JOURNAL OF FINANCIAL INTERMEDIATION 1, 215–241 (1991)

The Adequacy of Life Insurance Purchases*

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Received August 13, 1990

This paper examines whether middle age American households purchase adequate amounts of life insurance. The analysis is based on SRI International's 1980, 1982, and 1984 surveys of the financial positions of American households. Our findings indicate that a significant minority of American wives are highly underinsured with respect to the possible deaths of their husbands. We find that 25 to 30% of wives are inadequately insured, by which we mean that they would suffer a loss in their rate of sustainable consumption of at least 30% in the event of being widowed. These findings on inadequate life insurance are even more striking if one focuses on those households in which over half of the couple's present expected value of resources is dependent on the husband's survival. The results of this paper together with those of the related literature strongly suggest that raising the share of social security benefits that are paid to surviving spouses as well as increasing employer-provided group life insurance could have a very considerable impact on the alleviation of poverty among widows, especially elderly widows. *Journal of Economic Literature* Classification Numbers: G22.

* We are very grateful to the National Institute of Aging, Grant AG06380-02, for research support. We thank Jinyong Cai and Jagadeesh Gokhale for outstanding research assistance, and Mark Warshawsky and two anonymous referees for very helpful comments. *Journal of Economic Literature* Classification Numbers: G22.

1042-9573/91 $3.00

I. INTRODUCTION

In 1987, a total of 7.1 trillion dollars of face value life insurance was held by U.S. households. Yet, despite this large aggregate, there remains the question of whether insurance purchases are appropriate to individual circumstances. The familiar adage that life insurance is "sold, not bought" suggests a certain lack of information on the part of households concerning the function of life insurance and the appropriate level of coverage. How well households meet their insurance needs is an important policy issue for it influences not only the incidence of poverty among widows, particularly elderly widows, but also the efficacy of social insurance schemes aimed at alleviating such poverty. If poverty of widows is merely an extension of their poverty while married, then social insurance aimed at the general problem of poverty may be most appropriate. However, if poverty among widows is attributable to insufficient insurance purchases by deceased spouses, then survivor insurance is the more appropriate policy response.

This paper asks whether households purchase adequate amounts of life insurance. It extends our earlier analysis of this issue (Auerbach and Kotlikoff, 1987) through the use of a considerably richer data set and by considering the possibility that annuities are unavailable or too expensive to warrant its purchase. The new data are SRI International's 1980, 1982, and 1984 surveys of the financial positions of American households. While our previous results were limited to households whose heads ranged from 58 to 65 in age, the present paper considers younger households whose heads are between 35 and 55 years old. Younger households are likely to have a greater fraction of their resources tied up in human wealth and, as a consequence, may be in greater need of life insurance.

The findings in this study reinforce our previous finding about the inadequacy of insurance coverage. Under the assumption that actuarially fair annuities are available we find that just over 30% of wives are inadequately insured, by which we mean they would suffer a loss in their sustainable consumption of at least 30% in the event of being widowed. If one assumes that annuities are not available, the fraction of wives who are inadequately insured is 25%. These findings on inadequate life insurance are even more striking if one focuses on those households where the husband has no employer-provided group coverage and where the wife is at risk, i.e., where over half of the couple's present expected value of resources is tied up in income streams that are contingent on the husband's survival. The fraction of such wives who are inadequately insured is 41%, if one assumes fair annuities are available, and 33%, if one assumes annuities are not available.

Our assessment that a significant degree of American wives are underinsured for the death of their husbands is sustained even if life insurance policies are actuarially unfair. In our analysis we consider how our measure of insurance inadequacy is altered by the assumption of a 30% loading factor as suggested by Friedman and Warshawsky (1988).

The new data set has some special information bearing on the failure of households to insure adequately. The data indicate the way in which life insurance is obtained (provision of group insurance through employers versus individual purchase) and the frequency with which individual life insurance policies are updated. These data can be used to determine whether provision by employers of life insurance affects the total level of coverage and the diligence of individual households in determining how much insurance to purchase. We find that group coverage positively affects the level of total coverage; households with group policies are somewhat more adequately insured than those without, although over 26% of households with group policies still have inadequate coverage. The fact that households with group coverage are somewhat better insured is not surprising since many at risk households without group coverage hold little or no insurance and/or have not updated their insurance coverage for several years.

The data on adjustment of individual life insurance policies is quite telling. Just over 60% of the sample of all husbands and 63% of those husbands with no group insurance report they have not changed their individual life insurance policies in the last 5 years. Given that the data cover a period of rapid inflation and that most life insurance policies are not inflation indexed, this seems prima facie evidence against a view of rational insurance purchase.

The paper proceeds in the second section with a brief summary of the findings of our previous paper and a discussion of several related papers. Section III discusses our method for assessing the adequacy of life insurance assuming the availability of actuarially fair annuities as well as life insurance. Section IV indicates how the method for assessing the adequacy of life insurance needs to be modified if annuities are not available. Specifically, we use a dynamic programming algorithm to deal with the case that annuities are not available and present results both for the cases that annuities are and are not available. In this section we also consider how our measure of insurance adequacy is affected by less than actuarially fair pricing of life insurance. Section V describes the SRI data and the construction of key variables. Section VI begins with a presentation of our findings on the adequacy of insurance when annuities are available; it then considers how the results are modified if annuities are not available and if there is a loading factor in the price of life insurance. Finally, Section VII concludes the paper.

II. LITERATURE REVIEW

The literature bearing on the adequacy of life insurance is rather limited. It appears that each of the relevant studies has focused on the elderly using the Retirement History Survey. As a group these analyses support a conclusion that inadequate purchase of life insurance is an important explanation for the poverty of elderly widows.

As in this paper, Auerbach and Kotlikoff (1987) consider the adequacy of life insurance by examining changes in the affordable standards of living of hypothetical widows before and after the hypothetical deaths of their husbands. Auerbach and Kotlikoff also consider changes in living standards of actual widows. Their procedure involves comparing (1) the constant and equal consumption streams that could be guaranteed for both the husband and the wife, when they are both alive, if the couple purchased the appropriate amount of life insurance with (2) the constant consumption stream that an actual or hypothetical surviving widow would be able to finance based on the resources she has or would have upon the actual or hypothetical death of her spouse. These comparisons indicated that a quarter of all actual and hypothetical elderly widows and almost one-half of the subset of these women who are at risk are significantly underinsured for the death of their husband in the sense that their affordable consumption stream did or would decline by at least 25%.

In addition to examining in this manner the adequacy of life insurance holdings, Auerbach and Kotlikoff construct an econometric model of life insurance demand and test whether the purchase of life insurance, inadequate though it may be, is influenced by the determinants suggested by economic theory. For example, do couples with most of their resources tied up in income streams that are contingent on the husband's survival purchase more life insurance than couples for whom this is not the case? Econometric analysis of the demand for life insurance produces many results that are strikingly at odds with theoretical predictions. One example is the prediction that couples should offset government provision of survivor insurance through social security by reducing their own holdings of life insurance dollar for dollar. In contrast to the theoretical one-for-one offset, Auerbach and Kotlikoff report essentially no private offset to government provision of survivor insurance.

A subsequent study by Hurd and Wise (1987) considers the high incidence of poverty among widows and asks whether a widow's poverty status arises as the direct result of the death of her husband. The authors show that this is definitely the case; they point out that while only 9% of their sample of couples (in which the husband subsequently dies) are poor, approximately 35% of subsequent widows in this sample are poor. One problem with the Hurd and Wise paper is that they compare poverty status based on income immediately before and immediately after the

husband's death. As Burkhauser *et al.* (1986) point out, surveys often incorrectly measure income in the year a spouse dies by ignoring the income received by the decedent spouse prior to that spouse's death. Indeed, according to Hurd and Wise the transition out of poverty of widows after their first year of reported poverty status is remarkably high. Hence, their analysis may overstate the number of widows who become impoverished through the death of a spouse.

In addition to examining changes in the incomes of new widows, Hurd and Wise compare the wealth of the couples in their sample with the wealth of the surviving widows from these couples. They point out that a large portion of the representative couple's wealth, including the present expected value of the husband's income stream, is lost when the husband dies. While this is true, it is to be expected and does not necessarily reflect inadequate holdings of insurance; the reason is that when a family member dies the family's total expenditures ought also to fall. To pin down the inadequacy of insurance one needs to consider whether the wealth that remains after the husband dies is sufficient to maintain the widow's prior living standard—a calculation that Hurd and Wise fail to do. Notwithstanding this problem of interpretation, the Hurd and Wise data do convey a strong impression of inadequate life insurance holdings by many elderly couples.

Two papers by Holden *et al.* (1986) and Myers *et al.* (1986) that focus on the choice of pension survivor benefits also support the view of inadequate life insurance protection for actual and potential widows. The two papers report that requiring all men with private pensions to choose a survivor benefit option rather than a single life annuity would have significantly mitigated the decline in living standards experienced by surviving widows whose deceased husbands were covered by private pensions.

Finally, Lewis (1989) considers the demand for life insurance, but only for 150 American households. His theoretical model collapses all future time periods into one period and fails to take into account the possibility that dependents, particular spouses, may die prior to the death of the household head. His empirical analysis depends on his particular assumptions about preferences, while our findings and the findings mentioned above are nonparametric; i.e., they are independent of the particular structure of preferences. Lewis reports that his model fits his data well, but it is difficult to compare our results with his because of differences in methodologies.

III. ASSESSING THE ADEQUACY OF LIFE INSURANCE WHEN ANNUITIES ARE AVAILABLE

In this section we assume that households can purchase annuities at actuarially fair rates; the next section considers the case in which annui-

ties are not available. The assumption that annuities are available and actuarially fair may seem unrealistic given that very few American households own private annuity policies. However, if one considers annuities that are provided in the form of private pensions, the fraction of American households with significant explicit private (non-social security) annuities rises to well over 50%. In addition, many, and perhaps, most American households may have implicit annuities provided in the form of insurance arrangements between themselves and their children. As Kotlikoff and Spivak (1981) point out, even a small number of children or other relatives can hedge almost all of the risk associated with outliving one's resources. Given the risk-sharing capacity of families and the fact that disproving such risk sharing is quite difficult and has not occurred, the benchmark assumption of perfect annuity insurance seems well worth considering.

To determine whether household insurance purchases are adequate one must measure the extent to which insurance reduces the impact of resource changes associated with the death of a husband or wife. For example, consider a family in which only the husband works and assume the wife would not work if the husband dies. If the husband dies the consumable resources of the family will be reduced due to the loss of his future labor and the possible loss of pension income. They may also be reduced due to changes in the social security benefits to which the family is entitled. At the same time, the needs of the family will be lower, since the widow will require lower absolute expenditures to achieve the same standard of living previously enjoyed by the husband and wife. A simple test for the rationality of insurance coverage is to compare the increase in resources provided by insurance on the husband's life (the difference between the face value and the cash value of all his life insurance) with the additional resources (beyond her earnings, pension benefits, social security benefits, and the couple's assets) his wife would need to sustain her current standard of living in the event of his death. We would expect husbands whose future labor income represents a significant fraction of the present expected value of family resources to hold substantial amounts of insurance. Wives in such families are clearly at risk in the sense that inadequate life insurance purchases mean a considerable decline in their living standards in the event of the husband's death.

The definition of living standard is, of course, arbitrary. In this paper, as in our earlier work, we define living standard as the sustained level of consumption of goods and services that can be guaranteed given the household's current assets and current and future labor income and net government transfers. Calculating this level both before and after the death of a spouse requires information on the couple's net worth, future labor earnings, private pensions, and social security benefits when both spouses are alive as well as when one is dead.

The size of consumption streams that can be financed from a given amount of resources depends on actuarial factors such as the interest rate, the extent to which annuities are available, mortality probabilities, and household economies of scale in joint consumption. Since many household goods and services are consumed jointly, "two can live cheaper than one." The greater the fraction of joint consumption, the greater the insurance needed to maintain a given standard of living of a single surviving spouse. In the extreme case in which all consumption is joint, it is necessary to insure fully each spouse's survival-contingent income stream in order to maintain the surviving spouse's living standard. More generally, the necessary insurance level would equal the present expected value of this income stream less the reduction in necessary consumption spending occasioned by the individual's death.

Because we do not know how much consumption is joint, we assume no such economies of scale. This has the effect of understating the degree of underinsurance.

The tables presented below that assume annuities are available compare pre- and postwidowhood standards of living, measured by the level of annuity that could be financed with available resources. More precisely, we calculate the combined present expected value of resources of the couple before the hypothetical death of a spouse and compute the level annuity, A_m, that could be purchased for each spouse based on these resources, assuming that annuities are actuarially fair and that each spouse receives an equal annuity. Next, we determine the annuity that could be afforded by the surviving spouse, A_s, based on the surviving spouse's present expected values of life insurance including the life insurance of the decedent spouse. The ratio of the second annuity to the first annuity, (A_s/A_m), which we refer to as the consumption ratio, is the measure used for the adequacy of insurance. We characterize insurance as inadequate only if this ratio is below 0.7.

The annuities are calculated in the following manner. Let PVR_m be the present expected value of resources a couple has when both members are alive. This variable equals

$$\mathrm{PVR}_m = \mathrm{NW} + \mathrm{PVE}_h + \mathrm{PVE}_w + \mathrm{PVB}_h + \mathrm{PVB}_w + \mathrm{PVS}_h + \mathrm{PVS}_w. \quad (1)$$

In Eq. (1), NW stands for net worth, PVE stands for the present expected value of earnings of husband (h) and wife (w), PVB stands for the present expected value of each individual's social security and pension benefits, and PVS stands for the present expected value of each individual's survivor benefits, the additional social security and pension benefits received if the other spouse dies. NW includes the cash value of life insurance.

The effective term insurance amount, equal to the difference between

face and cash values of life insurance, does not appear in (1) because the expression incorporates the assumption that insurance is actuarially fair. In this case, the present expected values of insurance proceeds and payments are equal and hence cancel in the expression.[1] Even though the insurance coverage does not appear directly in Eq. (1), the ability of households to purchase insurance is implicit in the conversion of future survival contingent earnings and benefit streams into components of total household wealth.

Each of the present expected values appearing in expression (1) is based on information regarding each household's earnings and social security benefits, the assumed interest rate, and age- and sex-specific mortality probabilities. The interest rates and mortality probabilities are also used to calculate the annuities that each household could purchase for its members with the present expected value of resources PVR_m. If D_h and D_w are discount factors for husband and wife based on these variables, the actuarially fair level annuity for each that could be funded by PVR_m is

$$A_m = \mathrm{PVR}_m/(D_h + D_w). \tag{2}$$

Equation (2) tells us how much each husband and wife could receive annually if they used all their wealth to purchase equal annuities. However, families cannot convert future earnings streams of one member directly into annuitized consumption for the other. It is here that life insurance plays a role by permitting households to transfer resources from states in which a member is alive to states in which he or she is not. The extent to which this will be necessary may be seen by calculating comparable annuities for the cases when either the husband or the wife is assumed to die. Let

$$\mathrm{PVR}_s = \mathrm{NW} + \mathrm{PVE}_s + \mathrm{PVB}_s + \mathrm{PVS}_s + I_d. \tag{3}$$

In this expression, the first four variables on the right-hand side are as defined in Eq. (1). Here, however, they are calculated for spouse s assuming the spouse's mate d has died. This has no effect on the value of net worth, but it does change the present expected value of the earnings and benefit streams. For example, the present expected value of s's survivor benefits increases, since they are no longer contingent upon the other spouse's death. The present expected value of s's earnings and own social security and pension benefits may change, too, if the labor supply behav-

[1] This could easily be generalized to the case of a fixed loading based on the insurance amount, in which case this additional cost would be subtracted from the present expected value of resources. For the sake of simplicity we do not pursue this issue here.

ior of s depends on whether s is widowed. The final term in Eq. (3), I_d, is the effective term value (face less cash value) of life insurance received upon the death of d. Note that NW should be understood to include the cash value of life insurance.

As in Eq. (2), we may define the maximum level annuity that the surviving spouse s can purchase with PVR_s by

$$A_s = \text{PVR}_s/D_s, \tag{4}$$

where D_s is the same annuity discount factor that appears in Eq. (2) for the spouse s, equal to D_h or D_w. Assume for the moment that I_d equals zero. Then if A_m exceeds A_s, we may infer that d's life must be insured in order to maintain a constant level of consumption for s (i.e., for $A_s = A_m$).

IV. INSURANCE ADEQUACY WHEN ANNUITIES ARE NOT AVAILABLE

The Case of Actuarially Fair Life Insurance

In comparing the consumption annuities based on Eqs. (2) and (4), we implicitly assume that households can convert their present expected resources, PVR_m and PVR_s, into annuities on actuarially fair terms. While life insurance purchases are commonplace, the market for private annuities is less well developed.[2] The lack of an annuity market or a close substitute would pose no problem with respect to our analysis if the husband and wife have all their resources tied up in equal and constant survival-contingent income streams. For such couples these income streams are equivalent to annuities, and our measured values of A_m and A_s would equal the true values, where "true" refers to what is feasible given the annuity market imperfection. On the other hand, if the couple or surviving spouse has resources not contingent on survival, such as shares and stocks, A_m and A_s will be overstated relative to their true values. A_m will also be overstated, even in the case that all resources are tied up in survival contingent streams, if one of the spouse's survival-contingent

[2] As demonstrated by Yarri (1965), the purchase of an annuity is formally equivalent to the same of life insurance and vice versa. The fact that there is a well developed insurance market in the United States means that the market for sales of annuities is well developed. In contrast, the market for purchases of annuities is quite thin. The two markets are, however, segmented. Those selling annuities (buying life insurance) tend to be young and middle age, while those interested in buying annuities (selling life insurance) are older individuals. One possible explanation for the poor functioning of the annuity purchase market compared to that of the life insurance purchase market is that adverse selection due to asymmetric information is a greater problem in the annuity purchase market.

income stream exceeds that of the other. In this case the couple effectively needs to transfer, through life insurance, a portion of one spouse's survival-contingent stream (the one that is larger) into a nonsurvival-contingent resource in order to secure an equal consumption stream for the spouse with the smaller income stream. Since the true values of both A_m and A_s may be less than their measured values if annuity markets are imperfect, the measured ratio of A_s to A_m based on the assumption that fair annuities are available may under- or overstate the true ratio.

In the case that annuities are unavailable, the constant and equal (for both spouses) lifetime consumption stream, A_m, that can be sustained for the couple must be calculated using dynamic programming. In contrast, the affordable consumption stream for the surviving spouse, A_s, in the absence of annuities can be calculated using Eq. (4), but taking the numerator to be the present value (discounting only by the interest rate) of the surviving spouse's resources and taking the denominator to be the present value (discounting only by the interest rate) discount factor.[3]

Our calculation of A_m when annuities are not available proceeds as follows. First we write, in Eq. (5), the budget constraining the size of the constant affordable consumption stream, denoted A_m, of the couple if they both live to their maximum length of life:

$$W_0R^n + [e_{h1} + e_{w1} - 2A_m - \pi_{h1}L_{h1} - \pi_{w1}L_{w1}]R^{n-1} + \cdots + [e_{hn-1} + e_{wn-1} - 2A_m - \pi_{hn-1}L_{hn-1} - \pi_{wn-1}L_{wn-1}]R + [e_{hn} + e_{wn} - 2A_m] = 0, \quad (5)$$

where (5) W_0 is the couple's initial (referenced as time zero) wealth, n stands for the maximum number of years during which at least one of the spouses could be alive, R stands for one plus the interest rate, e_{hi} and e_{wi} stand, respectively, for the nonasset incomes of husbands and wives in period i, π_{hi} and π_{wi} are the respective period i life insurance premiums per dollar of face value of life insurance, and L_{hi} and L_{wi} are the period i face values of term (one period) life insurance purchased on the husband's

[3] In the case of a surviving spouse with no access to annuities and who does not wish to borrow against future earnings or other income, the spouse must arrange his or her consumption such that if the spouse lives until the last possible date of life the realized present value of the spouse's consumption equals the realized present value of the spouse's resources, where both of these present values are calculated as of the time the spouse becomes a widow or widower. Hence, even though the surviving spouse faces lifespan uncertainty the budget constraint is the same as that which arises if the spouse lived until the last possible date of life with certainty. The intuition here is that the spouse must consume taking into account the possibility of living to the last period in which case the present value budget constraint just described cannot be violated.

and wife's lives, respectively. The e_{hi} and e_{wi} should be understood to include social security retirement and dependent benefits as well as labor earnings.

To use (5) to help calculate L_{hn-1}, the husband's purchase of life insurance at time $n-1$, we note that the couple will only purchase life insurance on the husband's life (make L_{hn-1} positive) if the wife is also alive at $n-1$. If the wife is alive at $n-1$, the couple will set L_{hn-1} (assuming it is positive) such that if the husband dies the wife can afford to consume A_m in period n, thus,

$$W_0R^n + [e_{h1} + e_{w1} - 2A_m - \pi_{h1}L_{h1} - \pi_{w1}L_{w1}]R^{n-1} + \cdots + [e_{hn-1} + e_{wn-1} - 2A_m - \pi_{hn-1}L_{hn-1} - \pi_{wn-1}L_{wn-1}]R + [e_{wn} + L_{hn-1} + S_{wn} - A_m] = 0. \quad (6)$$

In (6) S_{wn} is the additional social security survivor benefit (above and beyond the wife's social security retirement benefit or dependent benefit) available to the wife at time n if the husband dies prior to time n.[4] Subtracting (6) from (5) yields

$$L_{hn-1} = e_{hn} - A_m - S_{wn}. \quad (7)$$

The corresponding equation for L_{wn-1} is

$$L_{wn-1} = e_{wn} - A_m - S_{hn}. \quad (8)$$

Now consider the possibility that the husband dies at the end of period $n-2$ and the wife is alive after $n-2$. To insure that the surviving wife can continue to consume A_m if this occurs the couple must choose L_{hn-2} and L_{wn-2} as well as their life insurance purchases prior to $n-2$ to satisfy

$$W_0R^n + [e_{h1} + e_{w1} - 2A_m - \pi_{h1}L_{h1} - \pi_{w1}L_{w1}]R^{n-1} + \cdots + [e_{hn-2} + e_{wn-2} - 2A_m - \pi_{hn-2}L_{hn-2} - \pi_{wn-2}L_{wn-2}]R^2 + [e_{wn-1} + L_{hn-2} + S_{wn-1} - A_m]R + [e_{wn} + S_{wn} - A_m] = 0. \quad (9)$$

If we subtract (9) from (6) and subtract the analogous equations for the case where the wife dies prior to the husband, we find

[4] The social security survivor benefit depends, in general, on the age at which the decedent spouse died because the age of death affects the decedent spouse's earnings record. Our calculations of survivor benefits take this feature of social security into account. However, to ease notation we do not index S_{wi} and S_{hi} by the age at which the spouse dies.

$$L_{hn-2} = (R^{-1} - \pi_{hn-1})L_{hn-1} - \pi_{wn-1}L_{wn-1} + e_{hn-1} - S_{wn-1} - A_m$$
$$L_{wn-2} = (R^{-1} - \pi_{wn-1})L_{hn-1} - \pi_{hn-1}L_{hn-1} + e_{wn-1} - S_{hn-1} - A_m. \quad (10)$$

Together with (7) and (8), Eqs. (10) suggest a dynamic programming algorithm for solving for A_m when annuities are not available. The algorithm starts by guessing the value of A_m. Given this guess and our estimated values of nonasset income and survivor benefit streams, we use Eqs. (7) and (8) to determine the period $n - 1$ purchase of life insurance assuming the derived values of L_{hn-1} and L_{wn-1} are nonnegative. If either or both of the derived values are negative we have a situation in which the couple would like to purchase one or more annuities. In this case we set the values of L_{hn-1} and\or L_{nw-1} equal to zero; i.e., when a derived demand for life insurance is negative we constrain its purchase to be zero.

Given the nonnegative values of L_{hn-1} and L_{wn-1}, we calculate nonnegative values of L_{hn-2} and L_{wn-2} using (10) and the rule that any negative derived demand for life insurance is set to zero. Since the first-order difference equations (10) relating life insurance in two adjacent periods hold for any two periods we can use (10) to calculate nonnegative values of life insurance for the husband and wife at each period between zero and n. However, these calculated values of the time paths of life insurance purchases depend on the guess of A_m, and the initial guess of A_m may not satisfy the budget constraint given in (5). Hence, we insert into (5) the calculated paths of life insurance purchases based on the initial guess of A_m and use the resulting equation to solve for a new value of A_m. We take as our second guess of A_m a weighted average of the first guess and this value and proceed to calculate a second time path of life insurance purchases. We continue with this Guass–Seidel iteration until the guessed value of A_m equals the calculated value of A_m, i.e., until we reach a fixed point. In implementing this algorithm, we assume that life insurance can be purchased on an actuarially fair basis, hence, we set π_{hi} and π_{wi} equal to R^{-1} times the respective probabilities of the husband and wife dying in period i, conditional on surviving through period $i - 1$.

The Case of Actuarially Unfair Life Insurance

The algorithm just presented can be modified to consider how a loading factor on the purchase of life insurance would alter our estimates of insurance adequacy. We consider two different procedures. The first procedure is simply to set π_{hi} and π_{wi} equal to their actuarially fair values multiplied by 1.3, which incorporates a 30% loading factor.

This procedure assumes that despite the loading factor the husband and wife would choose to consume the same amount independent of whether or not the husband or wife died. But, if purchasing life insurance is actuarially unfair, couples might choose to save money on life insurance premia

and take the risk of consuming less in the event that one of them dies. Our second procedure incorporates this possibility. In addition to multiplying π_{hi} and π_{wi} by 1.3, we assume that the value of A_s that we calculate for the wife (from the data based on simple discounting) is the amount that the couple has rationally planned that a surviving spouse would consume. We then modify the above equations to incorporate the fact that planned A_s differs from planned A_m. We do this by replacing A_m in Eqs. (6) and (9) in those periods in which only the wife is alive by A_s. We then use our algorithm to calculate the implied value of A_m. By comparing A_s with the resulting value of A_m one can ask whether the difference between the two annuities appears reasonable given the loading factor. While we would expect with this procedure to compute values of A_m that are larger than those of A_s, very large values of A_m relative to A_s would appear hard to reconcile with a rational response to life insurance loading.

V. DATA

Sample Selection

Our data come from three Surveys of Consumer Financial Decisions conducted by SRI International in 1980, 1982, and 1984. These data provide detailed information on assets and insurance and the oversampling of wealthy households. While there is some overlap among households covered by the three cross sections, there are few families for which usable records are available for more than one year. Therefore, our analysis simply pools the observations from the three surveys. All variables are measured in constant 1985 dollars.

We consider only families in which both husband and wife are present in the household, the husband is working, and in which the husband is age 35 to 55. Given the method of reporting household income data, several records had to be eliminated due to our inability to distinguish between husband's and wife's labor income. The labor incomes of the husband and the wife are not separately reported in the surveys. Rather the surveys report total labor income and the share of total (labor plus nonlabor) income received by the husband, wife, and others. In selecting the sample, we eliminate records in which the income shares to not add up to 100%. We also delete observations in which the head's labor income is $5000 or less.

These sample selection criteria leave a total of 1243 observations: 447 from 1980, 439 from 1982, and 357 from 1984. Before turning to our results we briefly review the definition of variables needed to calculate the present expected values in Eqs. (1) and (3) and the consumption annuities in (2) and (4).

Net Worth

The SRI data include a fairly complete list of assets and liabilities. The asset data include the market values of ownership of businesses, real estate (including one's home), stocks, bonds, money market funds, checking and savings accounts, business enterprises, and annuities IRA/Keogh accounts, the value of autos, RVs, boats, planes and tangible assets, and employer-provided pension plans (available only for 1980 and 1982), and the cash value of life insurance. The liabilities include real estate mortgages, other home-related loans, loans for autos, RVs, boats, and planes, investment secured loans, all unsecured and other loans, borrowing on lines of credit, cash value loans, and credit card balances.

Present Expected Value of Earnings

Unfortunately the surveys report only current labor earnings. For our base case we assume that future earnings through age 65 (the assumed retirement age) equal current earnings adjusted for growth for both husbands and wives; hence, wives who are not working at the time of the survey are assigned human wealth of zero in the base case. The assumed rate of growth of real earnings is 0%. This assumption of a zero growth rate of real earnings biases our results toward a finding of greater insurance adequacy. To form the present expected value of human wealth for both the husband and the wife we discount future real earnings streams at a 5% real rate of interest and apply the sex-specific mortality probabilities reported in Faber and Wade (1983).

The projection of future earnings based on current earnings may, of course, under- or overstate the individual's true present expected value of earnings. The implication of this measurement problem for assessing insurance adequacy is particularly acute for wives who report they are not working at the time of the interview. Such wives may normally be in the labor force or may actively be engaged in unmeasured but valuable home production at the time of the survey. Alternatively, such wives may intend to work in the future if their husbands died. In these cases, our estimate of the annuity ratio for hypothetical widows will overstate the problem of inadequate insurance. Hence, in addition to the base case, we consider two other assumptions about the future earnings of wives who report zero earnings. The first is that wives with zero reported earnings earn in each year in the future an amount equal to the earnings level predicted by a regression relating the earnings of working wives to their characteristics.[5] The second is that wives with zero reported earnings earn zero while their husbands are alive, but go to work if their husbands

[5] These characteristics are a polynomial in age, education dummies, occupation dummies, and number of children.

die, earning the amount predicted by the working wives' earnings regression.

A related reason for potential overstatement of inadequacy is the possibility of remarriage. If widows frequently marry soon after their husband's deaths, their need for insurance would be mitigated. However, the probability of remarriage for widows (as opposed to women who are divorced) in the age range being considered appears sufficiently low to make this factor seem unimportant. In addition, those widows who do remarry may, in part, do so in part to maintain their living standards. Hence, our analysis of inadequate life insurance can be understood as studying the ability of new widows to both maintain their living standards and not remarry.

Pensions

Unfortunately, there is very limited information in the survey concerning private pensions and what information is available only for 1980 and 1982. For these years the questionnaire asks the value of employer pension plans, which we include in our measure of net worth for those years. These data appear to understate the amount of pension wealth. Since most pensions during this period did not offer automatic joint survivor benefits this understatement of pension wealth is likely to understate the need for life insurance by understating the resources lost upon a husband's death.

Taxes

In calculating the present expected values of the husband's and wife's future labor earnings, we reduced the projected stream of annual labor earnings by 20%. While this is a crude calculation it appears to be in the right order of magnitude for at least middle income households. The 20% figure, by the way, is meant to include both average federal income taxes, average employee social security taxes, and average state and local taxes. The 20% figure may be a bit high for low income (relative to our data) households, but if so, this will, by reducing the size of human wealth, lead to an overstatement of insurance adequacy for such households. For higher income households the simple 20% average tax rate adjustment may lead to a small overstatement of insurance inadequacy. Given that the problem of inadequate life insurance is most severe for poorer households, this assumption appears to bias the findings toward greater insurance adequacy.

Present Expected Value of Social Security Benefits

The construction of social security wealth is based on projected past and future earnings streams of the husband and wife. Given these earn-

ings streams, we followed social security law as amended in 1983 in determining the amount of retirement, dependent, and survivor benefits available to each spouse under each mortality contingency of the husband and wife. Each individual's future social security benefit is determined based on the individual's projected future and past earnings. The projected past earnings are determined by taking current earnings and reducing them in real terms according to the historical rate of growth of real compensation per hour in the business sector reported in *The Economic Report of the President 1987.*

Our procedure for computing social security wealth takes into account that each spouse's completed earnings history will depend on that spouse's date of death. This is important for computing the present expected value of survivor benefits when both members of the couple are still alive; for example, the survivor benefit available to a surviving wife at say age 66 will be based on a short earnings history if the husband died at a young age and a long earnings history if the husband died in his 60s. Our method of calculating survivor benefits properly adjusts for the probability that a spouse will die at an early age and, as a result, have a short earnings history.

Insurance

All three of the SRI surveys ask about the husband's and wife's individual insurance and the husband's group insurance. However, only the 1982 and 1984 surveys report the wife's group insurance.

VI. FINDINGS

Characteristics of the Data

We begin with a table that provides an overall picture of the composition of household resources in the sample. Each column in Table I provides a percentage breakdown of the resource variable PVR_m for families in a particular wealth range, starting in the first column with those families having between 100 thousand and 250 thousand dollars of total wealth[6] (4% of the sample) through those having between 250 and 500 thousand dollars of wealth (29% of the sample), between 500 thousand and 750 thousand (36% of the sample), between 750 thousand and 1 million dollars (18% of the sample), and more than 1 million dollars (13% of the sample). The table also displays for each wealth class the average face values of insurance for husbands. The face value of insurance coverage is not a component of a couple's overall wealth, PVR_m. We provide the insur-

[6] In our sample there are no households with total resources below 100 thousand dollars.

TABLE I
THE SIZE AND COMPOSITION OF RESOURCES AND INSURANCE BY PVR CLASS[a]

Variable	PVR_m class				
	100K–250K	250K–500K	500K–750K	750K–1 million	1 million +
PVR_m					
Average	205K	393K	614K	852K	1522K
% of PVR_m	100	100	100	100	100
HWH					
Average	112K	211K	330K	446K	754K
% of PVR_m	55	54	54	52	50
HWW					
Average	14K	43K	96K	147K	154K
% of PVR_m	7	11	15	17	10
SSWH					
Average	31K	43K	49K	52K	53K
% of PVR_m	15	11	8	6	4
SSWW					
Average	27K	40K	50K	55K	56K
% of PVR_m	8	7	5	4	2
NW					
Average	21K	56K	91K	152K	505K
% of PVR_m	10	14	15	18	33
IH					
Average	17K	32K	57K	88K	212K
% of PVR_m	8	8	9	10	14

[a] Percentages may not sum to 100% due to rounding. K stands for thousands of dollars. PVR_m stands for the present expected value of the couple's resources. HWH stands for the human wealth (present expected earnings) of the husband. HWW stands for the human wealth (present expected earnings) of the wife. SSWH stands for the social security wealth of the husband when both spouses are alive. SSWW stands for the social security wealth of the wife when both spouses are alive. NW stands for the couple's net worth. IH stands for the face value of life insurance on the husband's life.

ance numbers to offer some initial insight into the patterns of insurance coverage and adequacy.

The table indicates several patterns regarding the composition of resources. First, the fraction of resources accounted for by net worth increases with total resources, rising from 10% for those with total resources of 100–250 thousand to 33% for those with resources above 1 million. Second, the fraction of total PVR_m accounted for by wives' human wealth also increases through the first four categories. The sum of these two components increases throughout, from 17% for the lowest resource group to 43% for the highest. Since these are the two major components of resources that do not decline when a husband dies, there is

clearly a greater need for insurance to protect wives' consumption at lower wealth levels. An examination of insurance coverage, however, does not reflect this greater need. While husbands' human wealth accounts for 55% of family resources for the lowest resource group, declining to 50% for the highest resource group, the ratio of husbands' insurance to overall resources is 8% for the first group and 14% for the latter. Note that for the lowest resource group only 15% of the husband's human wealth is insured on average. The corresponding figure for the highest resource group is 28%.

Table II presents the distribution of observations by age and PVR_m category. Among young households, whose heads are age 35 to 39, insurance on the husband as a percentage of PVR_m is similar to that for the entire sample except for the lowest PVR_m class. For the five different PVR_m classes starting with the lowest, husbands' life insurance is 10, 9, 9, 11, and 17% of PVR_m. The corresponding percentages for the subsample ages 50 to 55 are 5, 8, 9, 11, and 15%.

Table II also indicates the fraction of households in each cell who are at risk, where at risk means that over half of the household's PVR_m consists of income flows that are contingent on the husband's survival. Finally, it reports the fraction of households with positive life insurance on the husband's life. The table indicates that most (74% for the entire sample)

TABLE II

PERCENTAGE AT RISK AND PERCENTAGE WITH LIFE INSURANCE BY PVR_m AND AGE[a]

	PVR_m class					
Age group	100K–250K	250K–500K	500K–750K	750K–1 million	1 million +	Total
35–39						
No. of obs.	17	92	126	82	48	365
% at risk	94	86	91	68	65	81
% with IH	76	83	85	87	98	86
40–44						
No. of obs.	13	64	120	63	42	302
% at risk	69	83	81	71	64	76
% with IH	69	75	86	90	98	85
45–49						
No. of obs.	8	91	98	46	34	277
% at risk	100	89	68	63	53	73
% with IH	50	84	91	78	88	85
50–55						
No. of obs.	11	114	98	40	36	299
% at risk	81	84	57	52	50	62
% with IH	81	86	83	100	94	89
Total						
No. of obs.	49	361	442	231	160	1243
% at risk	86	81	76	65	59	74
% with IH	71	83	86	88	95	86

[a] PRV_m stands for the present expected value of the couple's resources. IH stands for the face value of life insurance on the husband's life.

TABLE III
CONSUMPTION RATIOS FOR WIVES USING CURRENT EARNINGS[a]

	PVR_m class					
A_s/A_m	100K–250K	250K–500K	500K–750K	750K–1 million	1 million +	Total
<0.10						
No. of obs.	0	1	0	0	0	1
Col. %	0	0.3	0	0	0	0
0.10 to 0.20						
No. of obs.	2	3	3	1	2	11
Col. %	4	1	1	0	1	1
0.20 to 0.30						
No. of obs.	1	9	5	3	1	19
Col. %	2	2	1	1	1	2
0.30 to 0.40						
No. of obs.	4	22	24	10	3	63
Col. %	8	6	5	4	2	5
0.40 to 0.50						
No. of obs.	8	28	34	13	4	87
Col. %	16	8	8	6	3	7
0.50 to 0.60						
No. of obs.	7	24	34	8	4	77
Col. %	14	7	8	3	3	6
0.60 to 0.70						
No. of obs.	6	43	38	19	13	119
Col. %	12	12	9	8	8	10
0.70 to 1.00						
No. of obs.	8	126	139	62	32	367
Col. %	16	35	31	27	20	30
1.00 to 1.25						
No. of obs.	8	68	113	70	41	300
Col. %	16	19	26	30	26	24
1.25+						
No. of obs.	5	37	52	45	60	199
Col. %	10	10	12	19	38	16
Total	49	361	442	231	160	1243

[a] Percentages may not sum to 100% due to rounding. PVR_m stands for the present expected value of the couple's resources.

households are at risk, and most (86% for the entire sample) households are at risk, and most (86% for the entire sample) have insurance on the husband's life. Among households falling in the lowest three PVR_m ranges the cell fraction at risk often exceeds the cell fraction with insurance on the husband.

Analysis of Insurance Adequacy

Hypothetical Widows Assuming Annuities Are Available. In Table III we assume the availability of actuarially fair annuities and present consumption ratios for hypothetical widows under the base case assumption that future earnings equal current earnings adjusted for growth. A total of 15% of the potential widows have an annuity ratio (A_s/A_m) of less than 0.5; 30% have a ratio below 0.7. Inadequate insurance holdings are more

prevalent among the lower PVR_m groups. Of the 410 hypothetical widows from households with PVR_m less than \$500,000, 19% have consumption ratios below 0.5, and 38% have ratios below 0.7. In contrast only 6% of the potential widows in the highest PVR_m have a ratio less than 0.5, and only 17% have ratios below 0.7.

The degree of measured insurance inadequacy depends on our estimate of the future earnings of nonworking wives. Table IV shows the implications for the distribution of consumption ratios of assuming that wives with no reported earnings earn an amount predicted by an earnings regression both (1) when the husband is alive and when he is dead and (2) only after he is dead. Under the first alternative assumption (all wives always work) the percentage of widows with ratios below 0.7 drops from 30% in the base case to 19%. Under the second assumption (all widows work) the percentage below 0.7 totals 16%. While substantially smaller than the base case numbers, these figures still suggest an important minority of hypothetical widows are underinsured.

Table V repeats Table III for 888 of the 1243 women who are at risk. Under the base case earnings assumption 20% of women at risk have consumption ratios below 0.5; 41% have ratios below 0.7. These figures can be compared with 15 and 30%, the corresponding percentages for the entire sample in the base case. If one assumes instead that nonworking wives always work upon the deaths of their husbands (not shown separately), the fraction of wives with ratios below 0.5 drops from 20 to 6%, and the fraction below 0.7 drops from 41 to 23%.

In contrast to the earlier tables, Table V seems more relevant to the issue of adequacy because it focuses on those couples who have the potential to make the mistake of underinsuring. But some of those couples at risk may not be making a voluntary decision about purchasing life insurance because their employers are providing them with life insurance. The subsample who permit the clearest test of insurance choice is, therefore, households in which wives are at risk, but which have no employer-provided group life insurance. Repeating Table V for this subsample of 382 observations, the base case fraction of wives with consumption ratios below 0.5 is 26%; the fraction with ratios below 0.7 is 51%. In other words, slightly more than half of households who need insurance and are not forced to hold insurance by their employers are inadequately insured. The fraction of this sample that is inadequately insured remains quite large even under the assumption that widows return to work; in this case 31% of the 382 wives have consumption ratios below 0.7.

Consumption Ratios of Hypothetical Widows When Annuities Are Unavailable. Table VI analyzes insurance adequacy when annuities are unavailable. The calculations are based on the dynamic programming algorithm of Section IV. Table VIII should be compared with Table III;

TABLE IV

CONSUMPTION RATIOS FOR WIVES UNDER ALTERNATIVE EARNINGS ASSUMPTIONS

	Earnings definition		
A_s/A_m	Base case	All wives always work	All widows work
%<0.50	15	5	4
%0.50–0.70	16	14	12
%0.70–1.00	30	36	33
%1.00–1.25	24	26	29
%1.25+	16	17	22

TABLE V

CONSUMPTION RATIOS FOR WIVES AT RISK USING CURRENT EARNINGS[a]

	PVR_m class					
A_s/A_m	100K–250K	250K–500K	500K–750K	750K–1 million	1 million +	Total
<0.10						
No. of obs.	0	1	0	0	0	1
Col. %	0	0	0	0	0	0
0.10 to 0.20						
No. of obs.	2	3	3	1	2	11
Col. %	6	1	1	1	2	1
0.20 to 0.30						
No. of obs.	1	9	5	3	1	19
Col. %	3	3	2	2	1	2
0.30 to 0.40						
No. of obs.	3	22	24	10	3	62
Col. %	9	8	7	7	3	7
0.40 to 0.50						
No. of obs.	8	28	34	13	4	87
Col. %	25	10	10	9	4	10
0.50 to 0.60						
No. of obs.	5	24	34	8	4	75
Col. %	16	8	10	5	4	8
0.60 to 0.70						
No. of obs.	2	41	38	19	13	113
Col. %	6	14	12	13	14	13
0.70 to 1.00						
No. of obs.	5	117	132	59	30	343
Col. %	16	41	40	39	33	39
1.00 to 1.25						
No. of obs.	2	31	48	28	19	128
Col. %	6	11	15	19	21	14
1.25+						
No. of obs.	4	9	11	10	15	49
Col. %	13	3	3	7	16	6
Total	32	285	329	151	91	888

[a] Percentages may not sum to 100% due to rounding.

TABLE VI
CONSUMPTION RATIOS FOR WIVES ASSUMING ANNUITIES ARE UNAVAILABLE AND BASE CASE EARNINGS[a]

	PVR_m class					
A_s/A_m	100K–250K	250K–500K	500K–750K	750K–1 million	1 million +	Total
<0.10						
No. of obs.	0	1	0	0	0	1
Col. %	0	0.3	0	0	0	0.1
0.10 to 0.20						
No. of obs.	3	5	3	0	0	11
Col. %	6	1	1	0	0	1
0.20 to 0.30						
No. of obs.	5	6	2	1	0	13
Col. %	10	2	0.5	0.4	0	1
0.30 to 0.40						
No. of obs.	8	24	15	2	1	50
Col. %	16	7	3	1	1	4
0.40 to 0.50						
No. of obs.	7	25	33	7	0	72
Col. %	14	7	7	3	0	6
0.50 to 0.60						
No. of obs.	8	44	30	10	1	93
Col. %	16	12	7	4	1	7
0.60 to 0.70						
No. of obs.	3	30	32	10	1	76
Col. %	6	8	7	4	1	6
0.70 to 1.00						
No. of obs.	7	81	122	58	10	278
Col. %	14	22	28	25	6	22
1.00 to 1.25						
No. of obs.	2	67	70	54	22	215
Col. %	4	19	16	23	14	17
1.25+						
No. of obs.	6	78	135	89	125	433
Col. %	12	22	31	39	78	35
Total	49	361	442	231	160	1243

[a] Percentages may not sum to 100% due to rounding. PVR_m stands for the present expected value of the couple's resources.

while Table III, which assumes annuities are available, reports that 15% of wives have consumption ratios under 0.5 and 30% have consumption ratios under 0.7, the respective figures in Table VI are 12 and 25%. Table VII also assumes annuities are unavailable, but considers wives who are at risk. This table should be compared with Table V where 20% of wives have consumption ratios below 0.5, and 41% have ratios below 0.7. The corresponding figures in Table VII are 16 and 33%. Hence, the assumption that annuities are unavailable mitigates somewhat the picture of insurance inadequacy, but even if one assumes that annuities, both explicit and implicit, are completely unavailable almost a third of the wives who need insurance are inadequately insured. The picture of inadequate protection is particularly clear for poorer wives. According to either Table V

TABLE VII
CONSUMPTION RATIOS FOR WIVES AT RISK ASSUMING ANNUITIES ARE UNAVAILABLE AND BASE CASE EARNINGS[a]

	PVR_m class					
A_s/A_m	100K–250K	250K–500K	500K–750K	750K–1 million	1 million +	Total
<0.10						
No. of obs.	0	1	0	0	0	1
Col. %	0	0	0	0	0	0
0.10 to 0.20						
No. of obs.	3	5	3	0	0	11
Col. %	9	2	1	0	0	1
0.20 to 0.30						
No. of obs.	5	6	2	1	0	14
Col. %	16	2	1	1	0	2
0.30 to 0.40						
No. of obs.	6	24	15	2	1	48
Col. %	19	8	5	1	1	5
0.40 to 0.50						
No. of obs.	5	24	33	7	0	69
Col. %	16	8	10	5	0	8
0.50 to 0.60						
No. of obs.	4	41	30	10	1	86
Col. %	13	14	9	6	1	10
0.60 to 0.70						
No. of obs.	2	24	31	10	1	68
Col. %	6	8	9	7	1	8
0.70 to 1.00						
No. of obs.	2	70	107	44	10	233
Col. %	6	25	33	29	11	26
1.00 to 1.25						
No. of obs.	1	48	50	35	16	150
Col. %	3	17	15	23	18	17
1.25+						
No. of obs.	4	42	58	42	62	208
Col. %	13	15	18	27	68	23
Total	32	285	329	151	91	888

[a] Percentages may not sum to 100% due to rounding.

or VII almost half of wives at risk who fall in the lowest two resource categories have consumption ratios below 0.7.

Consumption Ratios of Widows When Annuities Are Unavailable and Life Insurance Pricing Incorporates 30% Loading. Recall that our first procedure for dealing with life insurance loading is simply to raise life insurance premia by 30% and use the no annuities algorithm to recompute the annuity ratios. The resulting annuity ratio distribution is essentially identical to that reported in Table VIII. The sole difference is that there are now 214 rather than 215 wives with ratios between 100 and 125% and 434 rather than 433 wives with ratios equal to 125% or greater. The same very modest changes in the annuity ratio distribution occur for the subsample of households whose wives are at risk. Intuitively, the impact of higher insurance premia leads households in the algorithm optimally to

TABLE VIII
CONSUMPTION RATIOS FOR HUSBANDS USING CURRENT EARNINGS[a]

	PVR_m class					
A_s/A_m	100K–250K	250K–500K	500K–750K	750K–1 million	1 million +	Total
<0.5						
No. of obs.	0	0	0	0	0	0
Col. %	0	0	0	0	0	0
0.50 to 0.60						
No. of obs.	0	0	1	0	0	1
Col. %	0	0	0	0	0	0
0.60 to 0.70						
No. of obs.	0	0	1	0	0	1
Col. %	0	0	0	0	0	0
0.70 to 1.00						
No. of obs.	0	5	3	2	2	12
Col. %	0	1	1	1	2	2
1.00 to 1.25						
No. of obs.	4	19	26	17	5	71
Col. %	10	7	7	8	4	9
1.25+						
No. of obs.	30	207	247	125	102	711
Col. %	90	92	91	91	94	89
Total	34	231	278	144	109	796

[a] Percentages may not sum to 100% due to rounding.

purchase somewhat less life insurance, with the result that there is only a very modest effect on the level of A_m that the couple can afford to consume. Since the calculated values of A_s are not affected by the loading factor, the distribution of the ratio of A_s to A_m is basically unchanged. While we have not performed calculations for the case of unfair insurance and fully available annuities, one may infer then, in this case as well, the results would be quite similar to those for the case of fair insurance given in Table III.

Our second procedure assumes that the couple has planned to consume only A_s (calculated for the surviving wife) if one of the spouses dies and that the couple determines its value of A_m taking this value of A_s into account. The resulting distributions of A_s/A_m for the entire sample and for the subsample of wives at risk are much more skewed toward lower values of the ratio. For the entire sample 10% of households now have a ratio equal to or less than 0.3, 20% of the sample have a ratio equal to or less than 0.5, and 33% of the sample have a ratio equal to or less than 0.7. The corresponding no loading percentages in Table VI are 2, 12 and 25%. For the wives at risk subsample, the percentages of households with ratios less than or equal to 0.3, 0.5, and 0.7 are, respectively, 7, 20, and 38%. The corresponding Table VII figures are 3, 16, and 33%.

To argue that a fifth of the sample is responding to the loading factor on

life insurance by planning to have the surviving wife suffer a 50% or greater reduction in her standard of living seems extreme. Moreover, since these calculations are based on the assumption of no annuities, in which they probably understate the implied gap between intended consumption before and after the husband's death. Therefore, we view the result of this second procedure for considering loading as quite supportive of the general finding of inadequate insurance purchase.

Hypothetical Widowers. Calculations for widowers are interesting in themselves, and also in relation to those already presented for widows. Because measurement error alone can cause our estimates of the ratio of A_s to A_m to vary randomly around their true values for each households, we may have overstated the number of widows actually suffering a significant loss in consumption capacity: some of these widows may appear to experience such a loss simply because they are in the lower tail of the distribution of errors caused by measurement problems. Such measurement error should also apply to the calculations for widowers, while underlying differences between widows and widowers would lead one to expect considerably less of a problem of underinsurance among widowers. Hence, a comparison of the importance of underinsurance among widows and widowers also provides some sense of the underinsurance problem among widows.

In Table VIII we again assume that actuarially fair annuities are available and present the base case consumption ratios for the complete sample of hypothetical widowers based on the 1982 and 1984 surveys. Recall that the 1980 survey fails to ask about the wife's group insurance. Hence, there are only 796 observations. The results in Table VIII are also quite striking. Almost 90% of hypothetical widowers have consumption ratios above 1.25. Clearly, there is no evidence of inadequate insurance for this sample of husbands. Quite the contrary; the evidence indicates that despite the advances of females in the labor market, husbands remain the principal earners. While these numbers are sensitive to the assumption of whether or not currently nonworking wives work in the future, even if one imputes earnings for wives who report no earnings and assumes wives always work, the fraction of husbands with consumption ratios below 0.7 is less than 1%. This assumption does, however, significantly reduce the fraction of husbands whose ratio exceeds 1.25.

Adjustment of Individual Life Insurance Policies. In total only 40% of the sample reported altering their individual life insurance policies within the last 5 years. For middle age men between 45 and 54 the fraction is even smaller—less than 30%. The data suggest that people purchase their insurance in their 30s and then fail to adjust their holdings for quite a while. Given that the data cover a period during and immediately follow-

ing a rapid inflation, these figures are even more surprising. While some policies may have included provisions indexing coverage to the price level, this is not yet standard practice and certainly was not during the period when the surveys were conducted.

Those with group insurance may not need to adjust their insurance as often as those without group insurance. However, the extent of adjustment for the subsample of men who do not report group insurance is only marginally larger. Of the 542 men who do not have group insurance only 46% report changing their coverage within the last 5 years.[7]

VII. CONCLUSION

The findings in this paper suggest that somewhere between 30 and 40% of middle age American wives in need of life insurance protection are poorly insured. While this estimate may be biased upward because of errors in forecasting the earnings and remarriage potential of wives, it is biased downward because of the lack of adjustment for the economies of scale in shared living associated with marriage. Two additional reasons that the estimate may be biased downward are that we have made no adjustment for the consumption requirements of young children, and that we have excluded, because of the lack of data, most pension benefits. On balance, we believe our estimate of insurance inadequacy understates the problem of inadequate life insurance holdings of American households. In addition, our estimate is an average across wealthy households and those of more modest means. For lower income households our estimate is that almost half of those wives in need of life insurance protection are inadequately insured.

The results of this paper together with those of our previous study and the related literature strongly suggest that increased levels of social security survivor insurance as well as increases in employer-provided group life insurance could alleviate poverty among widows, especially elderly widows.

REFERENCES

AMERICAN COUNCIL OF LIFE INSURANCE (1988). "1988 Life Insurance Fact Book." Washington, DC.

[7] Indeed, in multivariate probit equations to characterize the factors contributing to insurance inadequacy (presented in an earlier version of this paper), we found that the presence of some group insurance reduced a wife's likelihood of suffering a serious drop in her living standard in the event of her husband's death.

AUERBACH, A. J., AND KOTLIKOFF, L. J. (1987). Life insurance of the elderly: Its adequacy and determinants, *in* "Work, Health, and Income among the Elderly" (G. Burtless, Ed.). The Brookings Institution, Washington, DC.

BURKHAUSER, R. V., HOLDEN, K. C., AND MYERS, D. A. (1986). "Marital Disruption and Poverty: The Role of Survey Procedures in Artificially Creating Poverty," Vanderbilt University Working Paper 86-W11.

FABER, J. F., AND WADE, A. H. (1983). "Life Table for the U.S., 1900–2050," Acturial Study No. 89 of December 1983, Social Security Administration Office of the Actuary, Publication SSA 11/11536.

FRIEDMAN, B. M., AND WARSHAWSKY, M. (1988). Annuity prices and saving behavior in the United States, *in* "Pensions in the U.S. Economy" (Z. Bodie, J. Shoven, and D. Wise, Eds.). Univ. of Chicago Press, Chicago.

HURD, M. AND WISE, D. "The Wealth and Poverty of Widows: Assets Before and After the Husband's Death," NBER Working Paper No. 2325, Cambridge, Mass.: National Bureau of Econonic Research, 1987.

HOLDEN, K. C., BURKHAUSER, R. V., AND MYERS, D. A. (1986). "Pensioners' Annuity Choice: Is the Well-Being of Their Widows Considered?," University of Wisconsin, Institute for Research on Poverty Discussion Paper 802-86.

KOTLIKOFF, L. J., AND SPIVAK, A. (1981). The family as an incomplete annuities market, *J. Polit. Econ.* **89,** 372–391.

LEWIS, F. D. (1989). Dependents and the demand for life insurance, *Amer. Econ. Rev.* **79**(3).

MYERS, D. A., BURKHAUSER, R. V., AND HOLDEN, K. C. (1986). "The Transition from Wife to Widow: The Importance of Survivor Benefits to the Well-Being of Widows," University of Wisconsin, Institute for Research on Poverty Discussion Paper 806-86.

YAARI, M. E. (1965). Uncertain lifetime, life insurance, and the theory of the consumer, *Rev. Econ. Stud.* **32,** 137–150.