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Occupation, Retirement and Cognitive Functioning

Shinya Kajitani, Meisei University,
Kei Sakata, Ritsumeikan University
and
Colin McKenzie, Keio University

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Keywords: cognitive functioning, endogeneity, retirement, two stage estimation
JEL Classification Numbers: I10, J2

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Introduction

An aging population is a common serious issue for many countries. The combination of a low fertility rate and increases in life expectancy has magnified the problem. An aging population challenges the maintenance of a pay-as-you-go pension system and also raises concerns that there may be a shortage of labour supply. A delay in the retirement age is an obvious policy option to deal with some of these problems, and many countries have already raised their retirement ages by delaying the age for which people are eligible to start receiving pension payments[2]. The Organization for Economic Co-operation and Development (OECD) (2012) has recently argued that governments will need to raise the retirement age to ensure that pension systems are both affordable and adequate.

It has been argued that there may be other externalities of delaying the retirement age because continued intellectual stimulation can potentially help reduce the deterioration of cognitive functioning (Potter et al. (2008), Small (2002)). The relationship between retirement and cognitive skills has attracted much attention (Rohwedder and Willis, (2010) for a survey). These studies test the so-called 'use-it-or-lose-it' hypothesis, that is, they test for a causal effect of retirement on cognitive performance that suggests that following retirement cognitive performance declines because retired individuals do not use their cognitive skills as much as when they are working.

One challenge in this area of research is the potential endogeneity of retirement choices as people with lower cognitive abilities may decide to retire earlier or there may be correlation between the choice of the age of retirement and unobservable factors such as health. The typical identification strategy is to use a change in the social security system as an instrument.

Using cross-sectional data from the United States and Europe, Adam et al. (2006) found that there is a positive causal relationship between retirement and cognition. Moreover, they found that the longer the retirement period, the lower the cognitive skills. However, Adam et al. (2006) did not take into account of endogeneity. In order to address endogeneity, the legal age of retirement which differs across countries has been used as an instrument for retirement in cross-national data (Adam et al. (2006), Coe and Zamarro (2011), Mazzonna and Peracchi (2012), and Rohwedder and Willis, (2010)). After taking account of the endogeneity of retirement, Mazzonna and Peracchi (2012) and

[2] See, for example, http://www.guardian.co.uk/news/datablog/2010/jun/24/retirement-ages-oecd-countries

Rohwedder and Willis (2010) found that there was a significant and negative effect of retirement on cognitive skills, while Coe and Zamarro (2011) did not find such a causal effect.

Critics of using the legal age of retirement across countries as instruments for retirement argue that the approach has a limitation that individuals in different countries face different social and cultural constraints. Mazzonna and Peracchi (2012) also indicate that the cross-country variation in eligibility ages in early and normal retirement is actually small. Moreover, cross-sectional or cross national data cannot remove time invariant individual heterogeneity.

Bonsang et al. (2012) use panel data from the Health and Retirement Study (HRS) for the United States to investigate the causal effect of retirement on cognitive function. Bonsang et al. (2012) control for time invariant heterogeneity, and examine a single country where all individuals face the same social and cultural constraints. They find that the effects of retirement on cognitive function appear with a lag, and conclude that there are positive externalities of a delayed retirement for older individuals.

Coe et al. (2012) use offers of early retirement windows as instruments for retirement, but they do not find a clear relationship between retirement and cognitive skills. Coe et al. argue that the choice of instruments (international differences in retirement age versus nondiscriminatory offering of retirement windows) and the choice of specification (retirement status versus retirement duration) may explain some of the contradictory findings in this area.

In neuropsychological research, Stern (2002, p.448) defines the cognitive reserve as "more efficient utilization of brain networks or of enhanced ability to recruit alternate brain networks as needed". Stern (2002) distinguishes between passive models and active models for the brain reserve hypothesis. Passive models indicate that a larger reserve (larger brain) has a better capacity to replace damaged brain areas, and this enables the brain to maintain higher functioning. In contrast, active models suggest that the brain actively compensates for damaged area. Higher levels of intelligence such as educational and occupational attainment are good predictors of which individuals can sustain greater brain damage before demonstrating functional deficit. This suggests taking account of the relationship between occupation and cognitive reserves (and functioning).

Some research has found that education plays a role in the cognitive reserve (Evans et al., 1993, Le Carret et al., 2003). Other research has studied the effect of occupation on dementia and Alzheimer's disease, and the results suggested that cognitive decline is related to occupation (Evans et al., 1993, Schooler et al., 1999, Stern et al., 1994). Adam et al. (2006) contends that continuing professional activities can be a protective strategy against cognitive decline. On the other hand, Coe et al. (2012) compares white collar workers to blue collar workers, but they could not find a positive causal association between retirement and cognition among white collar workers. Interestingly, they found some evidence that there is a *positive* effect of retirement on the cognitive skills for blue collar workers.

We use Japanese data to study the impact of retirement on cognitive functioning. There are some advantages in using Japanese data to study the impact of retirement on cognition. Figure 1 depicts the old age (65+) dependency ratios[3] among some developed countries. Japan is the leader of aging population in terms of its pace and scale. By 2010, the dependency ratio has reached 35%, and it is estimated that it will reach as high as 70% by 2050 (United Nations 2011). There is another advantage in using Japanese data. Figure 2 shows the labour participation rates of elderly male workers (65+) among some developed countries. Although the Japanese labour participation rate has dropped dramatically over the past 35 years the Japanese elderly males (and females) tend to remain in the labour force longer than in other developed economies, so that investigating the Japanese situation may provide useful information for other countries. This difference may give more variation in their actual retirement ages in Japan than in other countries. It should be pointed out that to our knowledge there is no other study examining the impact of retirement on cognitive functioning for Japanese male (or female) workers.

[Figures 1 and 2 around here]

This paper examines the causal impact of retirement on cognitive functioning for elderly male workers using three waves of the "Longitudinal Study of a National Survey of Japanese Elderly" (NSJE), the initial 1987 survey, and two supplementary samples obtained in 1990, and 1996. We use these samples because they contain information on when the respondents retired, whereas the continuing samples in 1990, 1993 and 1996 only contain information on the current status of retirement, but not when respondent's retired. This paper's contribution is its exploration of the effects of the longest tenure job (career job) on cognitive functioning. In particular, we focus on the worker's job tasks rather than industry where the worker worked or his/her occupation. We merge the occupational characteristics in the Dictionary of Occupational Titles (DOT) by 3 digit occupational code, and examine how occupational task requirements such as physical demands, mathematical development, reasoning development, and language development impact on

3 The old age dependency rate is defined as the ratio of the population aged 65 years or over to the population aged 20-64. All ratios are presented as the number of dependents per 100 persons of working age (20-64).

cognitive functioning after retirement. Unlike Coe et al. (2012) or Adams et al. (2006), we will examine the effects of the required work tasks in the individual's career job rather than the effects of simple occupational category. We argue that our strategy is more beneficial to account for the heterogeneity of work tasks. To our knowledge, this is the first study to examine the effects of retirement on cognitive functioning in Japan.

In analyzing the causal impact of retirement on cognitive functioning, we will use retirement duration rather than retirement status as the variable of interest. Some studies such as Bonsang et al. (2010) and Rohwedder and Wills (2010) use a 0-1 retirement dummy variable which takes 1 if the individual is retired and takes 0 otherwise, but we argue that this approach is problematic as it regards retirement as having an immediate constant shift effect on cognition. It is difficult to argue that two individuals one of whom retires the day of the survey and is treated as retired and one who retires the day after the survey and who is treated as working would have significant differences in their cognitive functioning. As Coe et al. (2012) point out, it is more natural to assume that retirement gradually affects cognition, and modeling the 'dose-response' of retirement on cognition is more appropriate.

Our two stage estimation technique deals with the potential endogeneity of retirement decisions by using two instruments. In addition to the pension eligibility age, which is the standard instrument in this area, this paper also uses a self-employed dummy as a second instrument. It is important to note that the self-employed dummy refers to whether or not the respondent's career job was self-employment, not whether or not the respondent's job immediately prior to retirement was self -employment.

One potential problem in using retirement duration as the variable of interest is that the retirement duration is left censored, that is for individuals who are still working retirement duration is treated as being zero. Previous studies do not take account of 0 values in the retirement period variable. Here, we apply a Tobit model to deal with this problem in the first stage estimation when we model retirement duration.

Another estimation issue relates to mixing data from the initial 1987 survey and the supplementary samples in 1990 and 1996. Mere pooling of these samples significantly changes the age distribution of the overall sample due to the usage of the supplementary samples which are focused on the young elderly. In order to adjust the age representation in the sample, we use weights from the Census when estimating models at both the first and second stages.

Why should economists pay attention to the relationship between retirement and cognitive functioning? Mazzonna and Peracchi (2012) contend that cognitive functioning is a crucial factor for formulating consumption and saving plans. Moreover, it is important to examine whether or not declines in cognitive ability is a natural process of aging or whether it can be controlled or affected by work, education or other behavioral choices (Mazzonna and Peracchi (2012) and McFadden (2008)).

Some studies have examined the effect of job type on health status, and found that workers whose career job is a blue collar occupation are more likely to show health status deterioration. The results suggest that physically more demanding blue collar occupations lead to the health deterioration in the elder age (Case and Deaton (2005), Kajitani (2011), Morefield et al. (2011)). It may also be the case that the cumulative effects of occupational characteristics may be crucial to cognitive functioning in later life.

The rest of this paper consists of four sections. Section 2 discusses the identification strategy and the models to be estimated, while section 3 describes the data. Section 4 reports the results of estimation and discusses their implications, and section 5 contains a brief conclusion.

2. Empirical Model and Identification Issues

The main goal of this paper is to identify the causal effect of retirement on cognitive functioning and to examine whether aspects of the career job can have any effects on cognitive functioning after retirement. The following model is considered:

$$COG_i = \tau_1 RET_i + \tau_2 (RET_i \cdot DOTJ_i) + \tau_3 DOTJ_i + X_i \beta + u_i \qquad (1)$$

where COG_i is the outcome variable (cognitive test score), RET_i is the duration of retirement, $DOTJ_i$ is a 0-1 dummy variable relating to the Jth occupational characteristics of the respondent's career job, X_i is a vector of control variables, which includes a constant, the respondent's age and the respondent's years of education, u_i is an error term, and the subscript i refers to the ith individual. Following Roberts and Binder's (2009) suggestion, we also include 1990 and 1996 survey year dummies in X_i to account for the fact that we are combining information from three surveys, the 1987, 1990 and 1996 surveys. The use it or lose it hypothesis suggests that as the duration of retirement gets longer, decline in cognitive skills should decline, that is, $\tau_1 < 0$.

In equation (1), this paper uses retirement duration rather than the status of retirement since we are more interested in uncovering any dynamic effects of retirement on cognitive functioning. When using the retirement duration variable, it is important to note that many respondents are still in the workforce and their value of retirement duration is zero. We argue that there may be non-trivial differences in cognitive functioning between those who are still in the labour force and those who are already retired.

The variable $DOTJ_i$ is a 0-1 dummy variable relating to the Jth occupational characteristics of the respondent's career job (longest job). We use four occupational characteristics in the Dictionary of Occupational Titles (DOT) of the respondent's career job, namely physical demands, mathematical development, reasoning development and language development. For the physical demands characteristic, we create a 0-1 dummy variable which takes the value unity if the score for the respondent's characteristic is higher than the median value, and zero otherwise. For other characteristics, we create a 0-1 dummy variable which takes the value unity if the score for the respondent's characteristic is higher than the median value, and zero otherwise. We label these variables DOTP for physical demands, DOTM for mathematical development, DOTR for reasoning, and DOTL for language development. We will include these four DOT variables one by one in equation (1). When the occupational characteristic relates to the physical demands of a job, a value of the dummy variable equal to 1 (0) relates to high (low) physical demands, so it is expected that $\tau_3 < 0$. For the other three variables, where a higher than median value corresponds to a value of the dummy variable equal to unity, we also expect that $\tau_3 > 0$. For the interaction term $RET_i \cdot DOTJ_i$, the rate of decline of cognitive function with retirement duration will be higher for job careers that involve higher than the median physical demand characteristics, so it is also expected that $\tau_2 < 0$. For the other three variables, it is expected that $\tau_2 > 0$.

The possibility that the length of retirement in equation (1) is endogenous is a major obstacle to estimating the causal impact of retirement on cognitive functioning. Individuals whose cognitive abilities are lower (higher) may retire earlier (later). Moreover, retirement choices may be correlated with unobservable factors such as health. The typical identification strategy in previous studies is to use change in the social security system as an instrument for the retirement variable, and we also adapt this strategy.

We consider the following model to explain the length of retirement:

$$RET_i^* = \gamma_1 PENSION_i + \gamma_2 SELF_i + \gamma_3 DOTJ_i + X_i\delta + w_i \qquad (2)$$

$$RET_i = 0 \text{ if}, RET_i^* \leq 0 \qquad (3a)$$

$$= RET_i^*, \text{if } 0 < RET_i^* < 10 \qquad (3b)$$

$$= 10, \text{if } 10 \le RET_i^* \qquad (3c)$$

where RET_i^* is an unobserved latent variable which is connected to the observed RET_i by equation (3), $PENSION_i$ is the age at which individual i is eligible to start receiving pension benefits, $SELF_i$ is a 0-1 dummy variable taking the value unity if the individual i's career job is a self-employed job, X_i is the same vector of control variables as used in equation (1), and w_i is a disturbance which is assumed to be normally distributed with zero mean and variance σ_w^2. Even though we have information on retirement durations of greater than 10 years, we have purposely chosen to censor this information because we believe that there is a limit to the impact of retirement duration on cognitive function.[4] The combination of (2) and (3), together with the assumption about w_i means that this model can be estimated using the Tobit technique (with left and right censoring).

By comparing equations (1) and (2), it can be seen that our "instruments" for RET_i are the age at which individuals are eligible to start receiving benefits, $PENSION_i$, and the self-employed dummy variable, $SELF_i$. The age at which individuals are eligible to start receiving pension benefits has changed over the years in Japan. Due to the amendments to the pension law in 1954, the age at which men are eligible to start receiving pension benefits for men had been gradually raised by one year in every four years from 55 to 60 over a period of 16 years, 1957 to 1973[5]. As a result, men born from 2 May 1902 to 1 May 1905 were eligible to start receiving their pension benefits at the age of 56. Similarly, men born from 2 May 1905 to 1 May 1908 were eligible to start receiving their pension benefits at the age of 57, and so on. Men born after 2 May 1914 were eligible to start receiving their pension benefits at the age of 60. We assume that these are exogenous changes to the timing of pension benefits, so that the changes in the eligibility age to receive pension benefits is only correlated with the retirement variable, but not with cognitive functioning.

The second instrument is a self-employment dummy which control for whether the respondent's career job was self-employment. Seike and Yamada (2004) indicate that the self-employed people are more likely to stay in the labour force after their mandatory retirement age.

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4 Appendix 2 provides details a cross tabulation of of retirement age and the duration of retirement for our sample.

5 It should be noted that this law did not change the age at which women were eligible to start receiving their pension benefits. This is another reason why we did not include females in our analysis.

In order to estimate the parameters of equation (1) taking account of the endogenity of the duration of retirement, three alternative ways of estimating equations (1)-(3) are maximum likelihood, instrumental variable estimation, and two step estimation. Here, we employ a two step estimator. First, we estimate the parameters in equations (2) using a Tobit estimator to obtain estimates of the parameters of γ_i and δ, $\hat{\gamma}_1$ and $\hat{\delta}$, respectively. From equations (2) and (3), the conditional expectation of RET_i can be computed as

$$E(RET_i \,|Z_i) = 10(1 - \Phi_U) + (\Phi_U - \Phi_L)Z_i\alpha + \sigma_w(\phi_L - \phi_U) \qquad (4)$$

where Z_i is the vector of regressors in (2), α is the vector of parameters in (2), $\Phi_U = \Phi\left(\frac{10-Z_i\alpha}{\sigma_w}\right)$, $\Phi_L = \Phi\left(\frac{-Z_i\alpha}{\sigma_w}\right)$, $\phi_U = \phi\left(\frac{10-Z_i\alpha}{\sigma_w}\right)$, $\phi_L = \phi\left(\frac{-Z_i\alpha}{\sigma_w}\right)$, $\Phi(.)$ is the cumulative distribution function of the standard normal distribution function, and $\phi(.)$ is the probability distribution function. With estimates of the parameters of equation (2), this conditional expectation can easily be estimated. In the second step, RET_i in (1) is replaced by this estimate of the conditional expectation of RET_i, and the equation is then estimated by ordinary least squares (OLS). To take account of the generated regressor problem caused by using an estimate of the conditional expectation, standard errors of these OLS estimates are computed using the bootstrap approach.

As noted in section 3, individuals aged in their early 60s are over-represented in the sample we use. In order to adjust the age representation in the sample, we compute the proportion of a particular age group to the population from data reported for the National Censuses conducted in 1985, 1990 and 1995, and use them as the weights when estimating the models at both the first and second stages.

3. Data

Our data are drawn from the 1987 (Wave 1), 1990 (Wave 2), and 1996 (Wave 4) waves of the "Longitudinal Study of a National Survey of Japanese Elderly (NSJE)" (Zenkoku Koureisha no Seikatsu to Kenkou nikansuru Chouki Jyuudann Chousa). For the purpose of this survey, the "elderly" are defined as people who are 60 years of age or over. These surveys were conducted by the Tokyo Metropolitan Institute of Gerontology and the University of Michigan. The data was provided by the Social Science and the Social Science Japan Data Archive, Information Center for Social Science Research on Japan, Institute of Social Science, the University of Tokyo. NSJE has been conducted every three years since 1987. The population of aged 60 and over was extracted by two-stage stratified random sampling. The surveys include information on the respondent's physical health, mental health, family relationships, social relationships, and economic status. Observations where for health reasons a family member answered the survey on behalf of the respondent are excluded from our analysis. Kan (2009) and Kajitani (2011) compare the differences between the sample distributions of the NSJE and the relevant Japanese Census data, and report that there is little difference between the two.

The initial sample for the longitudinal study was obtained in 1987, but was supplemented by additional samples in 1990 and 1996[6]. It is important to note that NSJE only asks respondents about their year of retirement in Wave 1 in 1987, and for individuals in the supplementary samples in Wave 2 (1990) and Wave 4 (1996). For the continuing individuals in Waves 2-4, we only know if they are currently retired or not. For those continuing respondents who were not retired at the time of the first survey participated in but who retire sometime later, it is possible by comparing their responses across two waves to determine that they retired sometime in a three year period, the time between successive surveys. However, trying to use this information will lead to potentially large measurement errors in the duration of retirement, so we only use Wave 1 (1987) and the supplementary samples in Wave 2 (1990) and Wave 4 (1996).

In the supplementary sample in Wave 2 (1990), an additional 580 individuals who are aged 60 to 62 obtained by the stratified random sampling added to those continuing from Wave 1. In Wave 4 (1996), an additional 1210 individuals who are aged 60 to 65 obtained by the stratified random sampling added to those continuing from Wave 3. Table 1 summarises the sample sizes and the response rates for each wave. As can be seen from Table 1, these four waves of the survey lead to an unbalanced panel, but to date we have not yet exploited the panel nature of the data, but rather have just pooled data from three of the four waves. As a result, we never observe the same individual twice in the sample we analyze in this paper.

Using the supplementary samples in Waves 2 and 4 in addition to the sample in Wave 1 means that individuals in their early 60s are over represented in the sample we use. All the descriptive statistics and estimation results reported in this paper, weight the data appropriately to take account of this over representation.

The analysis in this paper is restricted to males. In Japan, women are more likely to quit their jobs

[6] Since there was no supplementary sample added in 1993 (Wave 3), we do not use any of the data from this wave.

after marriage and child birth than in other developed countries. Some women come back to work after child birth, and others do not. The NSJE survey does not provide information on how long respondents are away from their jobs and at what age they returned to the workforce. More importantly, for females in these generations in the sample, in particular, a sizeable number of individuals never worked. These women called "Kaji Testudai" in Japanese help with domestic work in their parental home until they get married and then become a full time housewife after their marriage. For these reasons, the analysis of job effects on cognitive functioning for females could be a little more complicated than the analysis for males.

[Table 1 around here]

All data on the variables used in this paper are drawn from NSJE except the Dictionary of Occupational Titles (DOT). The definitions of all the variables are summarized in the Appendix 1.

3.1 Cognitive Test Scores

NSJE contains information on the respondents' answers to questions that test his/her memory. In an interview, the respondent is asked nine questions: 1) the respondent's address; 2) the date of the interview; 3) the day of the interview 4) the respondent's mother's maiden name; 5) the name of the current Prime Minister; 6) the name of the previous Prime Minister; 7) the respondent's date of birth; 8) the respondent's age; and 9) a question that requires the respondent to continuously deduct 3 from 20. We use the accuracy of the respondent's answers to these questions as a measure of cognitive functioning. For the question on successively deducting 3 from 20, the answer is recorded as being correct if the respondent could successfully deduct 3 six times until the number becomes 2. Over 80 percent of the respondents gave the correct answer to this question.

We create a cognitive score variable based on seven of the nine questions which excludes the accuracy of answering the questions about the current and the previous Prime Ministers because these two questions relating to the Prime Minister do not necessarily capture the respondent's memory loss. There were eight Prime Ministers within the sample period (1987-1996), and some of them did not even survive one quarter (for example, Sosuke Uno for 69 days and Tsutomu Hata for 64 days). It is hard to identify if the wrong answer means a memory loss or a low interest in politics.

For each of the remaining seven questions, a correct answer to a question is allocated one point and an incorrect answer is allocated zero points, so the maximum possible score for an individual is 7 and the minimum possible score is 0.

3.2 Retirement

Previous research uses two ways to alternative measures of retirement, the self-reported status of retirement and the retirement period. Previous studies such as Bonsang et al. (2010) and Rohwedder and Wills (2010) use a retirement dummy, which takes the value unity if s/he reports not working, and the value zero if s/he reports to be currently working for pay. However, the effects of retirement on cognitive functioning may not be instantaneous shift. Bonsang et al. (2012) found that the effect of retirement on cognitive functioning is not instantaneous, but appears with a lag. On the other hand, Coe et al. (2012) prefer to use the duration of retirement as retirement variable arguing that it is more natural to assume that retirement gradually affects cognition. They model the 'dose-response' of retirement on cognition. In order to capture the gradual effects of retirement, we will use the duration of retirement as the variable of interest.

The retirement period is computed as follows. As discussed earlier, in the first survey in 1987, individuals who have retired before the survey are asked when they retired. This information can be used to compute the duration of their retirement at the time of the survey. The same is true for individuals in the supplementary samples in 1990 and 1996 who have retired before these surveys. Individuals whose duration of retirement is greater than 10 years are treated as having a duration of 10 years..

3.4 Dictionary of Occupational Titles (DOT)

One main objective is to investigate how occupational characteristics of a respondent's career job are associated with cognitive functioning after retirement. We merge the 3 digit occupation codes in the Dictionary of Occupational Titles (DOT) with our data set using the 3 digit occupation code (288 occupations) in the NSJE. We examine four dimensions of an occupational task, namely, physical demands, mathematical development, reasoning development, and language development.

Following Fletcher et al (2011), in the physical demands category we focus on strength, which is measured as one of the five categories: Secondary, Light, Medium, Heavy and Very Heavy. We compute the physical strength variable by giving scores as follows: Secondary=1, Light=2, Medium=3, Heavy=4 and Very Heavy=5.

DOT also provides information of the General Educational Development (GED) associated with occupations. It describes the levels of educational aspects which are required of the worker for satisfactory job performance. There are three aspects of GED: mathematical development, reasoning development, and language development. Each of these GED variables is measured on a scale of 1 to 6. We merge this information using the occupational code in NSJE and examine the depth of white-collar-type work in the worker's career job.

[Table 2 around here]

Table 2 provides some examples of how we merged the DOT 3 digit code with 288 NSJE occupational codes. The occupation code 1 in NSJE is "Researcher in Natural Science", and the corresponding occupations in this category in the 3 digit code of DOT are 20 to 25, 40, 41 and 45 in corresponding occupations under this category. Similarly, the codes 50, 51, 52, 54 and 55 in the 3 digit code of DOT can be classified in "Researcher in Humanities and Social Science" category in NSJE. For each NSJE code we compute the average score for physical demands, mathematical development, reasoning development, and language development for the DOT codes corresponding to this category.

We then create a dummy variable for each of the four characteristics which take the value unity if the score of characteristics in the respondent's NSJE occupation is higher than the median value, and 0 otherwise. We will include DOT variables one by one in equation (1).

Table 3 shows the descriptive statistics for the occupational characteristics. Although due to the limitation in the space, we only show the aggregated occupational figures in Table 3, it should be noted that there are large variations in the score within white collar and within blue collar occupations. For example, veterinarians who are considered to be professional have a relatively high score in physical demands (2.357), and this physical demand score is similar to score for blue collar occupations such as "other logistic workers" (2.35) and "Textile workers" (2.364). On the other hand, "Furniture/wood finishers, other prec. wood workers" have a relative high mathematical development score (4.000), and this is the same score as high as for "judges, public prosecutors, and attorneys". Thus, simple blue collar and white collar or professional and non-professional divisions do not capture such variations within the groups.

[Table 3 around here]

Table 4 shows that there are high correlations between mathematical development, reasoning development, and language development. Although there are high negative correlations between physical demand and GED variables, they do not suggest these skills are substitutes. Considering these high correlations between job characteristics variables, we put each job characteristic variable one by one in the equation.

[Table 4 around here]

4. Results and Discussion

Descriptive statistics on all the variables used in the analysis are reported in Table 5. All estimates in this paper are obtained using STATA version 11.

First, as a benchmark case, we estimated equation (1) by OLS without taking into account the endogeneity of the duration of retirement. To be comparable with earlier research, we estimated a model which includes a blue collar dummy variable which takes the value unity if the career job is a blue collar occupation, and 0 otherwise. Table 6 reports the estimated results. As found in previous studies, before taking into acoount the endogeneity of retirement, the duration of retirement is statistically significant in some cases (4b, 5b and 6b in Table 6). Moreover, the blue collar dummy *per se* is insignificant. However, it is found that the occupations with high physical demands reduce the cognitive test score after retirement as the interaction term of the physical demand dummy and the duration of retirement is negative and statistically significant. The cross terms of the duration of retirement and the three GED indicators are positive and statistically significant. This means that individuals whose career jobs have a lower physical demands score group and or a higher GED score group are more likely to show the deterioration of memory loss.

[Tables 5 and 6 around here]

Table 7 summarises the estimated results when taking into account the endogeneity of retirement duration but ignoring the left and right censoring of the endogenous variable and the model is estimated by instrumental variable estimation. The first stage estimation results show that our instruments, the age at which an individual are eligible to start receiving pension benefits and the self-employed dummy are both statistically significant. The models estimated all pass the over-identification tests and the F-tests for weak instruments. The second stage estimates shows that the duration of retirement is no longer significant in any case, which is consistent with some of the previous studies. Furthermore, the interaction term of the blue collar dummy and the duration of retirement is negative and statistically significant. The cross term variable for physical demand is also negative and statistically significant, and the cross terms for mathematical development and language development are also positive and statistically significant.

Finally, in Table 8 we report the results of estimating our model taking into account both the endogeneity of retirement duration and the left censoring of retirement duration. The first stage estimations indicate that both instruments are individually and jointly statistically significant. The results of the effects of occupational characteristics on cognitive test score after retirement are all statistically significant in their cross term variable.

It should be noted that in none of the estimated results were the survey dummies ever significant in the first or second stage suggesting that it is legitimate to combine the information from different surveys with appropriate weights.

Our empirical findings highlight that the requirements in people's career job have statistically significant impacts on the cognitive functioning after retirement. This is quite different from Coe et al. (2012) where they compare white collar workers to blue collar workers, but they could not find a positive causal association between retirement and cognition among white collar workers. In addition, they report some evidence that there is a positive effect of retirement on the cognitive skills for blue collar workers. Due to potential multicollinearity, we could not include all of the job characteristic variables in one equation. Some may argue that the physical demand dummy merely reflects the effects of blue collar workers, and that the dummy variables for mathematical development, reasoning development and language development are absorbing the effects of white collar workers. However, our results are more plausible than Coe et al (2012), and the difference in the results may be due to how we classify occupations.

The results show that rough division between professional and nonprofessional or between white collar and blue collar workers cannot examine what really has impacts on cognitive functioning. The high physical demand reduces the memory test score after retirement. In contrast, high mathematical development, reasoning development and language development are important in preventing the decline of cognitive functioning after retirement.

[Tables 7 and 8 around here]

5. Conclusion

This paper examines the causal impact of retirement on cognitive functioning for elderly male workers in Japan using data from several waves of the National Survey of Japanese Elderly (NSJE). We contribute to the literature by exploring the effects of the characteristics of the longest tenured job (career job) on cognitive functioning. This paper focuses on the worker's job requirements rather than the industry he/she work in or his/her occupation. After merging the occupational characteristics in the 3 digit occupational code of the Dictionary of Occupational Titles (DOT) with 288 NSJE occupations, it is found that occupational task requirements such as physical demands, mathematical development, reasoning development, and language development have some impact on the cognitive functioning after retirement. Even after taking account of the endogeneity of retirement duration, and the left censoring of retirement duration, our empirical evidence suggests that if the individual's career job requirement has high mathematical development, reasoning development, and language development, the memory loss after retirement is slower. On the other hand, physical task performed in the individual's career job increases the deterioration of memory loss after retirement.

There are of course some reservations concerning the interpretation of our results. Although we found slower deterioration in the memory loss among people who engaged in the job tasks with a higher level of mathematical development, reasoning development, and language development, this may not mean such activities stimulate brain and delay the pace of deterioration of memory loss. One alternative interpretation is that people who worked in such occupations may have some specific patterns in how they spend time in their after-retirement life. In this case, occupational tasks may not have direct impacts on cognitive functioning. This issue should be dealt with in further studies.

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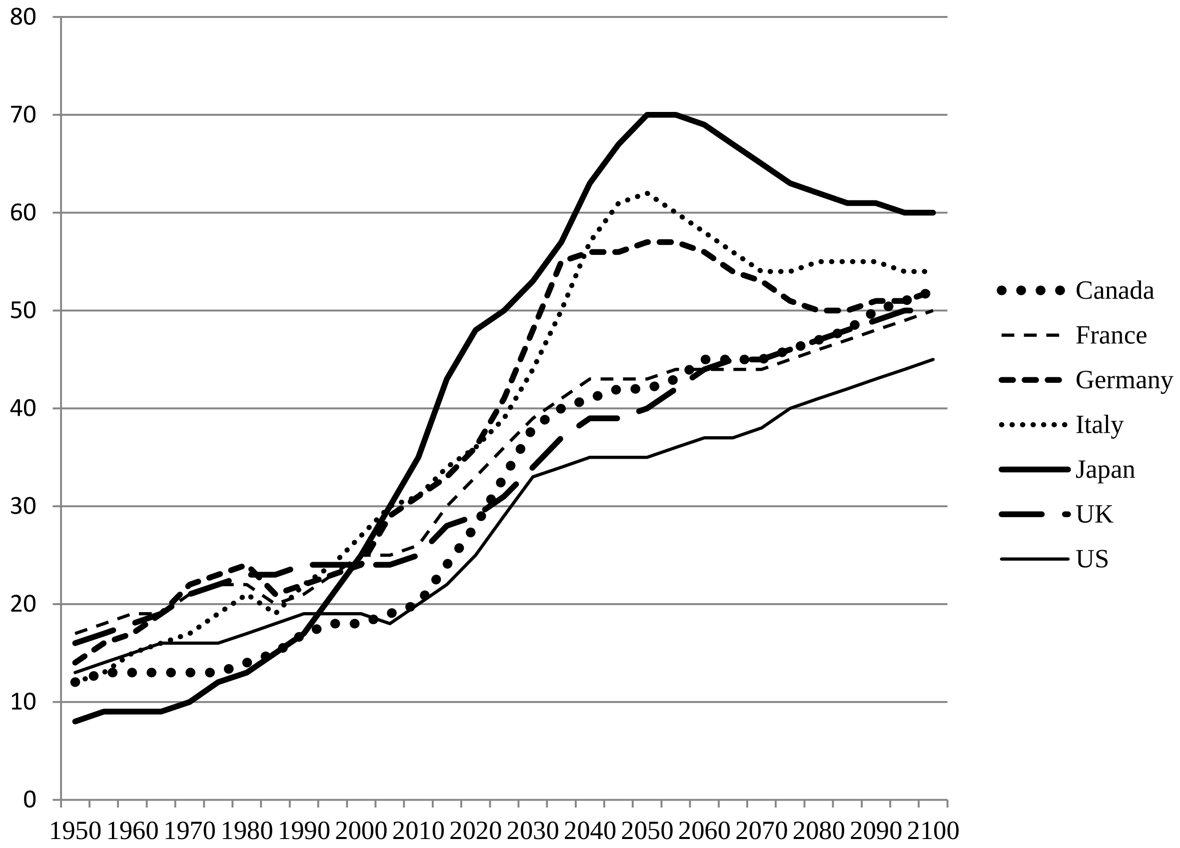
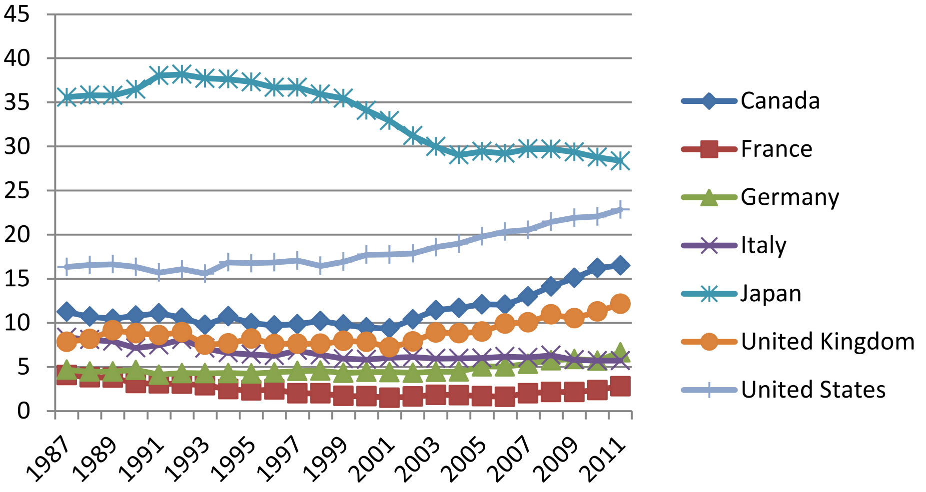
Figure 1: Old age (65+) dependency ratios among some developed countries.



Source: United Nation (2011).

Figure 2: Labour Force Participation Rate of the Aged (65 years or older Men)



Source: OECD.Stat Extracts (http://stats.oecd.org/)

Table 1: Response Rates

		Sample	Response (valid)	Respnse rate (excluding the
Wave 1 (1987)	New	3,288	2,200	66.9
Wave 2 (1990)	Continued	2,200	1,671	82
	Added	580	336	63.3
Wave 3 (1993)	Continued	2,441	1,864	83.8
Wave 4 (1996)	Continued	2,226	1,549	77.7
	Added	1,210	898	74.3

Notes:

(1) The "Continued" sample includes those who did not respond the previous survey.

(2) Cases where a family member answered the survey on behalf of the respondent due to health reasons of the respondent are excluded from the

Table 2: Examples of How to Merge 3 Digit Code in DOT with NSJE

NSJE OCCUPATIONAL CODE	DOT 3 DIGIT CODE								
1 Researcher in Natural Science	20	21	22	23	24	25	40	41	45
2 Researcher in Humanities and Social Science	50	51	52	54	55				
3 Mining engineer	10	11							
4 Metallurgical Engineer	11								
5 Mechanic Engineer	7								

Table 3: Characteristics of Career Job

		Job Characteristics															
With weighting		Physical demands				Mathematical demands				Reasoning development				Language development			
Career job	Obs	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Professional, Technical and Managerial	324	1.741	0.232	1	3	3.981	0.490	2.513	5.375	4.783	0.301	3.667	6	4.440	0.481	3.167	6
Clerical and Sales	198	1.793	0.280	1.417	2.763	2.706	0.365	1.658	3.111	3.604	0.415	2.476	4.333	3.277	0.631	1.763	4.1
Service	32	2.421	0.583	1.969	3.882	2.039	0.330	1	2.504	3.024	0.483	2	3.614	2.691	0.479	1.778	3.268
Agricultural, Fishery, Forestry, and Related	192	2.954	0.267	2	3.583	2.073	0.320	1.083	2.207	2.881	0.195	2.25	3.2	2.475	0.409	1.25	2.8
Processing	62	2.732	0.121	2.53	2.944	1.633	0.187	1.345	2.292	2.550	0.246	2.101	2.917	1.727	0.183	1.274	2.417
Machine Trades	81	2.776	0.249	1.75	3.443	2.322	0.734	1.103	3.889	3.063	0.462	2.121	3.923	2.370	0.624	1.328	3.615
Benchwork	85	2.422	0.333	1.839	3	2.071	0.839	1.013	4	2.906	0.570	2.125	4	2.124	0.620	1.138	3.333
Structual Work	121	3.096	0.182	2.598	3.317	2.203	0.365	1.733	3.313	3.260	0.203	2.733	3.83	2.272	0.235	1.75	3.094
Miscellaneous	82	2.819	0.334	2	3.264	1.597	0.388	1.193	2.688	2.776	0.326	2	4	1.822	0.380	1	2.813

Source: Authors calculations using data from NSJE.

Note:

Physical demands are measured on a 1-5 scale, whereas the other characteristics are measured on a 1-6 scale.

Table 4: Coefficients of Correlations between Job Characteristics

With weighting	Physical Demand	Reasoning Development	Mathematical Development	Language Development
Physical Demand	1.000			
Reasoning Development	-0.646	1.000		
Mathematical Development	-0.673	0.939	1.000	
Language Development	-0.681	0.920	0.962	1.000

Source: Authors calculations using data from NSJE.
Observations (1,177)

Table 5: Descriptive Statistics

With weighting	Observations (1,177)			
	Mean	Std. Dev.	Min	Max
Memory test score	6.730	0.586	2	7
Duration of retirement (year)	2.543	3.735	0	10
Physical demands (1 if > median)	0.498	0.500	0	1
Mathematical development (1 if > median)	0.513	0.500	0	1
Reasoning development (1 if > median)	0.503	0.503	0	1
Language development (1 if > median)	0.504	0.500	0	1
Age	67.375	6.456	60	87
Education (year)	9.889	2.942	0	17
Age eligible for pension benefit	59.559	1.035	55	60
Self-employed (1 if career job=self-employed)	0.417	0.493	0	1
year 1987	0.692	0.462	0	1
year 1990	0.061	0.239	0	1

Source: Authors calculations using data from NSJE.

Table 6: Estimated Results: Without considering endogeneity (*With weighting*)

A: Cognitive equation

	(1)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)	(5a)	(5b)	(6a)	(6b)
RET	-0.007	-0.008	0.008	-0.008	0.006	-0.008	-0.024 **	-0.008	-0.022 **	-0.008	-0.021 **
	[0.006]	[0.006]	[0.011]	[0.006]	[0.009]	[0.006]	[0.010]	[0.006]	[0.010]	[0.006]	[0.010]
RET*BLUE			-0.028 *								
			[0.016]								
RET*DOTP					-0.031 **						
					[0.014]						
RET*DOTM							0.028 *				
							[0.014]				
RET*DOTR									0.026 *		
									[0.014]		
RET*DOTL											0.023 *
											[0.014]
BLUE		-0.055	0.016								
		[0.055]	[0.053]								
DOTP				-0.055	0.018						
				[0.048]	[0.046]						
DOTM						0.047	-0.017				
						[0.052]	[0.047]				
DOTR								0.031	-0.028		
								[0.055]	[0.049]		
DOTL										0.045	-0.009
										[0.055]	[0.052]
AGE	-0.008 **	-0.008 **	-0.008 **	-0.008 **	-0.008 **	-0.008 **	-0.008 *	-0.008 **	-0.008 **	-0.008 **	-0.008 **
	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]
EDU	0.024 ***	0.019 **	0.018 **	0.020 **	0.018 **	0.020 **	0.018 *	0.021 **	0.020 **	0.021 **	0.019 **
	[0.008]	[0.009]	[0.009]	[0.009]	[0.009]	[0.009]	[0.010]	[0.009]	[0.010]	[0.009]	[0.010]
D87	-0.004	-0.008	0.012	-0.011	0.012	-0.008	0.008	-0.006	0.008	-0.008	0.006
	[0.068]	[0.068]	[0.063]	[0.069]	[0.063]	[0.069]	[0.063]	[0.069]	[0.063]	[0.069]	[0.064]
D90	-0.128	-0.130	-0.114	-0.131	-0.114	-0.126	-0.118	-0.128	-0.120	-0.127	-0.120
	[0.221]	[0.223]	[0.216]	[0.222]	[0.216]	[0.224]	[0.219]	[0.223]	[0.217]	[0.224]	[0.219]
Constant	7.082 ***	7.167 ***	7.109 ***	7.149 ***	7.123 ***	7.094 ***	7.111 ***	7.093 ***	7.128 ***	7.096 ***	7.131 ***
	[0.271]	[0.274]	[0.263]	[0.270]	[0.269]	[0.266]	[0.265]	[0.268]	[0.265]	[0.269]	[0.265]
Observations	1,177	1,177	1,177	1,177	1,177	1,177	1,177	1,177	1,177	1,177	1,177
R-squared	0.033	0.034	0.041	0.034	0.044	0.034	0.042	0.033	0.040	0.034	0.039
Wald test											
H_0: all coef. of variables except cons. in cognitive equation = 0	19.66 ***	21.59 ***	23.86 ***	21.84 ***	27.08 ***	22.55 ***	28.98 ***	21.32 ***	27.36 ***	21.88 ***	26.10 ***

Notes:

1) standard errors in brackets are estimated using a bootstrap approach based on one thousand replications.

2) *, ** and *** indicate statistical significance at 10%, 5% and 1% levels respectively.

Table 7: Estimated Results: With considering endogeneity (*With weighting*)

A: Cognitive equation (First-stage OLS)

	(1)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)	(5a)	(5b)	(6a)	(6b)
RET (fitted value)	0.005	-0.001	0.039	0.001	0.024	0.002	-0.025	0.003	-0.016	0.002	-0.019
	[0.025]	[0.025]	[0.035]	[0.026]	[0.028]	[0.026]	[0.031]	[0.027]	[0.031]	[0.026]	[0.031]
RET (fitted value)*BLUE			-0.057 *								
			[0.030]								
RET (fitted value)*DOTP					-0.048 **						
					[0.023]						
RET (fitted value)*DOTM							0.053 **				
							[0.024]				
RET (fitted value)*DOTR									0.037		
									[0.024]		
RET (fitted value)*DOTL											0.041 *
											[0.024]
BLUE		-0.048	0.108								
		[0.049]	[0.082]								
DOTP				-0.052	0.064						
				[0.047]	[0.053]						
DOTM						0.043	-0.084				
						[0.052]	[0.066]				
DOTR								0.024	-0.066		
								[0.057]	[0.068]		
DOTL										0.038	-0.061
										[0.055]	[0.068]
AGE	-0.011 *	-0.010	-0.011	-0.010	-0.010	-0.010	-0.011	-0.011	-0.011	-0.011	-0.011
	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]
EDU	0.023 ***	0.019 **	0.017 *	0.019 **	0.017 *	0.020 **	0.017 *	0.021 **	0.019 **	0.020 **	0.018 *
	[0.008]	[0.009]	[0.009]	[0.009]	[0.009]	[0.009]	[0.009]	[0.009]	[0.009]	[0.009]	[0.009]
D87	-0.004	-0.008	-0.001	-0.010	-0.007	-0.008	-0.006	-0.006	-0.005	-0.008	-0.006
	[0.067]	[0.067]	[0.065]	[0.067]	[0.066]	[0.067]	[0.066]	[0.067]	[0.066]	[0.067]	[0.066]
D90	-0.121	-0.126	-0.130	-0.126	-0.128	-0.121	-0.131	-0.122	-0.127	-0.122	-0.130
	[0.230]	[0.229]	[0.227]	[0.229]	[0.227]	[0.231]	[0.228]	[0.230]	[0.229]	[0.231]	[0.229]
Constant	7.259 ***	7.262 ***	7.229 ***	7.266 ***	7.221 ***	7.226 ***	7.331 ***	7.241 ***	7.304 ***	7.233 ***	7.311 ***
	[0.408]	[0.415]	[0.426]	[0.413]	[0.427]	[0.420]	[0.440]	[0.423]	[0.436]	[0.421]	[0.437]
Observations	1,177	1,177	1,177	1,177	1,177	1,177	1,177	1,177	1,177	1,177	1,177
R-squared	0.031	0.032	0.039	0.033	0.038	0.032	0.039	0.031	0.035	0.032	0.036
Wald test											
H_0: all coef. of variables except cons. in cognitive equation = 0	17.12 ***	18.08 ***	19.76 ***	18.87 ***	20.02 ***	20.25 ***	22.86 ***	18.84 ***	19.40 ***	19.40 ***	20.10 ***
Overidentification test of all instruments: J-test (p-value) 3)	0.38	0.35		0.38		0.37		0.38		0.38	

Notes:

1) "Duration of retirement" are calculated from the fitted values of a tobit model, standard errors in brackets are estimated using a bootstrapping technique. ten hundred bootstraps are run.

2) *, ** and *** indicate statistical significance at 10%, 5% and 1% levels respectively.

3) We report the test statistics using "ivreg2" in STATA.

B: First-stage equation (OLS)

	(1)	(2)	(3)	(4)	(5)	(6)
PENSION	0.610 *	0.602 *	0.607 *	0.606 *	0.598	0.601 *
	[0.367]	[0.364]	[0.365]	[0.366]	[0.365]	[0.365]
SELF	-1.994 ***	-1.925 ***	-1.985 ***	-1.971 ***	-1.942 ***	-1.950 ***
	[0.342]	[0.314]	[0.326]	[0.329]	[0.328]	[0.327]
BLUE		-0.266				
		[0.342]				
DOTP			-0.055			
			[0.283]			
DOTM				0.136		
				[0.276]		
DOTR					0.275	
					[0.273]	
DOTL						0.259
						[0.276]
AGE	0.338 ***	0.336 ***	0.338 ***	0.337 ***	0.335 ***	0.336 ***
	[0.064]	[0.062]	[0.063]	[0.063]	[0.063]	[0.063]
EDU	0.027	0.007	0.024	0.018	0.008	0.009
	[0.083]	[0.077]	[0.079]	[0.081]	[0.081]	[0.080]
D87	-0.291	-0.303	-0.296	-0.298	-0.305	-0.308
	[0.728]	[0.729]	[0.736]	[0.728]	[0.724]	[0.726]
D90	-0.440	-0.450	-0.444	-0.435	-0.442	-0.438
	[0.560]	[0.565]	[0.564]	[0.559]	[0.560]	[0.560]
Constant	-55.789 **	-54.803 **	-55.532 **	-55.480 **	-54.813 **	-55.079 **
	[25.540]	[25.138]	[25.270]	[25.444]	[25.353]	[25.352]
Observations	1,177	1,177	1,177	1,177	1,177	1,177
Log likelihood	-3055	-3054	-3055	-3055	-3054	-3054
R-squared	0.245	0.246	0.245	0.246	0.246	0.246
F-test						
H_0: all coef. of variables except cons. = 0	35.31 ***	30.35 ***	30.47 ***	30.48 ***	30.33 ***	30.37 ***
H_0: all coef. of excluded instruments = 0	17.32 ***	18.97 ***	18.85 ***	18.32 ***	17.92 ***	18.12 ***
Partial R-squared of excluded instruments 3)	0.09	0.07	0.08	0.08	0.08	0.08

Notes:

1) Robust standard errors in brackets

2) *, ** and *** indicate statistical significance at 10%, 5% and 1% levels respectively.

3) We report the test statistics using "ivreg2" in STATA.

Table 8: Estimated Results: With considering endogeneity (*With weighting*)

A: Cognitive equation (First-stage Tobit)

	(1)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)	(5a)	(5b)	(6a)	(6b)
RET (fitted value)	0.010	0.008	0.040	0.007	0.030	0.010	-0.025	0.011	-0.015	0.010	-0.017
	[0.025]	[0.025]	[0.033]	[0.025]	[0.027]	[0.026]	[0.032]	[0.026]	[0.033]	[0.026]	[0.033]
RET (fitted value)*BLUE			-0.054 **								
			[0.028]								
RET (fitted value)*DOTP					-0.052 **						
					[0.024]						
RET (fitted value)*DOTM							0.060 **				
							[0.025]				
RET (fitted value)*DOTR									0.042 *		
									[0.025]		
RET (fitted value)*DOTL											0.044 *
											[0.026]
BLUE		-0.039	0.103								
		[0.050]	[0.081]								
DOTP				-0.048	0.076						
				[0.048]	[0.059]						
DOTM						0.037	-0.103				
						[0.054]	[0.072]				
DOTR								0.017	-0.080		
								[0.059]	[0.074]		
DOTL										0.031	-0.071
										[0.058]	[0.075]
AGE	-0.012 *	-0.012 *	-0.012 *	-0.012 *	-0.012 *	-0.012 *	-0.012 *	-0.012 *	-0.012 *	-0.012 *	-0.012 *
	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]
EDU	0.022 ***	0.019 **	0.016 *	0.019 **	0.016 *	0.019 **	0.016 *	0.021 **	0.019 **	0.020 **	0.018 *
	[0.008]	[0.009]	[0.009]	[0.009]	[0.009]	[0.009]	[0.009]	[0.009]	[0.009]	[0.009]	[0.009]
D87	-0.007	-0.009	-0.002	-0.012	-0.005	-0.009	-0.004	-0.008	-0.005	-0.009	-0.005
	[0.067]	[0.067]	[0.064]	[0.067]	[0.064]	[0.067]	[0.064]	[0.067]	[0.064]	[0.067]	[0.064]
D90	-0.121	-0.123	-0.126	-0.124	-0.125	-0.120	-0.129	-0.121	-0.125	-0.121	-0.127
	[0.225]	[0.225]	[0.222]	[0.225]	[0.223]	[0.227]	[0.224]	[0.226]	[0.224]	[0.227]	[0.224]
Constant	7.326 ***	7.367 ***	7.301 ***	7.349 ***	7.300 ***	7.331 ***	7.424 ***	7.340 ***	7.382 ***	7.341 ***	7.396 ***
	[0.399]	[0.404]	[0.406]	[0.399]	[0.409]	[0.408]	[0.432]	[0.404]	[0.422]	[0.405]	[0.424]
Observations	1,177	1,177	1,177	1,177	1,177	1,177	1,177	1,177	1,177	1,177	1,177
R-squared	0.031	0.032	0.039	0.033	0.039	0.032	0.041	0.032	0.036	0.032	0.037
Wald test											
H_0: all coef. of variables except cons. in cognitive equation = 0	17.12 ***	18.37 ***	19.88 ***	18.95 ***	19.70 ***	20.32 ***	22.61 ***	18.88 ***	19.01 ***	19.44 ***	19.55 ***

Notes:

1) "Duration of retirement" are calculated from the fitted values of a tobit model, standard errors in brackets are estimated using a bootstrap approach based on one thousand replications.

2) *, ** and *** indicate statistical significance at 10%, 5% and 1% levels respectively.

B: First-stage equation (Tobit)

	(1)		(2)		(3)		(4)		(5)		(6)	
PENSION	2.536	**	2.502	**	2.520	**	2.502	**	2.463	**	2.478	**
	[1.186]		[1.176]		[1.179]		[1.184]		[1.181]		[1.180]	
SELF	-8.474	***	-8.189	***	-8.422	***	-8.296	***	-8.207	***	-8.240	***
	[1.503]		[1.428]		[1.461]		[1.459]		[1.450]		[1.449]	
BLUE			-1.112									
			[1.125]									
DOTP					-0.313							
					[1.007]							
DOTM							1.151					
							[0.997]					
DOTR									1.453			
									[0.988]			
DOTL											1.505	
											[1.000]	
AGE	1.174	***	1.164	***	1.171	***	1.167	***	1.157	***	1.161	***
	[0.257]		[0.252]		[0.255]		[0.255]		[0.255]		[0.255]	
EDU	0.077		-0.011		0.055		-0.004		-0.027		-0.033	
	[0.270]		[0.256]		[0.263]		[0.265]		[0.265]		[0.262]	
D87	-0.578		-0.590		-0.600		-0.608		-0.613		-0.639	
	[2.778]		[2.754]		[2.785]		[2.760]		[2.753]		[2.753]	
D90	-2.039		-2.034		-2.045		-1.961		-2.008		-1.995	
	[2.639]		[2.669]		[2.650]		[2.671]		[2.680]		[2.680]	
Constant	-230.034	***	-225.772	***	-228.483	***	-227.352	***	-224.300	***	-225.403	***
	[85.716]		[84.524]		[85.018]		[85.467]		[85.236]		[85.163]	
Observations	1,177		1,177		1,177		1,177		1,177		1,177	
Left-censored observations	805		805		805		805		805		805	
Right-censored observations	90		90		90		90		90		90	
Log likelihood	-1207		-1206		-1207		-1206		-1206		-1206	
F-test												
H_0: all coef. of variables except cons. = 0	20.38	***	17.65	***	17.50	***	17.58	***	17.69	***	17.73	***
H_0: all coef. of excluded instruments = 0	15.99	***	16.50	***	16.72	***	16.28	***	16.15	***	16.30	***

Notes:
1) Robust standard errors in brackets
2) *, ** and *** indicate statistical significance at 10%, 5% and 1% levels respectively.

Appendix I: Definitions of Variables

Short Name	Long Name	Defintion
RET	Duration of retirement (year)	Number of years between when the respondent reports retiring and the survey
BLUE	Blue-collar	0-1 dummy variable taking the value unity if the NSJE occupational code of the respondent's career job is 64～288，and 0 if the occupational code is 1～63.
DOTP	Physical demands (1 if > median)	0-1 dummy variable taking the value unity if the physical demand score for the respondent's NSJE occupational code is higher than the median value, and 0 otherwise.
DOTM	Mathematical development (1 if > median)	0-1 dummy variable taking the value unity if the mathematical development score for the respondent's NSJE occupational code is higher than the median value, and 0 otherwise.
DOTR	Reasoning development (1 if > median)	0-1 dummy variable taking the value unity if the reasoning development score for the respondent's NSJE occupational code is higher than the median value, and 0 otherwise.
DOTL	Language development (1 if > median)	0-1 dummy variable taking the value unity if the language development score for the respondent's NSJE occupational code is higher than the median value, and 0 otherwise.
AGE	Age	Respondent's age in years at the time of the survey
EDU	Education (year)	Number of years of schooling
PENSION	Age eligible for pension benefit	The age at which the respondent is eligible to start receiving pension benefits
SELF	Self-employed	0-1 dummy variable taking the value unit if the career job is a self-employed occupation, and 0 otherwise.
D87	year 1987	0-1 dummy variable taking the value unity if the respondent is surveyed in Wave 1 (1987), and 0 otherwise. (Reference year is Wave 4 (1996))
D90	year 1990	0-1 dummy variable taking the value unity if the respondent is surveyed in Wave 2 (1990), and 0 otherwise. (Reference year is Wave 4 (1996))

Appendix II: The Sample Distribution of Age and Duration of Retirement

	Duration of Retirement											
Age at Retirement/ Current Age for the	Employed	1	2	3	4	5	6	7	8	9	10 years or more	Total
50	0	0	0	0	0	0	0	0	0	0	3	3
51	0	0	0	0	0	0	0	0	0	0	2	2
52	0	0	0	0	0	0	0	0	0	0	3	3
53	0	0	0	0	0	0	0	1	0	1	1	3
54	0	0	0	0	0	0	4	1	1	0	2	8
55	0	0	0	0	0	4	3	4	1	1	1	14
56	0	0	0	0	1	0	2	2	2	0	0	7
57	0	0	0	2	4	3	2	0	2	2	4	19
58	0	0	3	7	2	5	0	4	2	0	2	25
59	0	6	4	3	4	3	5	1	0	0	7	33
60	119	13	17	7	11	11	7	1	3	1	2	192
61	141	2	5	1	3	2	0	2	1	0	6	163
62	141	4	4	4	1	1	1	1	0	0	5	162
63	86	1	3	3	0	1	1	1	0	0	11	107
64	82	4	0	0	2	1	2	2	0	2	8	103
65	67	1	1	2	1	3	2	1	0	1	3	82
66	15	0	0	1	0	1	0	1	0	0	4	22
67	20	1	1	4	3	0	0	2	0	0	4	35
68	18	0	1	0	1	0	0	3	0	2	5	30
69	10	0	1	1	1	1	0	1	0	1	3	19
70	15	1	1	1	0	2	0	2	0	1	3	26
71	9	1	1	0	1	1	0	0	0	0	0	13
72	12	0	0	0	2	0	0	0	0	0	4	18
73	15	1	0	0	0	0	0	1	0	0	2	19
74	15	0	0	1	0	0	2	1	0	0	3	22
75	13	0	0	0	0	0	0	1	0	0	2	16
76	5	1	0	0	0	0	0	0	0	0	0	6
77	4	0	0	0	0	0	0	0	0	0	0	4
78	2	0	1	0	0	0	0	0	0	0	0	3
79	5	0	0	0	0	0	0	1	0	0	0	6
80	1	0	0	0	0	0	0	0	0	0	0	1
81	3	0	0	0	0	0	0	0	0	0	0	3
82	2	0	0	0	0	0	0	0	0	0	0	2
83	1	0	0	0	0	0	0	0	0	0	0	1
84	2	0	0	0	0	0	0	0	0	0	0	2
85	1	0	1	0	0	0	0	0	0	0	0	2
87	1	0	0	0	0	0	0	0	0	0	0	1
Total	805	36	44	37	37	39	31	34	12	12	90	1,177