Published in final edited form as:

Work Aging Retire. 2017 December 19; 4(1): 37–51. doi:10.1093/workar/wax016.

A Comparison of Subjective and Objective Job Demands and Fit with Personal Resources as Predictors of Retirement Timing in a National U.S. Sample

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Abstract

Population aging and attendant pressures on public budgets have spurred considerable interest in understanding factors that influence retirement timing. A range of sociodemographic and economic characteristics predict both earlier and later retirement. Less is known about the role of job characteristics on the work choices of older workers. Researchers are increasingly using the subjective ratings of job characteristics available in the Health and Retirement Study in conjunction with more objective measures of job characteristics from the Occupational Information Network (O*NET) database. Employing a theoretically-informed model of job demands-personal resources fit, we constructed mismatch measures between resources and job demands (both subjectively and objectively assessed) in physical, emotional, and cognitive domains. When we matched comparable measures across the two data sources in the domains of physical, emotional, and cognitive job demands, we found that both sources of information held predictive power in relation to retirement timing. Physical and emotional but not cognitive mismatch were associated with earlier retirement. We discuss theoretical and practical implications of these findings and directions for future research.

Keywords

Job characteristics; Retirement timing; Health and Retirement Study (HRS); O*NET; Job demands-resources

Introduction

Given the clear benefit for both public and private finances of extending work lives, many policymakers are interested in finding and promoting ways to retain individuals in the workforce while balancing concerns for work ability at older ages. For some individuals, staying on the job longer has benefits beyond just the financial, such as maintaining cognitive and physical health (Rohwedder & Willis, 2010; Insler, 2014). Other evidence suggests that some workers stay on the job despite having health problems to offset diminished wealth accumulation resulting from poor health (Bound, Stinebrickner & Waidman, 2010) or because they otherwise perceive that they are “locked” into their jobs due the need for wages or other benefits, such as employer-provided health insurance (Fisher, Ryan, Sonnega, & Naudé, 2016). Thus, an important societal goal, and the main thrust of much public retirement and disability policy, is to foster employment opportunities for older workers while at the same time affording reasonable paths to exit the labor force for those who are unable or unwilling to work. Ideally, those who are near or at retirement age but want to keep working and are able to do so will have those opportunities. And those in poor health or with stressful, physically demanding, or otherwise undesirable jobs would be able to retire.

Research on retirement timing, that is, identifying factors that lead individuals to retire before, at, or beyond traditional retirement age—around ages 62 to 65 in the United States (U.S.)—has focused to a large extent on sociodemographic, health, institutional, and economic causes (for a review, see Fisher, Chaffee, & Sonnega, 2016). Indeed, the widely noted increasing average age at retirement has been attributed largely to the shift from employer-sponsored defined benefit (DB) to defined contribution (DC) pension plans (Hurd & Rohwedder, 2011), reductions in retiree health insurance coverage (Mermin, Johnson & Murphy, 2007), changes in Social Security rules (Gustman & Steinmeier, 2015), and increasing longevity and educational levels (Munnell, 2011). At the same time, a large literature has evolved that investigates the impact of characteristics of the work environment on the health and well-being of older workers (Fisher, Ryan, & Sonnega, 2015; Zacher, 2015), organizational outcomes such as job turnover (e.g., Arnoux-Nicolas, Sovet, Lhotellier, Fabio, & Bernard, 2016), and, to a lesser extent, retirement timing (Fisher et al., 2016). Researchers are building on this foundation to further elucidate factors affecting the decision by older workers regarding when and how to retire (Beehr & Bennett, 2015; Beehr, Glazer, Nielson, & Farmer, 2000; Carr et al., 2016; Liebermann, Wegge, & Muller, 2013).

The purpose of this study is to extend prior research on our understanding of the connection between the experience of work and retirement timing in two ways. First, we use data from a large, nationally representative sample to compare self-report and more objective measures of job characteristics toward the end of workers’ careers as predictors of retirement timing, defined as age at retirement. Second, we used both subjective and more objective sources of information on late-career job characteristics to illustrate an application to theory in the study of retirement timing. Specifically, we draw on the conceptualizations of the job demands-resources model (JD-R) and person-environment (P-E) fit theory to evaluate the role of potential lack of fit or mismatch between late career work demands and personal resources in determining when individuals choose to retire. To accomplish this, we begin by

providing a rationale for comparing the predictive validity of subjective and objective job characteristics. After that, we describe the theoretical contribution of this study and the hypotheses tested.

Rationale for Comparing Subjective and Objective Ratings of Job Characteristics

Most research that has examined the impact of job characteristics on retirement behavior has relied upon self-reported ratings of job characteristics primarily because 1) workers' own perceptions of their work environment are important; 2) workers with the same job title who work for the same firm may perceive their work experiences differently (Lazarus & Folkman, 1984); and 3) because self-reported ratings are fairly easy to obtain. Due to concerns about potential bias associated with self-reported information (Chan, 2009) as well as common method variance (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003), some have proposed creating subjective ratings that attempt to assess more objective aspects of work (Spector & Fox, 2003) or assessing more objective ratings of the work environment (Jahedi & Méndez, 2014). Relatively little research has compared self-report and more objective work environment characteristics, especially in relation to retirement.

To the extent that objective and subjective measures of the work environment have been compared, results have been inconclusive, and some have proposed creating subjective ratings that attempt to assess more objective aspects of work because of bias arising from subjective measurement (Spector & Fox, 2003). Jahedi and Méndez (2014) examined the performance of subjective measures relative to that of objective measures and further distinguished between general and specific subjective measures. Specific measures ask for information about more objective characteristics, i.e., "how many people do you work with?" whereas general measures ask about broader concepts, such as "is your work environment comfortable?" Results of an experiment comparing subjective perceptions and objective conditions suggested that subjective perceptions may actually be better suited for the study of more broadly defined concepts than objective measures because they contain implicit information that may not be easily observed (Jahedi & Méndez, 2014). Subjective ratings in the present study likely fall into the category of more general subjective measures. In particular, perceptions of work stress may contain a wide range of experiences that may not easily be captured by more objectively obtained ratings. On the other hand, the more objective ratings contained in the O*NET measures may contain information that is relevant to retirement timing that is not influenced by an individual worker's perceptions.

Although a number of studies have utilized the rich data resources available in the Health and Retirement Study (HRS) to examine the impact of self-reported ratings of work experiences on retirement (e.g., Angrisani et al., 2017; Shattuck, 2007), fewer have considered the more objective ratings of the work environment available in the Occupational Information Network (O*NET) database. Sponsored by the U.S. Department of Labor's Employment and Training Administration, the O*NET database provides detailed occupational information that was compiled from a combination of surveys among workers, expert assessments, and tests (Peterson, Mumford, Borman, Jeanneret, & Fleishman, 1999). Both sources can provide useful and potentially complementary information, but little

research using the HRS has sought to directly compare and use similar measures taken from both sources for understanding retirement behavior.

To our knowledge, only one other study has sought to directly compare subjective and more objective job characteristics in relation to a set of labor-supply decisions. Using similar data resources as the present study, Angrisani, Kapetyn, and Meijer (2015) generally found that in a range of domains studied, both subjective and objective measures of job characteristics influenced decisions about work at older ages. Objective measures were more strongly associated with transitions from full-time work to retirement and with retirement intentions. The HRS measures of job characteristics were more likely to be associated with moves to part-time work and with expected retirement age (Angrisani et al., 2015). Compared to the self-reported job characteristic items available in the HRS, these researchers constructed relatively heterogeneous but more detailed and reliable indices comprised of multiple items from several O*NET indicators for each domain studied. This may make it more difficult to distinguish the difference associated with different content measurement from that associated with the objective versus subjective nature of the measurement. In contrast, we provide a direct item-level comparison of the predictive validity of a more comparable set of self-reported job characteristics (from the HRS) and more objective ratings (from the O*NET database) of job characteristics in relation to retirement timing.

For each HRS job characteristic considered in the present study, we mapped items in the O*NET database which overlapped in content for each of the following three domains: physical, emotional, and cognitive job characteristics. As shown in Figure 1, in the physical domain, the HRS job characteristic of physical effort was matched to O*NET rating of jobs requiring physical activity. In the cognitive domain, we selected information processing demands from O*NET as the closest match to HRS job demands of intense concentration. To match the HRS job demand of work stress, we constructed a variable from two O*NET ratings based on the job demands-control model of work stress. Karasek (1979) first proposed, and a great deal of research has later supported (Luchman & González-Morales, 2013), that psychological strain is likely to result when job demands are high but the amount of control an individual has over their work is low. Similar to Andel et al. (2015), we created a measure of strain as consisting of jobs with high responsibility (demand) but low decision latitude (control). These characteristics may be especially salient for older workers (Shultz, Wang, Crimmins, & Fisher, 2010).

Given the relative paucity of research directly comparing subjective and objective characteristics of the work environment, it is not clear *a priori* whether subjective or objective characteristics would have greater or lesser predictive validity in relation to retirement timing. Given that each source may provide unique information regarding workers' job characteristics, it seems plausible that both type of job characteristics measures may predict retirement timing, even when included in analyses together.

Conceptualization of P-E fit and Retirement Timing

Wang and Shultz (2010) suggested that even theoretically-driven studies of retirement often fail to evaluate how multiple levels of variables may interact to affect the employment decisions of older workers. They suggest that P-E fit theory is an ideal framework for this

purpose. P-E fit theory in a work context suggests that match between various aspects of the person (worker) and his/her work environment may affect a variety of outcomes, such as workers' well-being and whether or not they remain in their jobs (Caplan, 1987; Feldman & Beehr, 2011; Kristof-Brown, 1996); yet surprisingly little research has applied this framework to develop hypotheses about retirement timing. Referencing work by Edwards and Shipp (2007), Wang and Shultz (2010) proposed that one manner in which fit or misfit can affect retirement decisions is through a 'demands-abilities fit' mechanism. In this scenario, misfit arises when 'individual abilities are not sufficient to meet environmental demands' (p. 196). We propose that integrating the concept of job demands-resources in a broad sense further improves the usefulness of this conceptualization.

Bakker and Demerouti (2007) defined job demands as potentially negative aspects of the job (e.g., work overload and time pressure) that require effort and may lead to psychological or physical strain. Job resources are positive aspects of the job that keep people healthy and motivated such as supervisor support, and can mitigate the negative impact of job demands. Prior research (e.g., McGonagle, Fisher, Barnes-Farrell, & Grosch, 2015) has also demonstrated the importance of personal resources (i.e., resources that individuals themselves bring to the job, such as health). This is especially important in the context of aging workers. For example, Feldman and Vogel (2009) proposed that fit is a dynamic state for individuals that can change over time as the demands of the job change and/or their resources for meeting the demands change. As job demands and personal resources potentially diverge over time, there may be some threshold at which demands exceed resources, and, all other things being equal, this discrepancy experienced by older workers may lead to retirement (Feldman & Beehr, 2011; Fisher et al., 2016).

We evaluated a job demands-personal resource mismatch model based on the JD-R model and P-E fit theory. This advances work, aging and retirement in a manner that follows recommendations by prior researchers (e.g., Fisher et al., 2016) to empirically investigate the JD-R model and P-E fit in relation to retirement timing. To date, few studies of which we are aware have done this. One such study, conducted among German insurance workers utilized the JD-R framework to study several hypotheses related to workers' expectations of remaining in the same job until retirement (Liebermann, Wegge, & Müller, 2013). In addition to job resources, similar to what we propose, Liebermann et al. conceptualized health as a personal resource and hypothesized an interaction between job demands and personal resources. Indeed, they found that the relationship between job demands and work expectations was stronger for those in poor health—that is, with lower personal resources. Similarly, McGonagle, Fisher, Barnes-Farrell and Grosch (2015) investigated a variety of personal and work-related resources as predictors of work ability and found that work ability mediated the relationship between resources and labor force behavior, including absenteeism, retirement, and disability.

We conceptualized a job demands-personal resources mismatch model within three domains of job characteristics—physical, emotional, and cognitive—which have previously been investigated (albeit independently on the demand side and the resources side) in relation to workforce departure. Job demands and particularly personal resources may change over time especially toward the end of workers' careers. Studies that investigated the job demands

within these domains have found overall that higher levels of physical effort, work stress, and cognitive demand put workers at risk for earlier retirement (Aaron & Callan, 2011; Modrek & Cullen, 2012; Wahrendorf, Dragano, & Sigerist, 2015; Willis, 2013). Interestingly, jobs that have more cognitive demands tend to be associated with white-collar work and could therefore be associated with much later retirement if demands do not exceed resources (Fisher et al., 2014). Although workers' personal resources can certainly be more broadly construed (Hobfoll, 2002), physical, emotional, and cognitive functioning are all important resources that may help workers with meeting their job demands and, in turn, their ability to stay on the job to older ages (Belbase, Sazenbacher, & Gillis, 2015; Jex, Wang, & Zarubin, 2007).

In operationalizing personal resources within these three domains, we selected characteristics that seemed not only likely to influence the ability to engage in work in the broadest set of occupations, but also that are likely to diminish with age. Following Belbase et al. (2015), in the physical domain, we proposed that mobility limitations would be likely to increase with age and have broad impact across occupations. We selected this aspect of physical functioning to reflect, not so much optimal functioning, but rather the minimum that would be required for most workers to be able to stay on the job. In the cognitive domain, we included fluid intelligence, which is a cognitive ability that declines with age and is required by many, but especially white-collar, occupations (Bugg et al., 2006). In the emotional domain, we measured elevated depressive symptoms which are likely positively associated with advancing aging (Yang, 2007).

In the present study, we examined how mismatch between physical, emotional, and cognitive job demands and relevant personal resources affected retirement timing. In a graph with levels of demands on one axis and resources on the other, we posit that the quadrant most likely to result in earliest retirement would be the one with high demands and low resources. We tested this proposition for each domain of job demand and personal resource using both HRS and O*NET ratings. Specifically, we hypothesized that:

1. the combination of physically demanding work and elevated mobility limitations will lead to earlier retirement compared to the effect of either or neither
2. the combination of stressful work and elevated depressive symptoms will lead to earlier retirement compared to the effect of either or neither
3. the combination of cognitively demanding work and low levels of fluid intelligence will lead to earlier retirement compared to the effect of either or neither

Given previous research and predictions of life-cycle models (Laitner & Sonnega, 2013), we identified a set of covariates as important control variables. Specifically, we expected that working part-time, being self-employed, and having higher education and earnings would be associated with remaining in the workforce longer, whereas female gender, being married, older age, presence of a DB pension and higher wealth would be associated with earlier retirement.

Method

Study Participants

We used data from $n=5,072$ participants in the Health and Retirement Study (HRS), a nationally representative biennial longitudinal study of the population over age 50 in the U.S. The HRS is sponsored by the National Institute on Aging (grant number NIA U01AG009740) and is conducted by the University of Michigan. The original HRS cohort was enrolled in 1992 and included men and women aged 51 to 61. The next year, the Asset and Health Dynamics Among the Oldest Old (AHEAD) cohort, who were aged 70 and older, was enrolled. In 1998, these studies merged, and cohorts were enrolled to fill in the age gaps for those over age 50. The sample is refreshed every six years to remain representative of the population over 50. Younger cohorts represent 51 to 56 year-olds in the enrollment year, i.e., 1998, 2004, 2010, and 2016. For those who are unwilling or unable to complete the interview, HRS offers the option for the interview to be completed by a proxy respondent, usually a spouse or a child. More details about the design and sampling in the HRS were provided by Sonnega et al. (2014).

We assembled information about respondents' employment history, job characteristics, financial, health, and sociodemographic information from the HRS Tracker file, HRS core survey data, and constructed variables from the RAND HRS data version P, a cleaned and ready-to-use version of the HRS data produced by the RAND Center for the Study of Aging (Chien et al., 2016). We used data from all HRS birth cohorts from 1996 to 2014 (waves 3 through 12). Waves 1 and 2 were excluded due to difference over time in a key measure, namely, word recall¹ (Ofstedal, Fisher, & Herzog, 2005).

We began with 32,561 HRS participants who completed non-proxy interviews. From that sample, we selected those who completed a non-proxy interview while there were in the age range 56 to 59 ($n=17,538$), which we defined as the baseline for this study. This baseline age range was selected to ensure that we were capturing retirement around the major retirement hazards at ages 62 and 65 while not including very early disability-related work departures or other very early workforce departure such as shorter military careers retire (Gustman & Steinmeier, 2015). We further restricted our sample to those who were working either full- or part-time at baseline ($n=11,324$). As noted, the HRS variable for job requiring intense concentration was only available every other wave, so we removed respondents missing on this variable at the baseline interview ($n=3,830$ removed). Limiting the sample to those with non-missing data on other study covariates restricting to respondents who were ever observed to have retired or who were still working as of their last HRS observation yielded an analytic sample of 5,072. Comparing this sample to the full HRS, we found, not surprisingly, that they tended to be younger, healthier and more likely to be married (especially unwidowed). The educational level and gender distribution, however, were comparable.

¹Specifically, the measure changed from using a 20-word list to a 10-word list which makes comparing scores over time difficult, though not impossible (Fisher et al., 2014).

Measures

Retirement timing—At enrollment into the study, HRS respondents provided a complete job history. At follow-up interviews, respondents who were no longer working were asked the year when they stopped working and if they were retired. Retirement was defined in this study as the date of last observed job for individuals who reported being fully retired. Birth date and interview date were used to calculate the respondent's age at the wave that they were in the target baseline age range (56–59) and the age they were when they retired. Using this, we calculated the event variable (retirement) and a time to event variable based on age in the baseline observation wave to the age when the last job ended. In this sample of relatively young, working men and women, the mortality rate was fairly low, around 4 percent. Therefore, we did not explicitly model death as a competing cause of labor force departure.

Subjective job demands: HRS characteristics—HRS contains individuals' self-reports of characteristics of their current job. We used self-reports of the degree of physical demand, stress, and need for intense concentration. Specifically, HRS asked respondents how much of the time their job required 'a lot of physical effort' and 'intense concentration or attention' (1=*all or almost all of the time*, 2=*most of the time*, 3=*some of the time*, 4=*none or almost none of the time*) and the extent to which they agreed or disagreed that their 'job involves a lot of stress' (1=*strongly agree* to 4=*strongly disagree*). All three variables have been reverse-coded for our analysis so that a higher score indicated a higher level of each type of demand.

Objective job demands: O*NET characteristics—Job characteristics compiled in the O*NET database are ratings categorized in the Standard Occupational Classification (SOC) system. HRS codes jobs reported by respondents using 3-digit detailed census occupational categories. To link O*NET ratings to HRS data, we used a crosswalk that maps the SOC codes to the HRS census occupation codes for the occupation reported by respondents as their main occupation. Given that the occupational coding schemes in HRS have changed over the years because of changes in the census occupational codes (Nolte, Turf, & Servais, 2014), the crosswalk also creates comparability over time and aggregates smaller occupational groups resulting in 192 categories (McFall, Sonnega, Willis, & Hudomiet, 2015).

The O*NET measure selected to reflect physically demanding work was *performing general physical activities* or "performing physical activities that require considerable use of your arms and legs and moving your whole body, such as climbing, lifting, balancing, walking, stooping, and handling of materials." In the cognitive domain, the O*NET measure selected was *processing information* or "compiling, coding, categorizing, calculating, tabulating, auditing, or verifying information or data." We also considered the ability measure *memorization* or "the ability to remember information such as words, numbers, pictures, and procedures" in sensitivity analyses. The work stress measures we selected were *freedom to make decisions* or "how much decision making freedom, without supervision, does the job offer?" and *responsibility for outcomes and results* or "how responsible is the worker for work outcomes and results of other workers?" Using these, we created a variable that

indicated having high responsibility but low control over work outcomes. For sensitivity analyses, we also evaluated the measure *stress tolerance*, that the “job requires accepting criticism and dealing calmly and effectively with high stress situations.”

O*NET provides information on the level and importance of each occupational requirement. Following Firpo, Fortin, and Lemieux (2011), we computed Cobb-Douglas weighted means to combine occupation-level *importance* and *level* measures. Importance weights are 2/3; level weights are 1/3. Next we aggregated the detailed occupational measures to the 192 occupations used in this study. We used the 2000 census to approximate this ideal. In step 1, we averaged the O*NET measures to the level of the 2000 census by taking a simple arithmetic mean of the corresponding more detailed O*NET occupations. In step 2, we averaged the census occupations to our 192 categories by taking the mean and weighting it by the size of the census occupations in the 2000 census. This resulting indicators ranged from 0 to 1, which we then standardized ($\sim N(0,1)$) to ease interpretation.

Personal resources—In the physical domain, we used a set of five items from the Nagi limitations battery reflective of mobility limitations (Fonda & Herzog, 2004). The five tasks were: walking several blocks, walking one block, walking across the room, climbing several flights of stairs, and climbing one flight of stairs. Respondents reported their level of difficulty with each task (not at all difficult, a little difficult, somewhat difficult, and very difficult). We used a mobility index ranging from 0 to 5 that represents the number of tasks respondents reported as being at least somewhat difficult.

We used an 8-item version of the Center for Epidemiologic Studies Depression Scale (CES-D) to measure depressive symptoms (Turvey, Wallace, & Herzog, 1999). Respondents reported whether or not much of the time in the past week they felt: 1) depressed, 2) everything was an effort, 3) sleep was restless, 4) that he or she could not get going, 5) lonely, 6) that he or she enjoyed life (reverse-coded), 7) sad, and 8) happy (reverse-coded). The RAND index variable CESD ranges from 0–8.

Of the several measures of cognitive functioning available in the HRS, we selected the immediate and delayed word recall tasks. The total score ranged from 0 to 20 for the number of words respondents were able to recall. Missing values were imputed as documented (Ofstedal et al., 2005).

Job demands-resources mismatch—To create an indicator for high demands and low resources, for each subjectively- and objectively-rated job demands-personal resources variable pair, we constructed an indicator of mismatch by dichotomizing and combining the variables in each pair. Note that for each mismatch indicator, the referent category (zero) includes those with only one or the other (high demand or low resource) or neither.

The HRS physical effort variable was dichotomized so that 1 was equal to “*all or almost of the time*” or “*most of the time*” and 0 was equal to “*some of the time*” or “*none or almost none of the time*.” The intense concentration variable was dichotomized so that 1 was equal to “*all of the time*” and 0 was equal to “*most of the time*” to “*none of the time*.” We set the HRS stress variable to 1 for “*strongly agree*” and to 0 for “*agree, disagree, or strongly*

disagree.” We set the measures based on the O*NET variables equal to 1 if the standardized value was at least 0.667 (that is, 2/3 of a standard deviation above the mean). These cut points all reflect a fairly high degree of job demand.

The personal resource variables were dichotomized as follows. For the mobility index, to indicate a potentially work-limiting level of physical limitation, we created a dichotomous indicator of having at least two difficulties (reported as at least somewhat difficult) with mobility limitations (1=*two or more limitations*; 0=*zero or one limitation*). Similarly, to indicate potentially work-limiting depressive symptomatology, in line with prior research (Zivin et al., 2010), we used a cut point of endorsing 4 or more depressive symptoms as an indication of substantially elevated depressive symptoms, comparable to a cut-off score of 16 on the full CES-D (1=*four or more depressive symptoms*; 0=*three or fewer depressive symptoms*). To indicate fairly significant loss of working memory likely to be work-limiting, we used a cut point of 6 or fewer words recalled (out of 20), which equated to the lowest 10th percentile of all HRS respondents to this task, regardless of age (1=*lowest 10 percent on total word recall score*; 0=*upper 90 percent on total word recall*).

Demographic characteristics—We obtained self-report data about demographic characteristics from the RAND HRS dataset. We used a dichotomous indicator for gender with male as the referent category. Educational level was included as a set of five dichotomous indicators for less than high school (referent), high school degree, some college, college graduate, and more than college. Marital status was dichotomized as married at baseline with unmarried (including separated, widowed, divorced, and never married) as the referent category. To account for changes over time in the retirement landscape (e.g., decreasing reliance on defined benefit pension plans), we included dichotomous indicators for respondent’s year of birth, ranging from 1937 to 1956 with 1936 as the referent category.

Income, wealth, and pension—We included constructed variables from the RAND HRS dataset for total non-housing wealth and the respondent’s labor earnings at baseline. The wealth variable included all sources of financial wealth (i.e., savings, investments, retirement pensions such as 401k, etc.) minus housing wealth and all debt. The RAND HRS earnings variable is the sum of all wage/salary income as well as bonuses, overtime pay, commissions, and tips. Missing values for income and wealth were imputed by RAND according to procedures detailed elsewhere (Chien et al., 2015). Descriptive results are shown in nominal dollars. Both variables were log transformed for the regression models, with values below \$1 being coded as \$1 (resulting in a logged value of 0). We created a dichotomous indicator for presence of a defined benefit pension for job held at baseline, with no pension or DC pension only as the referent category.

Employment type—Two employment type variables were included: a dichotomous indicator for self-employment with not self-employed as the referent category and self-reported working part-time with working full-time as the referent.

Statistical Analysis

We conducted all analyses using Stata SE 14 (StataCorp, 2015). First we computed descriptive statistics for all study variables in the analysis dataset. We present bivariate correlations among the job characteristic variables. We used Cox proportional hazard models to investigate the effect of job characteristics on retirement timing, contingent on reaching ages 56 to 59. We reported hazard ratios and 95% confidence intervals. Although the HRS provides sample weights to adjust for the complex sample survey design in data analysis, following Lumsdaine and Vermeer (2015), we used unweighted data because it is unclear whether any sampling weights would be meaningful to apply given that weights are wave-specific.

To compare the predictive validity of the selected subjective and O*NET job characteristics on retirement timing, we conducted three Cox regression models. *Model 1* evaluated HRS subjective job characteristics; *Model 2* evaluated O*NET job characteristics; and *Model 3* evaluated both simultaneously. All three models included controls for gender, educational level, marital status, birth year, log wealth, log earnings, presence of a DB pension, self-employed work status, and part-time work status. We compared the change in model fit between only examining subjective characteristics to both and from O*NET characteristics only to both using the likelihood ratio test. We report the chi-square and significance level for this test.

To examine the effect of job demands-resources mismatch on retirement timing, we conducted a second set of three Cox regression models. *Model 1* evaluated the three indicators of mismatch between the HRS job characteristics and the personal resource characteristics. *Model 2* evaluated the three indicators of mismatch between the O*NET job characteristics and the personal resource characteristics. *Model 3* included both subjective and objective mismatch variables. All three models included a full set of controls, and we compared model fit as indicated above.

Results

Descriptive statistics for the analytic sample are displayed in Table 1. The mean age at retirement in this sample, for those observed to have completely retired, was almost 64 years of age with a minimum of 56 and a maximum of 77 years. Most HRS respondents' last observed jobs seem not to be particularly physically demanding ($mean=2.24$, $SD=1.14$, range 1–4) on average, but there was fairly high variability. These jobs on average did tend to involve a lot of stress ($mean=2.78$, $SD=0.83$, range 1–4). The mean of 3.38 (on a scale of 1 to 4; $SD = 0.83$) on the concentration job characteristic suggests that HRS respondents' last reported job required a high level of concentration. Recall that the O*NET variables were normalized with a mean of zero. The means for the physical activity was 0.06 and the stress variable was zero, suggesting that on average the later career jobs held by HRS respondents were not ranked as terribly physically demanding or stressful. The O*NET indicator of information processing was slightly negative, but again very close to the mean. With respect to personal resources, about 12 percent of the sample experienced two or more mobility limitations involving at least some difficulty with walking and climbing stairs; 11 percent experienced significantly elevated depressive symptoms; and about 6 percent had

word recall scores in the lowest decile. Both the HRS and O*NET job demands-personal resources mismatch variables all reflected relatively low proportions (from 1 percent for the O*NET cognitive mismatch variable to 5 percent for both the HRS and the O*NET physical mismatch variables), as expected given their coding as relatively high demands and low resources.

Correlations among the subjective and O*NET job demands are displayed in Table 2. The correlation between the HRS and O*NET measures of physical job demands (HRS: job requires physical effort and O*NET: job involves physical activity) was fairly large and positive ($r=.50$, $p<.01$). The correlation between the cognitive ratings (HRS: job requires intense concentration and O*NET: job requires information processing) was relatively small but positive ($r=.14$, $p=.01$). The O*NET stress measure indicating work that involves high responsibility but low control was negatively correlated with the HRS stress measure ($r=-.16$, $p<.01$) although relatively weakly. Cross domain correlations showed that both objective and subjective cognitive demand measures were somewhat correlated with the HRS measure of job stress. Interestingly, while the HRS physical activity and concentration variables were not correlated ($r=.01$, $p=.41$), the O*NET information processing measure and the HRS physical activity measures were strongly inversely correlated ($r=-.61$, $p<.01$). Similarly, the O*NET high responsibility/low control and information processing measures were also inversely correlated ($r=-.41$, $p<.01$), but the O*NET high responsibility/low control and physical activity measures were positively but relatively weakly correlated ($r=.09$, $p<.05$).

Hazard ratios and 95% confidence intervals from Cox regressions comparing the effects of HRS job characteristics and O*NET job characteristics on retirement timing are presented in Table 3. In these models, a hazard ratio less than one implies a lower instantaneous hazard of retiring in a given interval relative to the referent category, and a hazard greater than 1 implies a greater instantaneous hazard of retirement. Of the three HRS job characteristic variables in *Model 1*, only the stressfulness of the job (between ages 56 and 59) was associated with retiring earlier ($HR=1.08$, $p<.01$). Specifically, each unit increase on the HRS stressfulness scale (from strongly disagree to strongly agree, 1–4), was associated with an 8 percent increase in the instantaneous hazard of retiring. In *Model 2* evaluating the O*NET ratings, jobs that involved physical activity were associated with an increased retirement hazard ($HR=1.13$, $p<.001$). That is, an increase of one standard deviation in the more objectively rated physical demands of the job was associated with a 13 percent increase in the retirement hazard. When all six job demand variables were included in *Model 3*, both characteristics that were statistically significant in the separate models remained statistically significant and quantitatively similar to the separate models. Results of the likelihood ratio tests suggested that the model with HRS only ratings was significantly different from the combined model ($X^2=15.44$, $df=3$, $p<.01$). The difference between the model with the O*NET only and the combined model was also statistically significant but smaller in magnitude ($X^2=8.14$, $df=3$, $p<.05$). The log likelihood estimates indicated that *Model 3*, including both subjective and objective measures, was the best fitting model.

Covariates were generally in the expected direction and very similar across all three models. In *Model 3*, the hazard of retiring was slightly greater for women compared to men ($HR=1.15$, $p<.01$) and significantly greater for those with a defined benefit pension

compared to those with either a defined contribution pension or no pension. Compared to those with less education, those with higher education had a smaller retirement hazard. Likewise, compared to those working for an employer, those who were self-employed had a significantly smaller retirement hazard ($HR=0.48$, $p<.001$). Earnings were associated with working longer ($HR=0.97$, $p<.001$). Having a defined benefit pension and part-time employment were associated with earlier retirement. The hazards on birth year were not especially consistent, but we did find some evidence that more recent birth cohorts are working longer, as expected.

We next turn to results of the effects of job demands-resources mismatch. Table 4 presents Cox proportional hazards models of job demands and personal resources mismatch as predictors of retirement timing. *Model 1* included the mismatch variables created with the HRS job demand characteristics and personal resources. For those with low physical mobility and working in jobs requiring physical effort all/almost all of the time or most of the time, the retirement hazard ratio was 1.60 relative to those without this type of mismatch ($p<.01$), indicating an association with earlier retirement. Mismatch between HRS job stress and depressive symptoms was also significantly associated with earlier retirement relative to those with either one or neither of these risks ($HR=1.31$, $p<.05$). The concentration/word recall mismatch hazard ratio was not statistically significant. In *Model 2*, the hazard ratio associated with the O*NET job demand rating mismatch indicator for jobs that involved physical activity was 1.51 ($p<.001$), indicating an association between a mismatch of physical job demands and physical resources and earlier retirement. In this model, the information processing/word recall mismatch hazard ratio was 1.88 ($p<.05$), also indicative that a mismatch in cognitive job demands and personal resources was related to earlier retirement. In *Model 3*, which included both HRS and O*NET mismatch variables, both HRS mismatch indicators that were statistically significant in *Model 1* remained so, but the O*NET indicators were no longer statistically significant. The O*NET job stress mismatch indicator (i.e., those with elevated depressive symptoms and whose job involved a lot of responsibility but little control) was not significant in either *Model 2* or *Model 3*. Results of the likelihood ratio tests suggested that the model with O*NET only ratings was significantly different from the combined model ($\chi^2=15.54$, $df=3$, $p<.01$), but the difference between the model with the HRS only and the combined model was not statistically significant ($X^2(3)=6.37$, $p=.17$). In this case, transitivity implies that the HRS mismatch measures alone were better predictors of retirement than the O*NET predictors alone. Moreover, there was no statistical difference between *Model 1* with HRS only mismatch indicators and *Model 3* with the combined indicators, meaning that the O*NET predictors did not explain much once the HRS predictors are included. Collectively, these findings provide some support for each of our three hypotheses.

As mentioned, we also considered the O*NET measure of stress indicating that the job required a high degree of *stress tolerance*. Interestingly, while this measure was positively correlated with the HRS measure of stress ($r=.22$, $p<.01$), its inclusion in the Cox models in place of our constructed stress measures did not change the results qualitatively and only very modestly quantitatively. Likewise, using *memorization* as an alternative to *information processing* in the cognitive domain did not alter our substantive findings. In sum, we found

some support for our hypothesis that the combination of high demands and low resources led to earlier retirement or a lower hazard of working longer.

Discussion

Population aging and attendant pressures on public budgets have spurred considerable interest in understanding factors that influence retirement timing. A range of sociodemographic and economic characteristics have been shown to predict retirement. The purpose of this study was to fill an important gap in the literature and investigate the role of job characteristics, especially in relation to job demands, personal resources, and person-environment (P-E) fit on the work behavior of older workers (Carr et al., 2016). Furthermore, most research in this area has relied exclusively on subjective measures of the work environment, but concerns about bias and common method variance associated with such measures have led some researchers to begin using data from other sources in their studies. Two data sources that are beginning to be used in this regard are the HRS in conjunction with the O*NET database. Our first aim, therefore, was to compare the predictive validity of a small set of comparable job characteristics from HRS and O*NET, respectively, in relation to retirement timing in a national sample of workers nearing retirement. Our second aim built on these analyses to propose and evaluate a job demands-personal resources mismatch model of retirement timing by creating a mismatch indicator for each job characteristic and a corresponding personal resource and relating this lack of fit to retirement timing.

In the first part of our work, when considered either separately or simultaneously, we found that *both* subjective and more objective (i.e., O*NET) job characteristic ratings were predictive of retirement timing. Of the subjective measures assessed, late career job stress was significantly associated with earlier workforce departure. Among the objective measures assessed, physical job demands (i.e., jobs characterized as “performing physical activities that require considerable use of your arms and legs and moving your whole body, such as climbing, lifting, balancing, walking, stooping, and handling of materials”) were associated with earlier retirement. These results imply that in the domains of physical and emotional function as assessed in this study, both types of ratings appeared to contain information that is relevant to retirement timing. It is important to note that the content measurement across the subjective and more objective measures was not perfectly mapped. To the extent that these measures differ in their predictive validity, we cannot rule out the possibility that this difference in content is what accounts for finding a difference between objective and subjective measures.

Interestingly, the cognitive measures from both sources were not predictive of retirement timing. This suggests that jobs that demand intense concentration or require higher levels of information processing may permit workers to continue working, or that workers may enjoy these jobs more and therefore want to continue working. For example, Fisher et al., (2014) used O*NET ratings linked to the HRS to study the impact of the mental demands of jobs before and after retirement, and found that greater mental demands of work were associated with higher levels of cognitive functioning before retirement and a slower rate of cognitive decline after retirement. As is typically found in studies of retirement (e.g., Mermin et al.,

2007; Munnell, 2011), the present study found that higher levels of education were strongly associated with a lower hazard of retiring. Thus, it seems likely that individuals with higher levels of education are working in more cognitively complex jobs that, at the very least, do not hasten early work force departure, all other things being equal.

With longitudinal measurement of job characteristics as well as physical, emotional, and cognitive functioning, the HRS provides a unique opportunity to study a lack of fit (i.e., mismatch) that may arise in the normal aging process between job demands and workers' personal resources. For our second aim, we examined this connection in terms of physical, emotional, and cognitive demands and individuals' physical, emotional, and cognitive functioning to test hypotheses about job demands-personal resources in relation to retirement timing. When we considered the subjective mismatch variables along with a set of relevant covariates, we found that the combination of low physical mobility and reporting a job demanding a lot of physical effort was associated with retiring earlier compared to having either of these risks alone or having neither of them. Similarly, respondents who experienced a high level of depressive symptoms along with reporting that their job involved a lot of stress were significantly more likely to retire early.

When we considered the objective mismatch indicators, the physical mismatch indicator was strongly predictive of earlier retirement. However, in contrast to the subjective cognitive mismatch indicator, the objective cognitive mismatch variable emerged as significantly associated with earlier retirement. In the model considering all six mismatch indicators simultaneously, however, only the subjective physical and emotional mismatch variables remained significant, although the effect size of the objective mismatch remained high and near significance. Overall, these results imply some support for hypotheses 1 and 2, in line with other research showing an interactive effect of job demands and personal resources on earlier retirement (Liebermann, Wegge, & Muller, 2013). That is, at least in the physical and emotional domains, when job demands exceed personal resources, the hazard of retirement increases.

Although a main effect of the subjective physical demand characteristic was not apparent, physical mismatch, that is, working in late career in a job that requires a lot of physical effort while experiencing some mobility limitations, was strongly associated with earlier retirement. This finding is very consistent with research showing a strong impact on retirement of physically demanding work (Modrek, & Cullen, 2012) and physical limitations (Belbase et al., 2015), but is one of the first studies to specifically examine the interaction effect.

The relatively strong impact of the mismatch between perceived work stress and elevated depressive symptoms merits particular attention. Jalpa, Doshi, Cen, and Polsky (2008) followed men and women in the original HRS cohort from 1992 through 2002 and found that elevated depressive symptoms were a significant predictor of retirement. Depression has also been found to be a significant cause of leaving work because of disability (Wedegaertner et al., 2013). Karponsalo et al. (2005) found that workers with depression left work an average of 1.5 years sooner than those without depression. These researchers called for more research to understand how depression may lead to retirement. Our findings

suggested that work stress may be one important factor; importantly, this may be amenable to intervention.

The finding that neither the HRS nor the O*NET cognitive mismatch measure we tested was predictive of retirement timing in the combined model is at odds with other research, which has found significant effects of cognitive decline on retirement (Fisher et al., 2016). However, there has been relatively little research to date on this topic (McArdle, Smith, & Willis, 2009; Willis, 2013). It may be that the measures of cognitive demand both in the HRS and in O*NET actually capture a demand that is perceived (especially by those in more cognitively complex jobs) more as a stimulating challenge than as a potentially overwhelming demand. As we discuss below, we also may have lacked the statistical power to detect an effect of cognitive mismatch. The more objective measure of cognitive mismatch was predictive in the O*NET only model. Given the potentially greater complexity of the relationship between cognitive challenges as job demands and potential worker resources, this is a fertile area for future research.

Even as interest grows in extending working lives, it is important to also understand factors associated with leaving work at earlier ages. The present study used a model of retirement timing that assessed time to retirement. We could therefore distinguish hazards of earlier as well as later workforce departure. However, it may be the case that factors that keep people on the job until much older ages are not just the opposite of those that cause early retirement. Although reducing work stress is an important goal, if we are to interest workers in remaining at work past the full retirement age for Social Security (by which age most workers retire), it may be important to consider factors that attract them to work rather than just keeping them from being overwhelmed by the demands of work. This is consistent with the push/pull theory of retirement (Barnes-Farrell, 2003; Shultz, Morton, & Weckerle, 1998), which indicates that there are some factors (e.g., poor health; undesirable working conditions) that “push” people out of the workforce and others that either “pull” workers toward retirement (e.g., desire for leisure activity pursuits) or to remaining at work (e.g., social connections at work; meaningful work).

Limitations

There are several limitations of the present study. First, it is important to note that retirement is a process (Wang & Shultz, 2010) and patterns of retirement have become increasingly heterogeneous (Fisher et al., 2016; Maestas, 2010). For example, it is possible that those who have retired will ‘unretire’ and return to the labor force at some point after the last point of observation in the present study (Maestas, 2010). Additionally, some workers may have moved to part-time jobs as bridge work on their way to retirement (Beehr & Bennett, 2015; Cahill, Giandrea, & Quinn, 2015). With a maximum retirement age of 77, it is plausible that we included at least some workers who unretired and/or are working part-time or in a ‘bridge’ job. The relationship between job demands, personal resources and retirement may be different for such workers than for workers who are still in their main career job and/or working full-time. Further research is needed to investigate how mismatch is related to specific work and retirement patterns, such as unretirement and bridge employment.

Exploration of such nuances is beyond the scope of the current work but represents a promising area for future research.

Second, it is also important to note that our results do not necessarily imply a causal association. Although we hypothesized that mismatch between job demands and personal characteristics would lead to earlier retirement, there are potentially confounding causal relationships at play that we did not explicitly model. For example, elevated depressive symptoms may inhibit the ability to emotionally cope with work stress, and thus potentially lead to earlier retirement. However, it is also possible that work stress could lead to elevated depressive symptoms, which leads to retirement. As discussed above, workers in cognitively demanding jobs may be more likely to maintain higher cognitive functioning longer.

Third, although the HRS is a large study, our specific sample selection criteria limited the size of our analytic sample. In some analyses, we may lack the statistical power to estimate effects with precision. This may be especially true of analyses using the mismatch measures, where only a few individuals had high levels of mismatch.

Fourth, most of the HRS job characteristics in the main HRS interview were assessed with only a single item, which may have low levels of reliability and in turn, limit the extent to which these job characteristics predict retirement timing. There are three items in the HRS that could be considered physical demands of work, and an index could be created from these which might be preferable to a one-item measure. Only a single indicator of overall work stress was available. For consistency in measurement, we chose to use single items to reflect each domain. As discussed by Jex, Beehr, and Roberts (1992), a single job stress item may lack construct validity due to it being too broad and vague. Specifically, the extent to which one would agree or disagree with the statement that one's job is stressful yields little information regarding the cause of the stress.

Fifth, if respondents changed jobs after the baseline ages of 56 to 59, the job characteristics we assessed as risks for retirement would not necessarily reference the job from which they retired. However, another study using detailed occupations in the HRS found relatively little late-career job change (Sonnega, McFall, & Willis, 2016).

Lastly, it is important to note that for purposes of creating the crosswalk from O*NET to the HRS, we grouped many detailed occupations into larger categories. This likely increases measurement error and may result in attenuation bias. It was important to combine categories, however, to result in intertemporal consistency despite changes in occupation coding over time, to decrease the chance that the same occupation might be coded in different ways in different instances, and to increase the sample size of occupational groups for analysis purposes.

Implications

Despite these limitations, this study offers some interesting implications. Related to this study's first aim, we can ask why it should be important to try to distinguish the impact on work outcomes of subjective versus more objective measures of job demands. One reason might be to obtain unbiased estimates of the effect of job characteristics on retirement

timing. However, this study and other work (Rau, Morling, & Rösler, 2010) suggests that both sources may offer important information in determining work decisions. As a practical matter, if only subjective experiences prove predictive of work outcomes, perhaps the target of intervention should be workers' perceptions rather than objective conditions. However, it is important to be able to apply research findings to the objective work environment—that is, to potential jobs or work redesign—which means research linking objective conditions to outcomes remains important and relevant (Frese & Zapf, 1999). Nonetheless, interventions aimed at influencing perceptions of stress, for example, may also be warranted. Indeed, given rising levels of work stress (Johnson, Mermin, & Resseger, 2011) and the difficulties of changing work place policies and redesigning work, many workplaces are implementing programs to improve workers' strategies for managing work stress and “creating psychologically healthy workplaces” (American Psychological Association, 2016). Given our findings in the second aim of strong positive effects on early retirement of the combination of high levels of perceived work stress and high levels of depressive symptoms, interventions aimed at helping older workers—especially those who may be “job locked” (Fisher et al., 2016)—cope more effectively with work stress seem expedient and highly worthwhile.

Future directions

Our work comparing subjectively and more objectively measured job characteristics in relation to retirement timing is only the second study we are aware of to do so. Additional research is still very much needed. In particular, it would be valuable to conduct additional research regarding the psychometric properties and measurement of job characteristics. For example, we understand the limitations of using single item measures (Fisher, Matthews, & Gibbons, 2016), but additional work to compare and perhaps further develop self-report measures of job characteristics that could be used in large-scale surveys like the HRS could be beneficial. Doing so would build on our understanding of what these subjective and objective ratings mean in relation to each other. For reasons detailed above, it is desirable to have both sources of information, but it is still not conceptually clear how they relate to each other.

The theoretical contribution of this study has been to use both the JD-R and P-E fit theories to inform the development of a job demands-personal resources mismatch model of retirement timing. Future research could enrich the conceptualization of mismatch by further elucidating the causal ordering of potentially evolving mismatch in later career workers, for example, by modelling demands and resources as time-varying covariates in the Cox framework. It would also be interesting to consider a mismatch index across several domains to ascertain whether specific kinds of mismatch matter or whether any mismatch increases risk for early retirement. On the other side, the same conceptual model could be used to develop hypotheses about what keeps individuals at work longer. For example, does exceptionally good fit between job demands and personal resources lead to longer work lives?

Even with the present data resources, additional research could investigate antecedents and outcomes of mismatch. By constructing multiple-item measures across a variety of domains

in the O*NET database, it would be possible to create indices based on several items for each domain. In order to do the same in the HRS, researchers can consider using data that has been available since 2006 with considerably more information about the work environment that could potentially extend these findings in interesting new directions. Because of changes to the HRS sample design beginning in 2006, however, longitudinal measurement of these characteristics is only available every four years. Finally, with information on detailed occupations in the HRS, the present study could be extended to study the prevalence of mismatch within particular occupations to understand more about which occupations allow continued employment even with large measured demands-resources discrepancies.

Despite our lack of findings in the cognitive domain, the potential effect of cognitive decline on retirement and interactions with job characteristics remains an important area for future research. Given the rapid aging of the population, and given that the changing nature of the workforce implies that the intellectual demands of jobs will grow, it will be important to understand more about the role that age-related cognitive decline may play in retirement decisions.

Finally, another interesting direction would be to replicate the findings of the present study using different outcomes of interest. An interesting extension would be to consider retirement expectations instead of actual retirements. Given the larger sample available using this outcome, it would be possible to explore potential cohort differences even for much younger cohorts (such as the late baby boomers) who have yet to reach the most common retirement ages. It would also be valuable to consider other work outcomes such as disability, which may be especially relevant in the context of job demands-personal resources mismatch.

Acknowledgments

The research reported herein was pursuant to a grant from the U.S. Social Security Administration (SSA), funded as part of the Retirement Research Consortium (RRC). The findings and conclusions expressed are solely those of the authors and do not represent the views of SSA, any agency of the federal government, or the University of Michigan.

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Domain	HRS Subjective Job Characteristics	O*NET Job Characteristics	HRS Personal Characteristics
Physical	Job requires a lot of physical effort	Performing general physical activities	Mobility limitations
Emotional	Job involves a lot of stress	High responsibility- low control	Elevated depressive symptoms
Cognitive	Job requires intense concentration	Processing information	Low word recall

Figure 1.
Job characteristics and personal characteristics

Table 1

Descriptive statistics on all study variables

Variable	n	Mean	SD	Min	Max
Retirement age	2,124	63.78	3.75	56.17	77.25
HRS: Job requires physical effort	5,070	2.24	1.14	1.00	4.00
HRS: Job involves a lot of stress	5,070	2.78	0.83	1.00	4.00
HRS: Job requires concentration	5,070	3.38	0.83	1.00	4.00
O*NET: Job involves physical activity	5,070	0.06	1.01	-1.77	2.26
O*NET: Job involves high responsibility/low control	5,070	0.00	1.00	-2.99	1.96
O*NET: Job requires information processing	5,070	-0.03	1.02	-2.97	2.26
Limited mobility	5,070	0.12	0.33	0.00	1.00
Elevated depressive symptoms	5,070	0.11	0.31	0.00	1.00
Lowest 10 percent on word recall	5,070	0.06	0.24	0.00	1.00
HRS physical mismatch	5,070	0.05	0.22	0.00	1.00
HRS mental mismatch	5,070	0.03	0.18	0.00	1.00
HRS cognitive mismatch	5,070	0.03	0.18	0.00	1.00
O*NET physical mismatch	5,070	0.05	0.21	0.00	1.00
O*NET mental mismatch	5,070	0.04	0.19	0.00	1.00
O*NET cognitive mismatch	5,070	0.01	0.07	0.00	1.00
Female	5,070	0.54	0.50	0.00	1.00
Less than high school	5,070	0.14	0.35	0.00	1.00
High school	5,070	0.30	0.46	0.00	1.00
Some college	5,070	0.26	0.44	0.00	1.00
College graduate	5,070	0.15	0.35	0.00	1.00
More than college	5,070	0.15	0.35	0.00	1.00
Married	5,070	0.68	0.47	0.00	1.00
Birth year	5,070	1947	5	1936	1957
Household wealth	5,070	22,7393	744,428	-644,400	21,500,000
Earnings	5,070	38,300	52,659	0	1,425,000
Has defined benefit pension	5,070	0.27	0.44	0.00	1.00
Self-employed	5,070	0.17	0.37	0.00	1.00

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Variable	n	Mean	SD	Min	Max
Work part-time	5,070	0.17	0.38	0.00	1.00

Source: Health and Retirement Study 1996–2014

Table 2

Pearson correlations of HRS and O*NET job characteristics

	(1)	(2)	(3)	(4)	(5)	(6)
HRS						
1) Job requires physical effort	1.00					
2) Job involves a lot of stress	0.02 (.10)	1.00				
3) Job requires concentration	0.01 (.41)	0.23 (.00)	1.00			
O*NET						
4) Job involves physical activity	0.52 (.00)	-0.13 (.00)	-0.08 (.00)	1.00		
5) Job involves high responsibility/low control	0.10 (.00)	-0.14 (.00)	-0.03 (.01)	0.09 (.00)	1.00	
6) Job requires information processing	-0.23 (.00)	0.17 (.00)	0.14 (.00)	-0.62 (.00)	-0.40 (.00)	1.00

Source: Health and Retirement Study 1996–2014

Cox proportional hazard regressions comparing subjective and objective job characteristics

Table 3

	(1)		(2)		(3)	
	HR	95%CI	HR	95%CI	HR	95%CI
HRS Job Characteristics						
Job requires physical effort	1.03	(0.99–1.07)			0.99	(0.95–1.04)
Job involves a lot of stress	1.08**	(1.02–1.14)			1.08**	(1.02–1.14)
Job requires concentration	0.97	(0.92–1.03)			0.98	(0.93–1.03)
O*NET Job Characteristics						
Job involves physical activity			1.13***	(1.06–1.19)	1.15***	(1.06–1.20)
Job involves high responsibility/low control			1.01	(0.96–1.06)	1.01	(0.96–1.07)
Job requires information processing			1.05	(0.99–1.12)	1.05	(0.98–1.12)
Female	1.08	(0.99–1.19)	1.16**	(1.05–1.28)	1.15***	(1.04–1.27)
Education: High school	1.03	(0.90–1.18)	1.05	(0.92–1.21)	1.06	(0.92–1.21)
Education: Some college	0.86	(0.74–1.00)	0.90	(0.77–1.04)	0.89	(0.77–1.04)
Education: College	0.71***	(0.59–0.85)	0.75**	(0.62–0.90)	0.75**	(0.62–0.90)
Education: More than college	0.61***	(0.51–0.74)	0.66***	(0.54–0.80)	0.65***	(0.54–0.79)
Married	1.01	(0.91–1.11)	1.02	(0.92–1.12)	1.02	(0.92–1.12)
Born 1936 ref	1.00	(1.00–1.00)	1.00	(1.00–1.00)	1.00	(1.00–1.00)
Born 1937	0.82	(0.51–1.30)	0.78	(0.49–1.25)	0.77	(0.48–1.23)
Born 1938	0.78	(0.50–1.21)	0.75	(0.48–1.17)	0.74	(0.48–1.16)
Born 1939	0.88	(0.57–1.37)	0.84	(0.55–1.31)	0.83	(0.54–1.29)
Born 1940	0.81	(0.53–1.25)	0.77	(0.50–1.19)	0.76	(0.49–1.17)
Born 1941	0.78	(0.50–1.20)	0.75	(0.49–1.16)	0.74	(0.48–1.14)
Born 1942	0.90	(0.58–1.38)	0.86	(0.56–1.32)	0.85	(0.55–1.31)
Born 1943	0.93	(0.60–1.43)	0.89	(0.58–1.37)	0.88	(0.57–1.35)
Born 1944	0.96	(0.62–1.48)	0.92	(0.60–1.42)	0.91	(0.59–1.40)
Born 1945	0.78	(0.50–1.22)	0.76	(0.49–1.18)	0.74	(0.47–1.15)
Born 1946	0.91	(0.59–1.42)	0.87	(0.56–1.36)	0.86	(0.55–1.33)
Born 1947	0.91	(0.58–1.43)	0.88	(0.56–1.38)	0.87	(0.55–1.36)

	(1)		(2)		(3)	
	HR	95%CI	HR	95%CI	HR	95%CI
Born 1948	0.83	(0.53–1.29)	0.79	(0.51–1.24)	0.78	(0.50–1.22)
Born 1949	1.12	(0.72–1.75)	1.06	(0.68–1.66)	1.04	(0.66–1.63)
Born 1950	1.02	(0.65–1.60)	0.97	(0.62–1.53)	0.96	(0.61–1.50)
Born 1951	0.69	(0.43–1.10)	0.65	(0.41–1.05)	0.65	(0.41–1.03)
Born 1952	0.75	(0.46–1.21)	0.71	(0.44–1.15)	0.70	(0.44–1.14)
Born 1953	0.36**	(0.19–0.70)	0.35**	(0.18–0.67)	0.34**	(0.18–0.65)
Born 1954	0.30***	(0.15–0.59)	0.29***	(0.15–0.57)	0.28***	(0.15–0.55)
Born 1955	0.39*	(0.17–0.92)	0.38*	(0.16–0.88)	0.37*	(0.16–0.87)
Born 1956	0.53	(0.18–1.53)	0.50	(0.17–1.45)	0.50	(0.17–1.44)
Log wealth	1.00	(0.99–1.02)	1.01	(0.99–1.02)	1.01	(0.99–1.02)
Log earnings	0.97***	(0.95–0.99)	0.97***	(0.95–0.99)	0.97***	(0.95–0.99)
Has defined benefit pension	1.60***	(1.46–1.77)	1.62***	(1.47–1.78)	1.60***	(1.45–1.76)
Is self-employed	0.48***	(0.40–0.58)	0.50***	(0.41–0.60)	0.49***	(0.41–0.60)
Works part-time	1.15*	(1.02–1.30)	1.11	(0.99–1.26)	1.13*	(1.00–1.28)
Observations	5,072		5,072		5,072	
Log likelihood	–15978.18		–15974.53		–15970.46	
Likelihood ratio test (compared to Model 3)		15.44		8.14		
$\chi^2(df=3)$						
p-value		.0015		0.04		

Notes: HR is hazard ratio with 95% confidence intervals in brackets; statistical significance indicated by

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

Source: Health and Retirement Study 1996–2014

Cox proportional hazard regressions comparing subjective and objective mismatch indicators

Table 4

	(1)		(2)		(3)	
	HR	95%CI	HR	95%CI	HR	95%CI
HRS Job Characteristics						
Physical effort mismatch	1.60 ^{***}	(1.34–1.91)			1.45 ^{**}	(1.16–1.82)
Job stress mismatch	1.31 [*]	(1.05–1.64)			1.27 [*]	(1.00–1.61)
Job concentration mismatch	1.14	(0.90–1.45)			1.06	(0.82–1.37)
O*NET Job Characteristics						
Physical activity mismatch			1.51 ^{***}	(1.26–1.82)	1.19	(0.94–1.50)
High responsibility/low control mismatch			1.23	(0.99–1.51)	1.13	(0.91–1.41)
Information processing mismatch			1.88 [*]	(1.06–3.33)	1.83	(0.99–3.37)
Female	1.08	(0.99–1.19)	1.09	(0.99–1.19)	1.08	(0.99–1.19)
Education: High school	1.03	(0.90–1.19)	1.04	(0.91–1.19)	1.04	(0.90–1.19)
Education: Some college	0.88	(0.76–1.02)	0.89	(0.77–1.03)	0.89	(0.77–1.03)
Education: College	0.72 ^{***}	(0.61–0.86)	0.73 ^{***}	(0.61–0.87)	0.73 ^{***}	(0.61–0.87)
Education: More than college	0.62 ^{***}	(0.52–0.75)	0.63 ^{***}	(0.53–0.76)	0.65 ^{***}	(0.53–0.76)
Married	1.02	(0.92–1.12)	1.01	(0.91–1.11)	1.02	(0.92–1.13)
Born 1936 ref	1.00	(1.00–1.00)	1.00	(1.00–1.00)	1.00	(1.00–1.00)
Born 1937	0.85	(0.53–1.35)	0.81	(0.51–1.29)	0.84	(0.53–1.34)
Born 1938	0.79	(0.51–1.23)	0.75	(0.48–1.16)	0.78	(0.50–1.21)
Born 1939	0.89	(0.58–1.38)	0.86	(0.55–1.32)	0.88	(0.57–1.35)
Born 1940	0.83	(0.54–1.28)	0.79	(0.51–1.21)	0.81	(0.53–1.25)
Born 1941	0.80	(0.52–1.24)	0.77	(0.50–1.19)	0.79	(0.51–1.22)
Born 1942	0.91	(0.59–1.40)	0.87	(0.57–1.35)	0.89	(0.58–1.37)
Born 1943	0.95	(0.61–1.46)	0.91	(0.59–1.41)	0.93	(0.60–1.43)
Born 1944	0.99	(0.64–1.53)	0.94	(0.61–1.45)	0.97	(0.63–1.51)
Born 1945	0.80	(0.51–1.24)	0.76	(0.49–1.19)	0.79	(0.50–1.22)
Born 1946	0.94	(0.61–1.46)	0.90	(0.58–1.39)	0.93	(0.60–1.44)
Born 1947	0.92	(0.59–1.45)	0.90	(0.57–1.40)	0.91	(0.58–1.43)

	(1)		(2)		(3)	
	HR	95%CI	HR	95%CI	HR	95%CI
Born 1948	0.84	(0.54–1.31)	0.80	(0.51–1.25)	0.82	(0.53–1.28)
Born 1949	1.13	(0.72–1.77)	1.10	(0.70–1.71)	1.12	(0.71–1.74)
Born 1950	1.05	(0.67–1.65)	1.01	(0.64–1.58)	1.03	(0.66–1.62)
Born 1951	0.70	(0.44–1.11)	0.66	(0.42–1.06)	0.68	(0.43–1.08)
Born 1952	0.76	(0.47–1.22)	0.73	(0.45–1.17)	0.74	(0.46–1.20)
Born 1953	0.37**	(0.19–0.70)	0.36***	(0.19–0.69)	0.36**	(0.19–0.69)
Born 1954	0.30***	(0.16–0.59)	0.29***	(0.15–0.57)	0.30***	(0.15–0.58)
Born 1955	0.39*	(0.17–0.92)	0.38*	(0.16–0.89)	0.39*	(0.16–0.90)
Born 1956	0.53	(0.18–1.53)	0.52	(0.18–1.52)	0.52	(0.18–1.53)
Log wealth	1.01	(0.99–1.02)	1.01	(0.99–1.02)	1.01	(0.99–1.02)
Log earnings	0.97***	(0.95–0.99)	0.97***	(0.95–0.99)	0.97***	(0.95–0.99)
Has defined benefit pension	1.60***	(1.46–1.77)	1.63***	(1.48–1.79)	1.61***	(1.46–1.77)
Is self-employed	0.49***	(0.40–0.59)	0.49***	(0.41–0.59)	0.49***	(0.41–0.59)
Works part-time	1.14*	(1.01–1.28)	1.12	(0.99–1.27)	1.13*	(1.00–1.28)
Observations	5,070		5,070		5,070	
Log likelihood	–15957.13		–15961.72		–15953.95	
Likelihood ratio test (compared to Model 3)		6.37		15.54		
$\chi^2(df=3)$						
p-value		.17		0.0014		

Notes: HR is hazard ratio with 95% confidence intervals in brackets; statistical significance indicated by

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

Source: Health and Retirement Study 1996–2014