subtracting the cost of additional years of school before entry into the labor force.

\textsuperscript{11}When available, completed education is set equal to the intended educational achievement of the child reported in the claim files. However, information on the proposed occupation or educational attainment of juveniles was available only for 5 percent of cases. For the remaining cases, completed education is imputed by assigning the mean education by sex/race of the most recent cohort from the CPS. If this predicted education is less than the current level, the highest level achieved is used.
age of labor-market entry and schooling.\textsuperscript{12} Earnings in the first year of work are assigned using our CPS sex-specific earning equations. As with adult decedents, total economic loss for juveniles consists of market loss and the value of household services.\textsuperscript{13}

Table 10.5 lists the projected base-year earnings of juveniles in their first full-time job.\textsuperscript{14} The average base income of all juveniles was a little over $16,000. At this young age, we find that girls will earn 80 percent as much as boys. This projected wage disparity is larger by nationality, with foreign citizens earning 72 percent of U.S. wages.

Between the years separating the age at death and projected age of entry into the labor market, future costs associated with investments in

\begin{table}[h]
\centering
\begin{tabular}{lcc}
\hline
Group & Distribution & Mean \\
\hline
All & 161 & $16,046 \\
Boys & 59.0 & $17,438 \\
Girls & 41.0 & $14,042 \\
U.S. & 75.2 & $17,237 \\
Foreign & 24.8 & $12,443 \\
\hline
\end{tabular}
\caption{Imputed Future Earnings of Juvenile Decedents}
\end{table}

\textsuperscript{12}We assign to these juvenile children the mean education level of the most recent cohort who have completed their schooling. As a result, over 90 percent are projected to attain two years of college, and the majority are expected to enter the labor force at age 21.

\textsuperscript{13}From the age of death to the age of entry into the labor force, hourly wage rates are derived from imputed earnings based on the current education level (if known) and current age. There is, however, no income information for juveniles below age 16 in the CPS series. We assume that wage rates are zero at ages five and below, and that wage rates between ages 6–15 are a fraction of the prevailing minimum wage (with a simple monotonic increase with age). This method yields hourly wage rates ranging from $0.50 at age 6 to $3.45 at age 15. Finally, we are not able to impute total household hours from the Michigan Time Use Survey for decedents who were younger than 16. For these decedents, nonmarket production hours up to age 15 are derived from data published in Walker and Gauger (1973). Household hours of 0.98 hours per day for a child aged 12–15 and 0.54 hours per day for a child aged 6–11. Children below 6 are assumed to have zero hours of nonmarket production.

\textsuperscript{14}Since the last year of our CPS series is 1985, the very young decedents of the more recent accidents are projected to enter the labor force after 1985. For these base-year incomes, labor-force productivity in the imputation equations grow by the projected economy-wide growth rate of 1.9029 percent per year.
children must be deducted. These costs are not the same for all parents. Among the factors most likely to affect child costs are parental income, the number of children, and whether or not the mother is employed. Parents with high incomes are likely to spend more on their children than parents with low incomes, in part because they are better able to do so. Per-child costs decrease with number of children because of economies of scale in both out-of-pocket expenses as well as parental time for child care.\textsuperscript{15} Since rearing children also requires expenditures of time, the cost of raising a child should include the value of time spent by parents on child care and by juveniles on their own schooling. Parental time costs include the income or other home production activities that parents have to give up in order to care for children. In our calculations, the costs of children differ depending on the family's socioeconomic status, whether the mother is employed or not, the number of children in the family, the birth order of the child, and race.

We use Espenshade's (1984) estimates of the cost of raising a child up to age 17 in the United States. His estimates, based on consumer expenditure patterns in 1972–1973,\textsuperscript{16} include both out-of-pocket expenses of parents and the value of parents' time spent in child care. However, they do not include children's time during the years they spend in school.\textsuperscript{17} The full cost of their education should incorporate the foregone earnings while the student is in school.\textsuperscript{18} Espenshade's estimates are supplemented with the cost of attending college for those

\textsuperscript{15}Moreover, we expect that, controlling for age and other factors, firstborn children are more expensive than younger children.

\textsuperscript{16}Other studies have also estimated the value and cost of raising children. See Edwards (1981), Espenshade (1980, 1977), Muehlbauer (1977), Olson (1983), Pennock (1970), Reed and McIntosh (1973), Schm (1970), Turchi (1975, 1979), and van der Gaag (1982). The differences among them are due in part to whether costs include college education or not, the type of college attended (i.e., a four-year private college or a state university), the opportunity cost of parents' time, and the income level of the family. We base our estimates for foreign juveniles also on Espenshade's cost estimates. Just as we adjust the future earnings of foreign juveniles by the ratio of GNP per capita in the foreign country relative to U.S. GNP per capita, we also adjust the cost of raising children by this GNP ratio. A weakness of our cost estimation is that it assumes that the distribution of total costs among different types of expenditures (such as food, clothing, shelter, and so on) is the same in foreign countries as in the United States. Issues related to this assumption are discussed by Deaton and Muehlbauer (1986).

\textsuperscript{17}The 1981 Espenshade numbers are adjusted for past productivity growth for accidents before 1981 and for future productivity growth for later accidents. These adjustments do not take account of the fact that patterns of family expenditures may have changed since the 1970s.

\textsuperscript{18}We assume that full-time students do not earn income; thus, we equate their annual foregone earnings with their potential earnings given age and educational attainment at the time of death. Different methods of estimating the cost of school time appear in the economics literature (see, for example, Becker, 1964; Mincer, 1974; and Parsons, 1974).
children who advance beyond high school. College costs include direct expenses for tuition, board, and lodging, and the value of time students spend in school (or forgone earnings).  

Table 10.6 illustrates our estimates of the future cost of raising a child of a given age up to age 20. According to our estimates, the cost of raising a child from birth to age 20 is $181,210. Total costs obviously fall with children's age, but the incremental cost of the remaining investments rises with children's age. For example, the cost of raising a child from age 12 to 20 is 55 percent of the total, even though only 40 percent of a child's years to age 20 remains. This rising marginal cost with age reflects the rising costs of schooling investments as children work their way through the education system.

<table>
<thead>
<tr>
<th>Age Died</th>
<th>Cost to Parents</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$181,210</td>
</tr>
<tr>
<td>3</td>
<td>166,146</td>
</tr>
<tr>
<td>6</td>
<td>150,613</td>
</tr>
<tr>
<td>9</td>
<td>125,764</td>
</tr>
<tr>
<td>12</td>
<td>100,138</td>
</tr>
</tbody>
</table>

Their estimates found that costs are about 60 percent of all schooling costs in 1986; Becker's figured earnings are 74 percent of private college education costs. Parsons argued that these estimates may understate forgone earnings. He found that, at younger age levels, the bulk of schooling hours are at the expense of leisure time rather than work hours; hence, measuring forgone earnings alone underestimates the value of school time of juveniles. An offsetting factor is that students (especially those in postsecondary levels) may finance their education by working part-time.

We include forgone earnings in total cost of attaining education because these students could have contributed toward their cost of living in the family had they been working rather than attending school.

The annual direct costs of attending college were derived from several years of the Digest of Education Statistics. We computed a weighted average of private and public costs, using the ratio of enrollments in both types of school as the weight.

The numbers presented have been discounted to the year of the accident using a discount rate of 2.75 percent. The illustrative numbers in the table are for a child who died in a 1975 accident without siblings and with high-income parents. We assume that this child would complete two years of college.

These estimates do not measure the full costs associated with childbearing and childrearing. For example, monetary costs to parents associated with pregnancy and birth are not included. In addition, we have not attempted to measure the nonmonetary costs of having and raising a child. Our numbers serve as a lower bound estimate of full costs.
When we calculate the value of loss to survivor, our perspective changes from the future outlays on children to those expenditures incurred in the past. For juvenile children, loss to survivors is defined as the total outlays parents have made from age zero up to the child's age at death. These past costs incorporate the same components as just described for future costs. In essence, the sum of past outlays on the child reflects the economic cost to the surviving parents of replacing this child. The argument here would be that just as one would require tortfeasors to replace a damaged car, at a minimum they should be required to replace the past investments made in children. Children bring a stream of psychic and economic benefits to parents over their lifetime; the untimely death of a child deprives parents of those benefits.

Table 10.7 presents child costs from age zero up to various ages. The patterns in this table are the inverse of those obtained from Table 0.6. Loss to survivors is greater for older children simply because parents have already spent more resources on them than on younger children. This method produces quite small estimates of costs associated with the death of infants. It is important to remember that we are not attempting to measure the full costs (including loss of consorium) to the family associated with these deaths, which is obviously much higher than the figures in Table 10.7 indicate.

<table>
<thead>
<tr>
<th>Age Died</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>49,495</td>
</tr>
<tr>
<td>9</td>
<td>70,363</td>
</tr>
<tr>
<td>12</td>
<td>110,688</td>
</tr>
<tr>
<td>17</td>
<td>167,643</td>
</tr>
<tr>
<td>20</td>
<td>214,703</td>
</tr>
</tbody>
</table>

NOTE: These are present value estimates in March 1986 U.S. dollars.

22These child costs refer to the same hypothetical child as in footnote 20.
XI. CONCLUSIONS

This report has described the methodology we developed for calculating economic loss in wrongful death cases. In this final section, we present our conclusions about how widely applicable the methodology is and how it should be adapted for particular applications in litigation that may occur now and in the future.

HOW WIDELY CAN THE KING-SMITH METHOD BE APPLIED?

Our purpose was to develop a methodology that would most accurately estimate the actual economic loss caused by an individual’s death. To demonstrate the steps in our methodology, we used real data from aviation wrongful death cases, thinking through the problems that arise from estimating economic loss in that particular context. In a companion volume, we applied our methodology to the sample of airline decedents and compared the loss involved with the compensation actually awarded.¹

Although these results answered some important questions about air accident litigation, nothing in the methodology inherently limits it to aviation wrongful death cases. In our demonstration, the particulars of income and time period were naturally dictated by the sample. However, the principles, components, and procedures can be fully applied to all cases of wrongful death. For example, we would not have developed the components of the methodology any differently if we were dealing with wrongful death from automobile or industrial accidents instead of air crashes.²

Moreover, with some modifications, the methodology also applies to a wide range of other damage litigation cases, including personal injury, wrongful termination, discrimination, etc. In a typical personal injury case, for example, a person may be incapacitated for some time. Since he cannot work during that period, part of the economic loss he suffers includes his lost income now and in the future. To calculate that loss, one would need to know many of the seven elements of the methodology we developed.

¹The results are reported in Economic Loss and Compensation in Aviation Accidents, by Elizabeth M. King and James P. Smith.

²Some subsidiary issues that arose in aviation cases would not be as relevant in other cases. The question of income selectivity would always be present, but the highly selective nature of the air-crash sample would not generalize to other samples.
For example, the basis of any calculation of lost income involves knowing how much the person was earning when the injury occurred (base-year income). If the effects of the injury endure for many years, one must also estimate how much his income might have increased during the time he could not work (salary growth) and the length of time it takes to go back to work (worklife discount).\textsuperscript{3} If the injuries affect the ability to do nonmarket work as well, it is necessary to include how much time would have been spent in household tasks and what that time was worth (nonmarket loss).\textsuperscript{4} Tax-rate considerations arise in part because the interest from damage awards is taxed (the tax rate). In personal injury cases, damages are inflicted in the future as well as the time of the injury. As a result, a pervasive part of all damage calculations involves an interest rate to express how much the future economic loss would be in terms of present worth (discount rate).

There are two ways by which the computation for personal injury would differ significantly from wrongful death. Since the injured party is still alive, one would not reduce the loss by his proportion of family consumption (the personal consumption offset). Second, one must add all the medical costs associated with the injury.

A similar set of considerations arises in wrongful termination cases. Wrongful termination occurs when a person is dismissed from his job without sufficient cause. Therefore, the calculation of economic loss is based primarily on the lost income that results. Once again, this calculation involves base-year income, salary growth during the time the person is likely to be out of work, and the discount rate. Further, it would not include a personal consumption offset for the same reason given for personal injury. However, unlike the calculations for personal injury, it would most likely omit any nonmarket loss. As we saw in Sec. VI, people who are not working (and not injured) actually spend more time than people who work in nonmarket activities.

Economic loss also becomes an issue in discrimination cases when a person's sex, race, religion, etc., has caused him or her to lose a job, a promotion, or some other opportunity. This is particularly true when the damage phase of discrimination cases is reached. The same

\textsuperscript{3}The worklife discount models we developed would apply directly if the injury meant that the worker would never return to work. If the injury was not that serious, these models are not appropriate. One would have to estimate the length of the time out of the labor force by other means.

\textsuperscript{4}It may well be that if only the ability to work on the job is affected that the amount of time spent in nonmarket activities actually increases. In this situation, nonmarket work would become a mitigating factor in the calculation of damages. If the ability to work at home was not altered at all, one could use the difference in home time for non-workers and workers to obtain an estimate of the extent of the mitigation.
components of our methodology would be relevant here as in wrongful termination cases.

ADAPTATION FOR SPECIFIC CASES

Despite the general applicability of the methodology, it should not be applied automatically to individual cases without consideration of the specific nature of the cases. In this study, we intended to provide a general approach to calculating loss for the “average” person. Because we had to deal simultaneously with 2113 very diverse cases, our assumptions had to be general enough to apply in all cases.

For example, we used a single discount rate for all decedents, and that rate is a proxy for the long-term real interest rate. For our application to wrongful death in air crashes, the use of a long-term interest rate was appropriate because the economic loss for most decedents extends for decades into the future. However, for some decedents, particularly the elderly, a short-term interest rate might be more appropriate. By their very nature, short-term discount rates are more sensitive to the financial market conditions prevailing when the accident occurred. Thus, they are probably more appropriate in calculating the present worth of future economic loss for older people. Similarly, because of their shorter time perspective, the current economic conditions should receive more weight in assigning salary growth rates to more elderly workers. Finally, in valuing the fringe benefit, we ignored the consideration that these packages are not equally valuable for all decedents. Presumably, older workers put a higher value than younger workers do on the health benefits in these packages.

These arguments suggest that to make the correct valuation in specific cases, it is important to vary assumptions, as appropriate, for a decedent’s demographic characteristics. Our assumptions are intended to provide a general framework for valuing loss in wrongful death. They are not meant to be a straitjacket employed without considering how appropriate they are for specific cases.

The same is true of the numerical magnitudes that we selected for given components of the methodology. The King-Smith methodology is not an inflexible “set of numbers.” Rather, it is a way of thinking about calculating damages. As economic and social realities evolve, these magnitudes could change. For example, we selected numerical values of salary growth and discount rates for events that occurred in the mid-1970s where the damages extended far in the future. However, these magnitudes are subject to change as economic conditions change. Thus, at any given time of litigation, economic experts might well
argue for different discount and salary growth rates than we have
chosen. The numerical magnitudes of the elements will depend on how
the national economy stands, as well as on longer growth trends, when
the methodology is applied. But the thought processes underlying our
methodology, which guide selection of these magnitudes, remain sound.

One limitation of our data resulted in another important lesson for
practical applications. As we said in Sec. II, the files in the sample
often lacked data that we needed in our loss calculations—for example,
fringe benefits, how much time the decedent spent in household tasks,
and even salary information. Although we searched out the best exter-
nal data to impute values, they were no substitute for the real thing.
For example, a sensitivity analysis we report in the companion volume
indicates that when we had to impute incomes for decedents, the loss
values based on them were probably much lower than actual loss in
many cases. No matter how good the external data are, getting real
numbers for the calculations is better than imputing values.

With the evolution of science, further improvements in the method-
ology for computing economic damages should come forth. For exam-
ple, some economic assumptions that informed early cases in our sam-
ples would never be put forward today. In contrast, some principles
that were highly controversial in the early days are now commonly
considered essential—for example, the symmetry between nonmarket
and market loss, the necessity of discounting, and life-cycle salary
progression. In our methodology, the worklife discounts we developed
represent new thought on the subject of calculating economic loss.
However, there are many elements of damage calculations that we did
not push very hard even though we remain dissatisfied with standard
treatment. Two aspects in particular that need a critical look are the
valuation of loss for juveniles and the consumption offset. As econo-
mists and others work on these complex problems, further improve-
ments in the methodology should be made.

We believe that, under present conditions of both the economy and
scientific thought, our methodology is a considerable improvement over
existing methods of calculating economic loss and that it can be
applied in a wide range of tort cases. Perhaps the most important
implication it has for policy and for future research is how essential it
is to study the problems of calculating economic loss outside the adver-
sarial context of actual litigation.

In that context, people do not have the time, resources, and (some-
times) the motivation to look critically at economic methods for calcul-
ating loss. The deficiencies of existing methods implicitly bear witness
to that conclusion. Our study permitted us to take a global, disin-
terested, and scientific perspective. It gave us the opportunity and the
resources to bring first principles to bear on actual case data in rethinking how loss should be calculated. The results support our contention about the importance of approaching the problems in this way, because the methodology has the potential of helping the system realize more consistent and equitable treatment of loss.
Appendix A

STATISTICAL MODEL OF SALARY GROWTH

In this appendix, we outline the statistical model we developed to estimate individual specific salary growth. To estimate salary growth, we assumed that the model generating earnings is

$$\ln y_{it} = (\beta X + \delta_i) + (\beta_1 + \epsilon_i) t + u_{it}$$

where $\ln y_{it}$ is the (log) of salary of individual $i$ at age $t$, $\delta_i$ a permanent component in levels, $\epsilon_i$ a permanent component in growth, and $u_{it}$ is random.\(^1\)

The right-hand side of this equation describes the separate components determining salary levels. We separate these determinants into two parts. $\beta X + \delta_i$ in the first parentheses summarizes factors that affect salary levels. These salary levels are a function of observable attributes of individuals ($\beta X$) and unobservable factors that lead to permanent differences in salary levels ($\delta_i$). Since we are interested only in salary growth, we can eliminate the effect of level differences among individuals by first differencing for any individual.

For any individual, the salary growth from one age to the next is

$$\Delta y_t = \ln y_{it} - \ln y_{i,t-1} + \beta_1 + \epsilon_i + u_{it} - u_{it-1}$$

Salary growth consists of three parts. $\beta_1$ captures the average life-cycle profile of salary increases the mean life cycle wage growth at each point in the life cycle that all individuals will receive. $\epsilon_i$ is the unobserved individual-specific growth that makes this individual different from the mean. The third component reflects the impact of purely transitory factors ($u_{it} - u_{it-1}$). For example, if for purely transitory reasons, an individual received a temporarily high salary in one year (leading to a high positive salary growth), the salary in the next period will be low.\(^2\)

The first step in deriving an estimator to calculate the covariances in salary growth across individuals.

\(^1\)As is standard in the variance, components scheme, $\epsilon_i$ and $u_{it}$ are assumed to be independent. We also assume that $\sigma^2_u$ and $\sigma^2_\epsilon$ are independent of $N$.

\(^2\)\(\beta_1\), the typical average life-cycle effect, was estimated from Current Population Surveys using the methods described in the life-cycle growth section (Sec. IV).
\[ \text{Var } \Delta y_t = \sigma^2_t + 2\sigma^2_u \]
\[ \text{Cov } (\Delta y_t, \Delta y_{t-1}) = \sigma^2_t - \sigma^2_u \]
\[ \text{Cov } (\Delta y_t, \Delta y_{t-\tau}) = \sigma^2_t \quad \text{where } \tau > 1 \]

The within person average salary growth over the period beginning in period \( b \) and ending in period \( e \)

\[ \Delta y = \beta_1 + \varepsilon_i + \frac{u_e - u_b}{N} \]

where \( u_e \) is current period and \( u_b \) is initial period random error and \( N \) is the number of growth rates observed for individual \( i \) over the period (usually \( N = e - b \), but not necessarily). For \( N > 1 \), we can also derive the following expressions.

\[ \text{Var } (\Delta y) = \sigma^2_t + \frac{2\sigma^2_u}{N^2} \]
\[ \text{Cov } (\Delta y, \Delta y_t) = \sigma^2_t + \frac{\sigma^2_u}{N} \quad \text{if } t = b + 1 \]
\[ \sigma^2_t \quad \text{if } b + 1 < t < e \]
\[ \sigma^2_t + \frac{\sigma^2_u}{N} \quad \text{if } t = e \]
\[ \text{future } = \sigma^2_t + \frac{\sigma^2_u}{N} \quad \text{if } t = e + 1 \]
\[ = \sigma^2_t \quad \text{if } t > e + 1 \]

Our objective is to estimate salary growth in some future period, conditional on knowing the mean salary increase within the airline data.

\[ E (\Delta y_{e+\tau} \mid \Delta y) = \beta_1 + E (\varepsilon + u_{e+\tau} - u_{e+\tau-1} \mid \varepsilon + u_e - u_b) \]
\[ + \beta_1 + \gamma (\Delta y - \beta_1) \]

Therefore, our predicted growth rates values for all periods \( \tau \) in the future, i.e., \( t = e + \tau \) are \( \beta_1 + \gamma (\Delta y - \beta_1) \).

where \( \gamma = \frac{\sigma^2_t}{\sigma^2_t + \frac{2\sigma^2_u}{N^2}} \) for \( t = e + \tau, \tau > 1 \).
\[
\frac{\sigma^2_e - \sigma^2_u}{N} \text{ if } t = e + 1 \text{ or } e = 1
\]

\[
\sigma^2 + \frac{2\sigma^2_u}{N^2}
\]

and \( \gamma = \frac{\sigma^2_e - \sigma^2_u}{N} \text{ if } t = e + 1 \text{ or } e = 1 \)

The problem then is to calculate the unknown variance components parameters \( \sigma^2_e \) and \( \sigma^2_u \). First, we calculate \((\Delta y_t - \Delta y_{t-1}) = \Delta y_t\), the mean of these \( \Delta y_t \) (\( \Delta y \)) for each individual,\(^3\) and \((\Delta y_t - \Delta y)\).

The empirical \( \sigma^2_u \) is first computed for a given \( N \) where \( N \) is number of growth rates per individual. \( \operatorname{Var} (\Delta y_t - \Delta y) \) depends on whether end points (\( e \) or \( b \)) are in \( \Delta y_t \).

\[
(\Delta y_t - \Delta y) = \frac{(u_t - u_{t-1}) - (u_e - u_b)}{N}
\]

We used the method of moments to compute these parameters.

\[
\operatorname{Var}_N (\Delta y_t - \Delta y) = 2\sigma^2_u (1 + \frac{1}{N^2}) \text{ if } b + 1 < t < e
\]

\[
= 2\sigma^2_u \frac{(N^2 - N + 1)}{N^2} \text{ if } t = b \text{ or } e
\]

\[
\text{RSS} = \sum_{t=b+1}^e (\Delta y_t - \Delta y)^2
\]

\[
E(\text{RSS}) = \sum E(\Delta y_t - \Delta y)^2 = \sum \operatorname{Var} (\Delta y_t - \Delta y)
\]

\[
E(\text{RSS}) = 2 \frac{2\sigma^2_u (N^2 - N + 1)}{N^2} + \frac{(N - 2) 2\sigma^2_u (N^2 + 1)}{N^2}
\]

\[
\text{for } t = b + 1 \text{ and } e \text{ for other } N - 2 \text{ points}
\]

\[
= \frac{2\sigma^2_u}{N^2} (2N^2 - 2N + 2 + N^3 - 2N^2 + N - 2)
\]

\(^3\)To compute this mean, we subtracted from each yearly decedent's salary observed growth for the "normal" life-cycle salary growth that we estimated using methods described in the previous section. Because we did not know prior work experience for the decedents, we estimated CPS salary growth regression for women using age instead of experience as a covariate. These regressions were specified similarly to those of males. Separate regressions were estimated separately by race, education, and occupation groups. Covariates included a detailed age spline, average male income (in logs), and education (except for the education-specific regressions).
\[
\frac{2\sigma_u^2}{N^2} (N^3 - N) = \frac{2\sigma_u^2 (N^2 - 1)}{N}
\]

\(N(RSS) / 2(N^2 - 1)\) is an unbiased estimator of \(\sigma_u^2\) where RSS is the mean residual sum of squares across the \(m\) individuals with exactly \(N\) growth rates.

For every \(N\), we estimate \(\sigma_u^2\) and derive a pooled estimate by weighting each \(\sigma_u^2\) by the fraction of all observations \((m \ast N)\) at each \(N\). The final step involves computation of \(\sigma_t^2\):

\[
\text{Var} (\Delta y) = \sigma_t^2 + \frac{2\sigma_u^2}{N^2}
\]

so that \(\sigma_t^2 = \text{Var} (\Delta y) - \frac{2\sigma_u^2}{N^2}\)

where \(\text{Var} (\Delta y) = \sum_{i=1}^{m-1} \frac{(\Delta y_i - \Delta y)^2}{m - 1}\)

Once again, we compute a \(\sigma_t^2\) for each \(N\) and derive a pooled estimate by weighting each \(\sigma_u^2\) by the fraction of all observations \((m \ast N)\) at each \(N\).
### Appendix B

**SUPPLEMENTARY TABLES**

**Table B.1**

**EMPLOYEE BENEFITS AS PERCENTAGE OF PAYROLL**

**BY INDUSTRY GROUP AND YEAR**

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**NOTES**: Industry Codes: 1 = Total industry; 2 = All manufacturing; 3 = Total nonmanufacturing; 4 = Food, beverages, tobacco; 5 = Textile and wearing apparel; 6 = Pulp, paper, lumber and furniture; 7 = Printing and publishing; 8 = Chemicals and allied products; 9 = Petroleum; 10 = Rubber, leather, and plastic; 11 = Stone, clay, and glass; 12 = Primary metals; 13 = Fabricated metals; 14 = Machinery, excluding electric equipment; 15 = Electric machinery; 16 = Transportation equipment; 17 = Instruments and miscellaneous manufacturing; 18 = Public utilities; 19 = Department stores; 20 = Trade (wholesale and retail); 21 = Banks, finance; 22 = Insurance; 23 = Hospitals; 24 = Miscellaneous nonmanufacturing.
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NOTE: For states not included in this table it was assumed that state taxes were a fixed proportion of federal taxes.

1Not applicable.
2Based on Federal income tax liability, as follows: Nebraska, 11 percent; Rhode Island, 15 percent; Alaska 16 percent (1963 Federal tax rate apply); and Vermont, 25 percent plus 9 percent surcharge.
3As the Federal tax base on tax liability is used in computing the State tax, in effect the Federal standard deduction and exemption are adopted.
4Tax credit.
5Plus tax credit (or additional tax credit).
6Tax on capital gains.
7Incorporates 1973 or 1974 administrative or legislative action.
8Data apply to tax on earned income and annuities; 9 percent (flat rate) imposed on net capital gains, interest, and dividends.
9Plus 10 percent surcharge.
10Data apply to tax on interest and dividends; commuter tax (4 percent flat rate) also levied.
11Data apply to New York commuter tax, plus 2.5 percent surcharge; Pennsylvania commuter tax (2.3 percent flat rate) also levied.
12Refunds or forgiveness of tax due are based on certain poverty income levels established commencing with tax year 1974.
13Tax on interest and dividends.
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<th>Country</th>
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<th>Country</th>
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NOTES: These numbers are based on the long-term growth rate of real gross domestic product (GDP) per capita for the period 1950-1977 published by the World Bank (1984). The growth rate for American Samoa is based on the mean annual growth rate for low-income developing countries. The growth rates for the Bahamas, Puerto Rico, and the Virgin Islands are based on the mean annual growth rate for Latin America and the Caribbean. The growth rates for Ecuador, Iran, and Western Samoa are taken from published IMF data (1985).
BIBLIOGRAPHY


ICJ Publications

Process: Courts


Process: Lawyers and Litigants


___, Models of Legal Decisionmaking, R-2717-ICJ, 1981.

Process: Juries


Process: Alternative Dispute Resolution


Costs


**Trends in Outcomes**


**Understanding Outcomes**


**Alternative Compensation Systems**


**Toxic Substances**


Interaction Between the Civil Justice System and the Economy


Legislative Testimony

Danzon, P. M., The Effects of Tort Reforms on the Frequency and Severity of Medical Malpractice Claims: A Summary of Research Results, P-7211-ICJ, 1986. (Testimony before the Committee on the Judiciary, U.S. Senate.)

Hensler, D. R., Summary of Research Results on Product Liability, P-7271-ICJ, 1986. (Statement submitted to the Committee on the Judiciary, U.S. Senate.)

_____., Summary of Research Results on the Tort Liability System, P-7210-ICJ, 1986. (Testimony before the Committee on Commerce, Science, and Transportation, U.S. Senate.)

_____., Trends in California Tort Liability Litigation, P-7287-ICJ, 1987. (Testimony before the Select Committee on Insurance, California State Assembly.)

Kakalik, J. S., and N. M. Pace, Costs and Compensation Paid in Tort Litigation, P-7243-ICJ, 1986. (Testimony before the Subcommittee on Trade, Productivity, and Economic Growth, Joint Economic Committee of the Congress.)

Peterson, M. A., Summary of Research Results: Trends and Patterns in Civil Jury Verdicts, P-7222-ICJ, 1986. (Testimony before the Subcommittee on Oversight, Committee on Ways and Means, U.S. House of Representatives.)
Syntheses and Policy Implications


____, What We Know and Don't Know About Court-Administered Arbitration, N-2444-ICJ, 1986.


