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OCCUPATIONAL EXPERIENCE AND SOCIOECONOMIC VARIATIONS IN MORTALITY

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Occupational Experience and Socioeconomic Variations in Mortality

ABSTRACT

This paper explores to what extent occupational experience is responsible for the adverse effect of low income and education on mortality. Using Current Population Survey data on education and disability matched to Social Security data on earnings, disability, and mortality, this question is pursued by examining how the estimated effects of income and education are affected once occupational experience is included in the mortality model. The inclusion of various occupational experience variables, as measured in the Dictionary of Occupational Titles and the National Occupational Hazards Survey, has virtually no effect on the estimated effects of income and education on mortality. These findings suggest that the high mortality of low income and poorly educated persons is not due to characteristics of their employment but to other aspects associated with poverty.

Occupational Experience and Socioeconomic Variations in Mortality

I. Introduction

A strong inverse relationship between socioeconomic status and mortality in the United States has been well documented (e.g. Antonovsky, 1967; Kitagawa and Hauser, 1973; Yeracaris and Kim, 1978; Lerner, 1980; Rosenberg and McMillan, 1983; Rogot et al, 1988). Researchers have also found a pronounced effect of poverty on mortality even after accounting for the effect of health status on income (e.g. Caldwell and Diamond, 1979; Duleep, 1986a, Wolfson et al, 1993).[1] Yet, for policy purposes it is important to go beyond measuring the extent to which low socioeconomic status affects mortality and to identify what it is about low socioeconomic status that leads to higher mortality. This is particularly important given evidence that the relative relationship between mortality and socioeconomic status has stagnated or even worsened since 1960, despite improved access to medical care by the poor relative to persons with average and above incomes (Rosen and Taubman, 1979; Duleep, 1989; Feldman et al, 1989; Pappas et al, 1993).[2]

Exposure to unhealthy and hazardous work environments may be an important factor contributing to the relatively high mortality of poorly educated, low-income individuals. The lack of improvement in the relative socioeconomic mortality differential could conceivably be due to an over-time increase in the relative exposure to occupational hazards of low-wage, poorly educated individuals canceling out the effects of coincident improvements in their relative health

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[1]For British evidence, refer to Fox and Jones, 1985.

[2]Socioeconomic factors also appear to be responsible for persistent racial differences in mortality (Rogers, 1992).

environment such as improved access to medical care with the advent of Medicaid.[3]

Theoretically, one would expect occupational experience to contribute to the greater mortality of poorly educated, low-income individuals. Jobs requiring more education tend to be white-collar jobs. Hence, poorly schooled individuals face less of a choice of non-risky jobs than individuals with more education. As low-wage jobs generally require little or no training, the replacement costs of persons in such jobs are low. Consequently, the benefit to the employer of investing in the safety and health of workers in these jobs is lower than for highly trained individuals. The lower fixed costs associated with the employment of unskilled labor also implies that persons in low-wage jobs face less stable employment opportunities (Oi, 1962). As such, once employed, low-wage workers may be more reluctant to leave their jobs, even if they are hazardous, than would be the case for high-wage workers. This would, theoretically, be another factor lowering the benefit to the employer of investing in the safety and health of unskilled workers relative to highly skilled workers.

Empirical observations further hint of the possible importance of work experience in creating socioeconomic mortality differentials. The relative mortality differential between low-income and high-income individuals is larger for men than it is for women (Kitagawa and Hauser, 1973). It is also larger for adults of working age than for the retired population (Duleep, 1983; Kitagawa and Hauser, 1973). Bivariate tabulations of mortality rates and occupation show a strong relationship between occupational class and mortality. For instance, British death-certificate data classified by the decedent's usual occupation consistently reveal higher death rates

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[3]In commenting on this hypothesis, Rosen and Taubman (1979, p. 552) wrote: "Many of these [excess] deaths [of the poorly educated] may be related to a person's occupation because of accidents, exposure to chemicals and other dangerous elements, or stress. In a modern, industrialized economy, the more educated generally have different jobs [than the poorly educated] and may be less exposed to health hazards and perhaps to stress."

among persons in unskilled jobs than among persons in skilled and professional jobs (Townsend, Davidson, and Whitehead, 1988). Similar findings have been found with American data (e.g. Guralnick, 1963).[4] Although these analyses have not controlled for income and education -- hence the higher mortality of those in unskilled employment might be due to their low income and education rather than occupational hazards per se -- multivariate analyses have consistently found occupational experience to be significantly associated with disability, controlling for income and education (Burtless, 1987; Haveman and Wolfe, 1983; Leigh, 1983).

This paper explores to what extent occupational experience is responsible for the adverse effect of low income and education on the mortality of adult men in the United States. Section II discusses methodological considerations relevant to this study while reviewing several previous efforts to isolate the effect of occupational experience on mortality. Section III presents new empirical research that suggests that occupational experience is not an important factor underlying the higher mortality of low socioeconomic individuals. Section IV discusses caveats to the paper's central conclusion and speculates as to why the estimated occupational experience effects differ so dramatically from those found in disability studies.

II. Methodological Considerations

A crucial concern when measuring the effects of income and occupation on mortality is that ill health may lower wages and cause individuals to change their jobs or to stop working (Steiner and Dorfman, 1957, pp. 42-55; Luft, 1975; Bartel and Taubman, 1979).[5] Rather than reflecting the effect of low income on mortality, a negative income-mortality relationship may

[4]Refer to Rosenberg et al. (1993) for a very detailed recent analysis that relates mortality by cause to occupation and industry information on the death certificate.

[5]The research findings discussed in Section II are based on studies of men. Analysis of the effect of occupational experience (including housework) on the mortality of women may be found in Smith and Waitzman (1994) and references therein.

reflect the effect of poor health on mortality and on one's ability to earn (Kitagawa and Hauser, 1973; Fuchs, 1972; Auster et al., 1969). Estimated correlations between occupation and mortality are similarly suspect. For instance, Kitagawa and Hauser (1973) found service workers to have the highest mortality of all occupational groups. This association might be due, however, to a tendency for persons in poor health to be employed in such occupations rather than deleterious health effects associated with service occupations.[6]

To alleviate the reverse causality dilemma in mortality estimations the measurement of mortality risk can be temporally distanced from the measurement of income and occupation.[7] Distancing reduces the likelihood that measured income and occupation will reflect poor health preceding death. A related approach is to relate mortality to the usual occupation and usual income of respondents instead of the income and occupation immediately preceding the time period in which mortality risk is measured.[8] A third approach is to control for health conditions that may have affected measured income and occupation. Conditioning on previous health helps purge the estimated mortality effects of income and occupation from the reverse effect of poor health on these variables and may also help control for unmeasured variables such as genetics

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[6]Indeed, research by Verbrugge (1984) suggests that the relatively high chronic morbidity among male clerical workers reflects a process wherein men in poor health move from their usual blue-collar occupations to clerical jobs with lower physical demands. In their comparison of the mortality effects of latest occupation and longest occupation, Moore and Hayward (1990, p. 49) concluded that "...the high rate of death among clericals in terms of latest occupation is ... a product of the influx of less healthy men from other occupations. Almost without exception, those men entering clerical jobs have higher rates of death than incumbents."

[7]Caldwell and Diamond (1979) used this approach in their study of income's effect on mortality. Refer to Duleep (1986b) for a more complete discussion of various techniques to help control for health-related selection into socioeconomic categories.

[8]Burtless (1987) incorporated usual income and usual occupation into his analyses of disability and mortality. Moore and Hayward (1990) used usual occupation and controlled for health status in their analysis of mortality. Duleep (1986a), Menchik (1993), and Wolfson et al (1993) incorporated measures of usual income in their analyses of mortality.

and motivation that may affect both health and socioeconomic status.[9]

In addition to concerns about the direction of causality, another issue is, what income and what occupation should be used in the analysis? A problem with using measures that pertain to only one point in time is that higher or lower-than-average mortality may be due to experiences preceding or succeeding the chosen point in time. For instance, the premature death of an individual might be due to exposure to toxic chemicals on a job preceding a study's measure of occupation. Relating mortality experience to the measured occupation will incorrectly attribute the premature death to the measured occupation. To the extent that income and occupation affect mortality, this type of measurement error will downward bias the estimated coefficients. Since usual income and usual occupation are more likely to encompass experiences resulting in above- or below-average mortality risk than are point-in-time measures, measurement error may be reduced and the resulting estimated effects of income and occupation may be higher in studies that use usual occupation and income as opposed to point-in-time measures.[10] The estimated effects of usual income and usual occupation may also be higher than the estimated effects of point-in-time measures if prolonged exposure to low income or to certain occupations has a greater effect on mortality than short-term exposure.[11]

Given the correlation between income, education, and occupation, separating the effect of occupational experience on mortality from the effects of the other variables is problematic.

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[9]Studies of income's effect on adult male mortality that control for health conditions through the years in which income is measured include Rosen and Taubman (1979), Duleep (1986a), and Wolfson et al (1993). In an analysis of the mortality effects of occupational experience on women, Smith and Waitzman (1994) test the sensitivity of their results to a potential reverse causal path by limiting their sample to women who were healthy at the time employment status was measured. Nakamura, Nakamura, and Duleep (1990) discuss how conditioning on prior health may also help control for unmeasured variables that may affect both the probability of death and socioeconomic status.

[10]Duleep (1986a) found that the adverse effect of low income on mortality and disability increased when earnings averaged over several years were used instead of one-year measurements. Also refer to Smith and Zick (1994), Zick and Smith (1991), and Wolfson et al (1993).

[11]In analyses with point-in-time measures, the effects of long-term and short-term exposure are averaged.

One approach to isolate the mortality effect of occupational experience is to include in estimations of individual mortality categorical variables for occupation and industry along with measures of income and education. Using the National Longitudinal Survey of Older Men, Moore and Hayward (1990) included 10 broad occupational categories (but no industry variables) in a multivariate analysis of mortality from 1966 to 1981 for men aged 55 and older.[12] Controlling for family income, education, health status, demographic variables and year, Moore and Hayward found that men who had usually worked as craftsmen, operatives, servicemen, or laborers had significantly higher mortality than men who had usually worked in professional pursuits.

According to these results, occupational experience appears to be a key determinant of the high mortality of low-wage, poorly educated individuals. Yet, broad occupational categories such as laborer or professional may effectively proxy as measures of usual low or high income and low or high education, rather than capturing the effects of occupational experience per se. Furthermore, by using broad occupational categories, important hazards associated with specific jobs may be inadvertently concealed.

Given sufficient sample size, the ideal solution for separating the effects of occupational experience from those of income and education would be to include in multivariate mortality estimations categorical variables for detailed occupation and industry classifications. Detailed

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[12]Behrman, Sickles, and Taubman (1988, p. 177) incorporated three occupational categories (measuring the longest occupation) into their mortality analysis based on the Retirement History Study: "Compared to everyone else, managers and professionals live 0.6 to 0.9 percent longer." In addition, they found, using various measures of income such as Social Security benefits, pension income, and Supplemental Security income, that income mattered a great deal. Mare (1990) also incorporated occupational categories into his analysis of 1966-1983 male mortality. From the estimation of a model that included race, schooling, family assets, and the occupational categories associated with initial and 1966 occupations, Mare (p. 383) found that "...the mortality hazard for men in the top quartile of the asset distribution is only 60% of that for men in the bottom quartile". Once asset categories were included in the model, Mare found the mortality effect of the 1966 occupation to be much reduced. With respect to the initial occupation, a large benefit of initial employment in professional or managerial occupations persists. Among all other blue-collar and white-collar categories Mare found, controlling for assets, little difference in mortality.

occupation/industry categories will more effectively capture exposure to hazardous and unhealthy conditions associated with particular jobs than will broad occupational categories such as service worker or laborer. To the extent that income and education are picking up the mortality effects of job-specific health hazards, the finer control for work-related hazards with the inclusion of more detailed occupation/industry categories will result in a decline in the estimated effects of income and education. On the other hand, to the extent that broad occupational categories are serving as measures of socioeconomic status, rather than capturing the effects of occupational experience per se, the inclusion of progressively finer measures of occupation and industry will increase the estimated importance of income and education.

Although a longitudinal data set large enough to estimate in a multivariate framework the mortality effects of detailed occupation/industry categories does not exist, Burtless (1987) introduced broad measures of respondents' usual industry as well as their usual occupation into a multivariate analysis of the disability and mortality of older men based on the Retirement History Study. (The occupation categories were the same as those employed by Moore and Hayward.[13]) As long as the extent of occupational hazards varies across industries, the addition of industry variables should help to more effectively capture the mortality effects of exposure to work-related hazards. Thus, one would expect income's estimated effect to be lower in the Burtless analysis than in the Moore and Hayward analysis to the extent that income was picking up the mortality effects of work-related hazards in the Moore and Hayward analysis. Nevertheless, Burtless found that income has a large and highly significant effect on mortality. Furthermore, in contrast to Moore and Hayward, usual employment as a laborer, operative, or service worker was not significantly associated with mortality.

The Burtless results suggest that occupational experience does not importantly contribute

[13]Burtless combined farm laborers with other laborers whereas Moore and Hayward treated farm laborers separately.

to the high mortality of low-wage, poorly educated individuals. An important caveat to this conclusion is that the Retirement History Study is limited to persons who were at least 58 years of age when they were first interviewed. As pointed out by Burkhauser (1987), analyses based on the mortality of older persons will underestimate the mortality effect of occupational experience to the extent that occupational health and safety hazards cause persons to die at younger ages. Furthermore, the broad occupation and industry categories used by Burtless may have ineffectively controlled for health-related occupational experiences; the strong income effect found by Burtless may have been due to low income picking up the mortality effects of hazardous and unhealthy occupational experiences associated with low-wage jobs.

An alternative to directly incorporating occupational categories into the mortality estimation is to use measures of work-related health hazards associated with detailed occupation and industry categories. This approach requires a much smaller sample size than would be required to estimate a model that directly incorporates detailed occupation/industry categories since it groups occupation/industry categories according to measured exposures to occupational health hazards. The advantage of this strategy, over the use of broad occupational categories, is that it allows differentiation of the occupational risks associated with very detailed occupational/industrial categories. As such, health-related occupational experiences may be more effectively measured (and hence controlled for) than when broad occupational categories are directly incorporated into the analysis. One well known source of information on occupational characteristics, including the presence of health hazards, is the Dictionary of Occupational Titles (DOT).

The mortality effects of DOT job attributes were estimated by Moore and Hayward (1990) in addition to their analysis of occupational categories.[14] Four scales, created by combining various DOT factors and matched to the occupation codes of respondents, were included in the mortality analysis instead of the occupational categories. The DOT-based scales were substantive complexity, physical demands and environmental hazards, social skill, and manipulative skill:

> Substantive complexity reflects two key work features found to influence the risk of death from occupationally induced stress: routinization and autonomy... Accordingly, increases in substantive complexity should lower mortality. Physical and environmental demands are defined in terms of specific physical requirements and hazards on the job; thus this factor reflects a work environment that is potentially detrimental to the health of the individual and should increase mortality. Social and manipulative skills represent distinct orientations to the nature of work and indirectly condition exposure to work-related hazards. Social skill refers to the ability to adapt to situations involving interaction with others.... manipulative skills emphasize working with objects such as tools and machinery.... Exposure to health hazards is thus more likely in occupations with high manipulative skills than in those for which the demands are primarily people oriented. (Moore and Hayward, 1990, pp. 36-7)

Unexpectedly, given their results using occupational categories (and the results of disability analyses using the DOT[15]), Moore and Hayward did not find a statistically significant relationship between mortality and the physical demands and environmental hazards of the occupations in which the respondents were usually employed.[16] On the other hand, they found that men whose usual occupation ranked low in substantive complexity had significantly higher mortality than men whose usual occupation ranked high in substantive complexity.

In interpreting these results, it is well to keep in mind that Moore and Hayward combined

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[14]Another example of a mortality study incorporating information on work-place health conditions is Behrman, Sickles, and Taubman (1990). They matched insurance-premium risk classes and a physical activity index to occupation/industry categories in a study examining the sensitivity of estimated hazard function coefficients to sample length, alternative functions for the baseline hazard, and treatment of heterogeneity. They found that less occupational activity and greater occupational risk are associated with shorter life spans. Although their analysis did not include measures of income and education, and as such does not directly relate to the question explored in this paper, the issues that they analyze are important for future research on the effect of occupational exposure on mortality.

[15]Refer to the discussion of Haveman and Wolfe (1983), Iams (1983), and Leigh (1983) in Section IV.

[16]The level of social skills and the level of manipulative skills required by a person's usual occupation were also not significantly associated with mortality.

distinct DOT job attributes into composite measures.[17] The use of these multi-item scales makes interpretation of the estimated parameters difficult. Although in their discussion of the mortality effects of substantive complexity Moore and Hayward stress two components of that measure that have been linked to health -- routinization and lack of autonomy -- substantive complexity is in fact an amalgam of several DOT factors including the amount of training required for jobs. Since level of schooling is positively associated with on-the-job training (Mincer, 1962; D. O'Neill, 1977; J. O'Neill, 1983), lack of substantive complexity may be picking up mortality effects associated with the low education of persons who hold jobs ranking low in substantive complexity, rather than a detrimental health effect of repetitive work lacking autonomy. Conversely, the reason that exposure to environmental hazards failed to show a significant mortality effect may be due to its being combined with the level of physical activity required by a job in the composite measure "physical demands and environmental hazards." This composite measure is particularly troubling given evidence in Behrman, Sickles, and Taubman (1988, 1990) that employment in sedentary jobs increases mortality. By combining on-the-job exposure to health hazards with the level of job-related physical demands, a potentially adverse effect on mortality of occupational health hazards may be concealed by a potentially beneficial effect of greater physical activity. Furthermore, as with the Burtless study, Moore and Hayward analyzed the mortality of older men. As such, their estimates may underestimate the mortality effect of hazardous working conditions.

> Hazardous working conditions...may have the greatest impact on mortality at younger ages, a possibility we cannot observe. If true, only the hardiest men in these risky occupations will have survived long enough to have been included in our sample. Selectivity of this type will tend to bias downward the effect of occupational risks. (Moore and Hayward, 1990, pp. 35-36)

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[17]These composite measures were initially created for a study examining how the attractiveness of the work environment affects labor force participation at older ages (Hayward et al., 1989).

III. Occupational Experience and Socioeconomic Mortality Variations for Men 35-64 Years Old

I explored the effect of the occupational experience of men, 35-64 years of age in 1973, on their subsequent mortality during a six-year period following measurement of their income, education, disability status, occupation, and industry.[18] The basic data base used for analysis is the longitudinal CPS-IRS-SSA Exact Match file (Aziz, Kilss, and Scheuren, 1978; DelBene, 1979). This data set links information on the education, income, occupation, and industry of individuals, as measured in the 1973 Current Population Survey (CPS), to Internal Revenue Service (IRS) income tax return information and longitudinal Social Security Administration (SSA) records on earnings, disability, and mortality. The mortality data on the file indicate whether individuals in the CPS sample died during the years 1973-1978.[19] To ensure accurate use of the Social Security mortality data, the study population was limited to white married men employed in Social Security covered employment with sufficient quarters in that work to be eligible for disability benefits.[20]

Using occupation and industry of employment, I matched several DOT job characteristics to each individual record of the Exact Match File. The DOT data were collected by U.S. Employment Service inspectors from on-site observations and other sources of information for each of 12,099 "jobs".[21] To facilitate their use in statistical research, the DOT data were mapped

[18]The period over which mortality is measured is actually somewhat short of 6 years. The starting point of the mortality risk period is the March 1973 Current Population Survey. Deaths of survey respondents were searched in all sources of Social Security administrative data up through the records for 1978.

[19]A drawback of the original Exact Match file for this study's purposes is a severe undercoverage of mortality information for the non-retired population. This problem was overcome by accessing all sources of Social Security death reporting. The resulting mortality information, which indicates only whether or not an individual died during 1973-1978 and not the year of death during this time interval, precludes hazard analysis.

[20]Death reporting for this population should be close to perfect. Refer to the introductory discussion and cited references in Duleep (1989) for information on the quality of mortality reporting for this study population.

[21]The DOT jobs are really occupation-industry categories that are more detailed than the Census occupation-industry categories.

into detailed census occupation and industry classifications. In particular, the DOT data were averaged across all individuals within census occupation-industry codes by weighting the contribution of each DOT job according to the distribution of labor (by DOT job) within each census category.[22] The resulting data set contains the average working conditions of persons in each of 574 census occupation-industry categories. Typically, the DOT data collected by the U.S. Employment Service indicate the presence or absence of a given condition in a particular job. Thus, the corresponding census occupation-industry measure indicates the percent of workers within a given occupational/industrial group for which the condition is relevant. These measures could be interpreted as estimates of the likelihood that an individual in a particular occupation and industry will be exposed to particular working conditions.

DOT job characteristics that I linked to the Exact Match File include the percent of workers within each occupation-industry category who are exposed on the job to fumes, odors, dust, gases, and poor ventilation (ATMOSPHERIC CONDITIONS), the percent exposed to hazardous conditions other than atmospheric conditions (HAZARDS), and whether work in a given census occupation-industry category is sedentary (SEDENTARY).[23] I also added three DOT variables that may adversely affect health through their effect on stress.[24] Two of these variables are the percent of workers in a given occupation-industry category who are exposed to noise or vibration (NOISE) and the percent of workers performing repetitive tasks

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[22]Weights for the contribution of each DOT code within each census occupation-industry code were derived from an analysis of the April 1971 Current Population Survey, which was coded with both the census occupation and industry codes and the DOT codes. Refer to the Appendix for further details on the DOT data and their development.

[23]The DOT assigns a five-level code ranging from sedentary (code 1) to very heavy (code 5) for the degree of physical effort required in a particular job. Thus, the measure for each of the 574 census occupation-industry categories is the average level of effort required in that group of jobs. I designated the census job group as sedentary if the averaged value across all DOT codes within a census occupation-industry category equalled one. That is, a census job group is classified as sedentary if all of the jobs in the occupation-industry category were designated by the DOT as sedentary.

[24]Stress is believed to increase blood pressure and lower resistance to disease (Ashford, 1975).

(REPETITIVE).[25] Studies have also suggested that performing under stress in jobs with little or no authority adversely affects health (Ashford, 1975). As a proxy for this working condition, I used the product of two DOT-based variables: the percent of workers with little or no responsibility for the direction, control or planning of their work activity and the percent of workers in the occupation-industry category performing under stress (STRESS NO CONTROL).

Estimating the mortality effects of income and occupation requires information on health over each individual's life since past as well as current health problems could increase mortality risk as well as affect occupation and income. To help control for health status, a dummy variable (PREVIOUS DISABILITY) was created that equals 1 if the person was recorded as ever disabled prior to 1973 on the Social Security records or if the CPS reported that health prohibited or limited work in 1972.[26]

Table 1 shows the maximum likelihood estimates of the effects of "usual" earnings and education in a logit model of mortality. Social Security earnings data are used in this estimation.[27] The reference income variable in Table 1 is $31,909 and above in 1994 dollars.

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[25]Noise and repetitive work have also been hypothesized to increase the likelihood of accidents.

[26]The Social Security data provide an annual record of the onset of disability preventing gainful employment. The CPS data record whether ill health was the reason for no work or part-time work in the year 1972. Using both sources of information provides a better control for health conditions that could have affected income and occupation than a measure based on only one of these data sources: the Social Security data include cases of disability, prior to 1972, not measured by the CPS; the CPS measure includes less severe health problems affecting work in 1972 not measured by the Social Security data.

This paper's mortality equation is an outgrowth of a previous two-equation model (Duleep, 1986a) which estimated income's effect on mortality, controlling for disability, in one equation and income's effect on disability in another equation. This two-equation approach made it possible to estimate the extent to which income affected mortality through its effect on the disability experience that was controlled for in the mortality equation. (Further explanation of the model may be found in Duleep 1986a.) For providing estimates of income's effect on mortality through its effect on disability, it was convenient to combine the Social Security and CPS disability information into one variable. However, since the CPS and SSA measures respectively provide information on different dimensions of health status, future analysts may want to separately include these variables in the mortality estimation rather than combining them into one measure as I have done.

[27]To better approximate usual income, the Social Security earnings data were averaged over the four years, 1969 through 1972. During these years, Social Security earnings data were recorded only up to a taxable ceiling of $31,909 in 1994 dollars. This is not much of a constraint since analysis with 1972 IRS and CPS data, controlling for health status, age, and education, showed no significant income effect beyond the first three income categories used in this analysis. The estimated effects of income on mortality across a broader income range using CPS and

The basic question addressed in this paper is, to what extent does occupational experience account for the estimated effects of income and education on mortality? To explore this question, the association between income, education, and probability of death was estimated excluding and including measures of occupational experience in the mortality model.

The model in the first column of Table 1 excludes occupational experience. Consistent with an earlier analysis of the Exact Match File (Duleep, 1986a), this estimation suggests the following findings: (1) Controlling for previous and concurrent disability, low income has a large adverse effect on mortality. According to the estimated coefficients, the probability of death during 1973-1978 for a non-disabled 50-year-old man in the lowest income category with 12 years of schooling is 85 percent higher than for his counterpart in the highest income category.[28] (2) The pattern of estimated income effects suggests that the marginal benefits on mortality associated with income diminish as income increases.[29] (3) The estimated relationship between education and mortality is nonmonotonic.

The large adverse effect of low income on mortality may be due in part to occupational risks encountered in low-wage jobs. The fact that persons who do not complete high school or a four-year college program have higher death rates than those who graduate may be because members of the former group are more likely to work in blue-collar jobs where they run a greater risk of being exposed to occupational hazards. These hypotheses can be tested by incorporating occupational experience into the analysis.

The second model in Table 1 includes DOT variables measuring exposure to various

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IRS income data are given in Duleep (1986a).

[28]According to the logit model coefficients, the estimated probability of death during 1973-1978 for a 50-year-old, nondisabled man with 12 years of schooling in the highest income category is $1/(1 + e^{-(-7.488195 + .489186 + .081335 \times 50)}) = .0506$ versus .0937 for his counterpart in the lowest income category.

[29]As discussed in note 27, previous work using income information over a broader income range found that increases in income above average levels of income are not significantly associated with lower mortality.

environmental work-place conditions. Their inclusion has virtually no effect on the income and education coefficients. Furthermore, none of the occupational experience coefficients are statistically significant at conventional levels.[30] If exposures to hazards are compensated, as economic theory would predict (Thaler and Rosen, 1975; Leigh, 1991), the insignificant estimated occupational effects could be the result of a beneficial mortality effect of the higher income associated with hazardous jobs canceling out the detrimental mortality effects of increased exposure to hazardous conditions. If this were the case, then using more detailed income brackets to better control for income's effect on mortality should help reveal the mortality effect of occupational experience per se. However, re-estimating the second model in Table 1 with narrower income brackets had no effect on the estimated coefficients of the occupational variables.

Conceivably, the DOT data may only identify health and safety hazards for which firms have implemented control measures (Luft, 1978). Given the tendency for employers to invest less in unskilled labor, unskilled jobs would, theoretically, be less likely to have institutional mechanisms in place for monitoring occupational hazards. It may be exposure to *uncontrolled* hazards that accounts for the high mortality of low-wage earners. To test this idea, another source of information on work-place conditions was tapped.

The National Occupational Hazards Survey (NOHS) collected information from 1972 to 1974 on the distribution of potential employee exposures to chemical substances and physical hazards (National Institute for Occupational Safety and Health, 1977).[31] A special feature of the survey data is information on the percent of employees in given industries who are exposed to chemical and physical hazards without institutional mechanisms to control exposure to hazards.

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[30]The estimated effects of exposure to hazards, harmful atmospheric conditions, noise, and stress also have the "wrong" sign.

[31]Refer to the Appendix for further details on the NOHS data.

More specifically, data on exposure are delineated according to whether environmental conditions are monitored in the work place, whether safety engineering services are available, whether a safety committee is established, whether periodic medical exams are provided, whether absenteeism records are kept, and whether health information on new employees is collected. This information is provided for 28 industries in all.[32] The NOHS data provide the percent of workers in each industry who are exposed to health and safety hazards without a specific control mechanism.[33]

Using industry of employment, I linked to the Exact Match File the NOHS information on likelihood of exposure to uncontrolled health and safety hazards. To help differentiate likely exposure by type of worker, I assumed that white-collar workers were not exposed to uncontrolled health and safety hazards in their places of work. The mortality model was estimated including each of the NOHS variables measuring exposure to hazards without a specific control mechanism. For instance, one estimation included the variable "percent of men in industry *i* exposed to hazards in work places lacking a safety committee"; another estimation included the percent of men in industry *i* exposed to hazards in work places that do not monitor

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[32]The NOHS industrial classifications are: 1. agricultural services, forestry, and fisheries; 2. mining; 3. contract construction; 4. ordnance and accessories; 5. food and kindred products; 6. tobacco manufactures; 7. textile mill products; 8. apparel and other textile products; 9. lumber and wood products; 10. furniture and fixtures; 11. paper and allied products; 12. printing and publishing; 13. chemical and allied products; 14. petroleum and coal products; 15. rubber and plastics; 16. leather and leather products; 17. stone, clay, and glass products; 18. primary metal industries; 19. fabricated metal products; 20. machinery, except electrical; 21. electrical equipment and supplies; 22. transportation equipment; 23. instruments and related products; 24. miscellaneous manufacturing industries; 25. transportation and other public utilities; 26. wholesale and retail trade; 27. finance, insurance, and real estate; and 28. services.

[33]The NOHS data on the percent of employees in given industries who are exposed to chemical and physical hazards without institutional control mechanisms are not differentiated according to the type of hazard or the severity of exposure. If institutional control mechanisms are less likely where the type or the severity of exposure is less hazardous then estimates of the effectiveness of various institutional control mechanisms on employee health or mortality, using the NOHS data used in this paper, will be downward biased. Researchers who wish to estimate the potential effectiveness of institutional control mechanisms may want to use the NOHS data on exposure to specific hazards (such as asbestos) which is also delineated according to whether institutional control mechanisms are present rather than the more general data on exposure to chemical and physical hazards without a control mechanism present used in this analysis.

environmental conditions.[34]

I also linked to the Exact Match File, Bureau of Labor Statistics (BLS, 1979) information on job-related injury rates (including fatalities) by industry for the year 1978.[35] As with the NOHS data, I tried to differentiate expected job hazards by type of worker by assuming a zero incidence rate for white-collar workers.

The results from the analysis including one of the NOHS variables and the BLS accident rate are shown in the third column of Table 1.[36] Inclusion of these variables has very little effect on the estimated effects of income and education on mortality. This is true regardless of the particular NOHS exposure-without-control variable used in the estimation.[37]

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[34]Since the presence of any one of the institutional control mechanisms might help monitor and possibly control health hazards, we would ideally like to estimate regressions including the probability that individual *i* is exposed to hazards in a workplace without various combinations of institutional control mechanisms (e.g. without safety engineering services or a safety committee or periodic medical examinations but with the other NOHS-measured institutional control mechanisms, or without any type of institutional control mechanism). However, the published NOHS data only provide information on the percent of employees in an industry exposed to hazards without a particular institutional control mechanism rather than the percent exposed to hazards without particular combinations of control mechanisms. In order to more effectively control for the probability of being exposed to hazards without any type of institutional control mechanism (or potentially important combinations of control mechanisms), future analysts may want to include several of the NOHS measures in one estimation rather than one measure at a time as was done here. In practice, the different NOHS measures are highly collinear.

[35]The BLS data provided injury incidence rates for 68 two-digit Standard Industrial Classification (SIC) codes. This information was imputed to the 3-digit 1970 census industry codes used in the CPS using a BLS cross-walk. Information on the correspondence between the industry codes used in the BLS data and those in the Exact Match File is available from the author.

[36]The particular NOHS variable used in the estimation shown in Table 1 is the percent of workers in each industry that are exposed to health and safety hazards in facilities which do not record health information about new employees.

[37]Although uncontrolled occupational hazards do not appear to account for the higher mortality of low-income persons (since their inclusion in the estimation has almost no effect on the estimated income coefficients), the estimated coefficients hint at a potentially important effect on mortality. For instance, the estimated effect of the NOHS variable shown in the third column of Table 1 indicates that the probability of death during a 6-year period for a 50-year-old, nondisabled man in the highest income category with 12 years of schooling is 52 percent greater if he is exposed to hazards in a work place lacking control or information mechanisms than if he works in a setting where hazards are either absent or controlled. This analysis is based on NOHS data tabulated by industry. The effect of uncontrolled hazards on mortality could be more satisfactorily explored if the National Institute for Occupational Safety and Health made available tabulations of "exposure without control" for occupation/industry categories.

IV. Discussion

The central question pursued in this paper is, to what extent does occupational experience account for the high mortality of persons of low socioeconomic status? The large adverse effect of low income on mortality might be due to the working conditions of low-wage jobs. Occupational experience might also account for the estimated nonmonotonic relationship between education and mortality. These hypotheses were tested by examining how the estimated effects of income and education were affected once variables measuring occupational experience were included in the mortality model.

Including various occupational experience variables in the mortality model barely changes the estimated effects of income and education. Nor do the occupational experience coefficients achieve statistical significance. These results are consistent with those of Burtless (1987) in his analysis of the mortality of older men. By analyzing the mortality of men who are 35 and older, this study addresses an important caveat of the Burtless study -- that the lack of an occupation effect in a study based on the mortality of men 58 and older might have been due to a selection process whereby only the hardiest of men experiencing occupational hazards survive to older ages.[38]

The estimated effects of occupational experience in this study and in the Burtless mortality analysis are at odds with several disability studies that have estimated a strong and significant effect of occupational experience on disability controlling for income and education. Haveman and Wolfe matched Dictionary of Occupation Titles (DOT) information on working conditions to the occupation of individuals in an analysis of self-reported disability using the Panel Study of Income Dynamics. Controlling for income and education, their research revealed that "...hours exposed to hazardous jobs or those requiring stooping or outdoor work are

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[38]Such a selection process has been hypothesized as one reason for smaller mortality differentials by race and income at older ages (Kitagawa and Hauser, 1973; Duleep, 1986a).

statistically significant and are associated with health deterioration..." (Haveman and Wolfe, 1983, p.9).[39] Iams (1983) also estimated a strong relationship between job-related health conditions measured by the DOT and disability using the 1978 Survey of Work and Disability. Burtless (1987) found, in contrast to his mortality results, that usual employment as a laborer, operative, or service worker was strongly and significantly associated with disability.

What accounts for the difference between the estimated occupational experience effects on disability and mortality? One possibility is that many disabilities caused by work conditions do not shorten life. Another possibility is that the estimated occupation-disability relationship in studies of self-reported disability may reflect the effect of disability on a person's ability or propensity to continue working, rather than the effect of occupational experience on the incidence of disability. Luft (1978, p.91) suggested that the likelihood that an individual considers him or herself disabled can be divided into two factors that determine reported disability:

> The first factor is the likelihood that the job or working conditions lead to a given medical condition.... The second factor is the likelihood that this condition, regardless of its cause, interacts with the requirements of the job to make normal work activity difficult.[40]

In line with this explanation, Luft found that job characteristics are important in determining the overall probability of disability, regardless of the cause of the condition: "Some jobs that have essentially no conditions that lead to disability are nonetheless very sensitive to certain functional

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[39]Also see Leigh (1983).

[40]Iams (1983, p.1) comments: "Persons with greater educational levels take jobs with less activity demands than persons with lesser educational levels. When functional limitations develop for activities such as walking required on the job, lesser educated persons are more likely to limit their work than better educated persons. A work impairment plausibly reflects not only the individual's capacity, but the activity demands made in the work place." Burtless (1987, p. 105) also notes this problem: "An older worker might report a health limitation because his job has caused an actual deterioration in his health and because it requires better health than is typical for a worker his age." Burtless investigated these two effects by exploring the relationship between occupational experience and a variety of health measures which varied in their degree of subjectivity. One way to eliminate self-reporting bias is to use data from physical examinations such as those performed in the National Health Examination Survey (NHES). Luft (1978) used the NHES along with other data sources in his study of disability. A potential shortcoming of such data is that they are limited to health problems that can be easily identified in an examination.

limitations and will have high disability rates." (Luft, 1978, pp. 101-102). Burtless (1987, p. 106) also found that "industry and occupation have a much stronger influence on work-related health measures than on measures that are less directly related to work capacity."

More generally, Luft proposed that disability is a function of the interaction between physical limitations and normal activities and job requirements, the degree to which individuals and/or their jobs are adaptable, and alternatives to disability status (Luft, 1978, p. 21). In addition to the activity requirements of a person's job, individual assessments of health may be affected by how much a person enjoys their work (Hayward et al., 1989) and the difference between their wage and alternative income sources, as well as the probability of receiving alternative income support (Halperin and Hausman, 1986). Mortality studies are, of course, immune to these concerns.

The lack of a statistically significant occupational effect on mortality found in this analysis should not be taken as any indication of the importance of current or potential occupational safety and health regulations designed to counter specific work-related hazards. The data I have used are not refined enough or of sufficient sample size to, for instance, capture the relationship between job exposure to coal dust and shortened lives due to black lung disease or to reveal the extremely high accident rates accompanying certain lines of work.[41] Nor does this study address what would occur in the absence of existing occupational safety and health regulations.

In thinking about this study's estimated coefficients, several reasons come to mind as to why the effect of occupational experience on mortality may be understated. First, job characteristics were matched to respondents' usual occupation and industry in 1972, not their usual lifetime occupation and industry. Although usual job and most recent job are highly

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[41]Leigh (1989) finds high death rates in certain occupations such as timber cutters and loggers, asbestos and insulation workers, structural metal workers, and electric power-line and cable installers and repairers.

correlated,[42] both measurement error and duration effects (discussed in Section II) could work to understate the effects of occupational experience. Furthermore, the occupational experience data do not measure actual exposure to health and safety hazards. They measure instead the likelihood of exposure in a given industry and occupational category. Nor is the information differentiated according to intensity of exposure. Greater precision in measuring the incidence and intensity of exposure could affect the magnitude of the estimated effects of occupational experience. Finally, the analysis ignores the effect of occupational experience on mortality through its effect on disability that occurred prior to or concurrent with the measurement of occupation and which is controlled for in the estimation.[43,44] It is also questionable how generalizable results concerning the effects of occupational experience are for a sample restricted

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[42]In their study using the National Longitudinal Survey, Mott and Haurin found a close association between usual job and current or last job: "In most instances, [current or last job] is a good proxy for the longest job the respondent has held during his work life.... When the current or last job held by all respondents in the mature men's cohort as of 1976 was cross-tabulated by the *longest* job held by the respondents in 1966, there was a 71 percent correspondence at the 1-digit Census occupation level. In addition, a significant portion of the remaining 29 percent were in major occupation groups not dissimilar to the one reported as the longest occupation (e.g., laborer compared with operative, and manager with professional)." Mott and Haurin (1985, pp. 34-35, note 9)

[43]This unmeasured effect would be of greater concern if mortality risk was only measured immediately after the measurement of occupational experience rather than across a period of six years. One approach for learning the extent to which an indirect effect of occupational experience on mortality through disability has been ignored would be to examine how the estimated mortality effect of occupational experience is affected as the measurement of mortality risk is distanced from the measurement of occupational experience. Unfortunately, this type of analysis is not possible since the data set, which consolidated several sources of Social Security mortality information, only denotes the occurrence of mortality during 1973-1978. Another approach, which has been used in the analysis of income's effect on mortality, is to estimate a two-equation model in which the disability that is controlled for in the mortality equation is also predicted in a disability equation. This approach permits analysis of the "direct effect" of income on mortality, controlling for disability preceding or concurrent with the measurement of income in the mortality equation, and an "indirect effect" of income on mortality through income's effect on the disability experience controlled for in the mortality equation (Duleep, 1986a). Due to the concerns raised by Luft (1978) this approach, applied to the analysis of occupational experience, would require a measure of disability that is unaffected by a persons's circumstances, such as a medical examination.

[44]A shortcoming of all studies that use occupation-specific measures of risk (instead of the occupation-industry categories themselves) is that an accurate knowledge of what constitutes a health hazard is presumed from the outset. To guard against the possibility that the DOT and NOHS data are unreliable sources of information, the results of this analysis should be tested using other sources of occupational health and safety information such as Leigh's occupational hazard data based on Workers' Compensation files (Leigh, 1991) and the Behrman, Sickles, and Taubman (1990) insurance-premium risk index. Of course, care must be taken that the chosen index measures job attributes per se as opposed to the attributes of the job holders. Ideally, instead of using measures of risk which are then matched to occupation/industry categories, a multivariate data set should be created of sufficient sample size so that categorical variables for detailed measures of occupation and industry could be directly incorporated into the analysis. Proposals and exploratory work to create such a data set based on the Social Security Administration's Continuous Work History Sample are discussed in Kilss, Scheuren, and Buckler (1984), Koteen and Grayson (1984), Sailer, Orcutt, and Clark (1984), Rosenberg, Burnham, Spirtas, and Valdisera (1984), and Duleep (1986b).

to white married men in Social Security covered employment.

Despite the imprecision of the exposure data, the possible exclusion of an indirect occupational effect on mortality, and the restricted sample, one would have nevertheless expected a drop in the importance of the estimated effects of income and education on mortality with the inclusion of occupational experience if work-place health and safety hazards were a major reason for the relatively high mortality of persons of low socioeconomic status. The fact that the coefficient on low income is essentially unaffected by the inclusion of occupational experience variables suggests that the high mortality of low-income persons is not due to characteristics of their employment but to other aspects associated with poverty. Similarly, the nonmonotonic relationship between education and mortality is unaltered with the inclusion of occupational experience.[45]

As such, the findings of this paper constitute one piece of evidence that occupational experience is not responsible for the large adverse effect of low income and low education on mortality. On the basis of this analysis, it also seems unlikely that occupational exposure associated with low-wage jobs is responsible for the lack of improvement over time in socioeconomic mortality differentials or for the larger socioeconomic mortality differentials of men versus women and of the working-age population versus the retired population. The living environment of the poor, the extent of preventive health care, and the effect of poverty on motivation and time preferences[46] may be more fruitful areas to search for poverty's causal role in determining mortality.

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[45]Rather than reflecting the effect of the types of employment people have, the higher mortality rates of persons who drop out of high school and college may reflect a process whereby those who graduate are also more likely to invest in their health.

[46]Studies along these lines from a variety of perspectives include Leigh (1986), Duleep (1986c), Fuchs (1982), and Grossman (1972).

Table 1: Logit Model Estimation of Probability of Death from 1973-1978, White Males 35-64 Years Old[a]			
	Excluding occupational experience	Including occupational experience (DOT data)	Including occupational experience (DOT, BLS, and NOHS data)
Income Categories in 1994 Dollars[b]			
$0-10,635	.662776 (4.43)	.648663 (4.32)	.630638 (4.21)
$10,636-21,271	.315770 (2.38)	.311099 (2.33)	.284562 (2.11)
$21,272-31,908	.109998 (1.12)	.118265 (1.20)	.104645 (1.06)
Years of Schooling[c]			
0-8 years	.554880 (2.98)	.639289 (3.33)	.612380 (3.12)
9-11 years	.784255 (4.21)	.866464 (4.55)	.848185 (4.37)
12 years	.489186 (2.72)	.538012 (2.97)	.526181 (2.87)
13-15 years	.820727 (4.16)	.837400 (4.25)	.830216 (4.20)
Job Characteristics			
Noise		-.260014 (1.57)	-.378982 (2.51)
Repetitive		.112025 (0.79)	.139683 (0.96)
Stress no control		-.332264 (0.78)	-.404059 (0.99)
Sedentary		.007222 (0.06)	.025327 (0.20)
Atmospheric conditions		-.247591 (0.90)	
Hazards		-.070118 (0.43)	
Atmospheric conditions and hazards without control mechanism			.462513 (1.41)
Accident rate			-.002901 (0.33)
Previous and concurrent disability	.714785 (6.45)	.719298 (6.47)	.722318 (6.49)
Age	.081335 (14.90)	.080977 (14.82)	.081382 (14.86)
Intercept	-7.488195 (23.27)	-7.431969 (22.72)	-7.463096 (22.75)
-2 log-likelihood	4669.38	4660.32	4659.36

[a]9,618 observations; 753 deaths. Asymptotic t-statistics in parentheses.

[b]The reference variable is income above $31,909 in 1994 dollars.

[c]Completion of four years of college and above serves as the reference variable.

Appendix: Dictionary of Occupational Titles Data and the National Occupational Hazards Survey

For further information on the Dictionary of Occupational Titles (DOT) data as collected by the U.S. Employment Service, refer to the U.S. Department of Labor, Dictionary of Occupational Titles, Fourth Edition, Washington, D.C.: U.S. Government Printing Office, 1977 and U.S. Department of Labor, Handbook for Analyzing Jobs, Washington, D.C.: U.S. GPO, 1972. A computer tape known as the "DOT master file" contains the scores on 44 characteristics for 12,099 jobs. This tape is available from the National Technical Information Service. Refer to Pamela S. Cain and Donald J. Treiman, "The Dictionary of Occupational Titles as a Source of Occupational Data," in American Sociological Review, Vol. 46, 1981, pp. 253-278, for a description of the DOT data and the creation from these data of a job characteristics data set compatible with census occupation-industry categories. Each census occupation-industry category (to which the DOT job characteristics were mapped) is a 7-digit code consisting of three parts -- a census occupational code (3 digits), a census industry code (3 digits), and a self-employment code (1 digit). Documentation for the DOT-census occupation/industry data set can be found in Patricia A. Roos and June Price, Fourth Edition Dictionary of Occupational Titles: Scores for 1970 Census Categories, National Academy of Sciences, 1981. The documentation and tape are available from the National Technical Information Service.

The National Occupational Hazard Survey (NOHS), conducted from 1972 to 1974, was a national data-gathering effort undertaken by the National Institute for Occupational Safety and Health (NIOSH) to determine the extent of worker exposure to chemical and physical agents. The sample of businesses in the survey, representative of all non-agricultural businesses covered under the Occupational Safety and Health Act of 1970, was selected by the Bureau of Labor Statistics and consisted of approximately 5,000 establishments in 67 metropolitan areas throughout the United States. Data were collected by a team of 20 engineers who were specifically trained to recognize hazards in the occupational environment. During the survey, approximately 8,000 chemical substances and physical agents were identified as potential hazards. The first two volumes of the three-volume final report (NIOSH, 1977) provide information on the development of and statistical design of the survey. Volume 3 presents ninety-three summary tables derived from the survey data. These tables characterize the national universe, profile the medical, safety, and industrial hygiene programs by Standard Industrial Classification and plant size, present national exposure estimates for the 200 most common hazards by industry type, and provide information on the presence and types of control measures observed.

Information for the numerator of each NOHS variable used in this paper's analysis came from the following tables in volume 3 (NIOSH, 1977) -- table 53: number of persons exposed to hazards in facilities that do not receive industrial hygiene services; table 54: number of persons exposed to hazards in facilities that do not receive safety engineering services; table 55: number of persons exposed to hazards in facilities that do not record health information about new employees; table 56: number of persons exposed to hazards in facilities that do not require pre-placement physical examinations; table 57: number of persons exposed to hazards in facilities that do not provide periodic medical examinations of any type; table 58: number of persons exposed to hazards in facilities that do not keep absenteeism records; table 59: number of persons exposed to hazards in facilities with no formally established safety committee; table 60: number of persons exposed to hazards in facilities that do not carry workmen's compensation insurance; and table 61: number of persons exposed to hazards in facilities where environmental conditions are not routinely monitored. Hazards include all NOHS-identified chemical and physical hazards. Information is also available on exposure to specific hazards such as asbestos.

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