Online Appendix for "The Effects of Increasing the Eligibility Age for Public Pension on Individual Labor Supply: Evidence from Japan"

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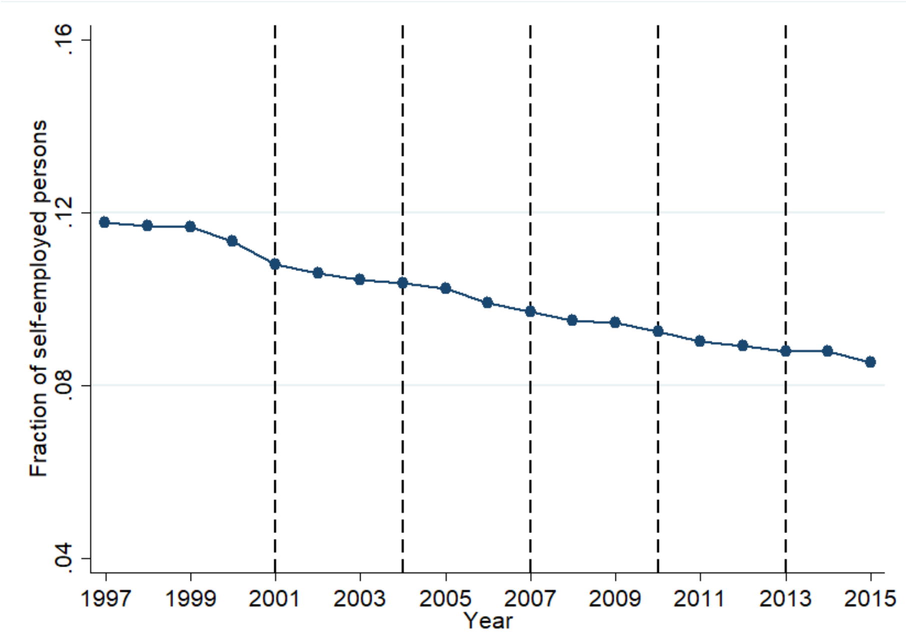
Sections

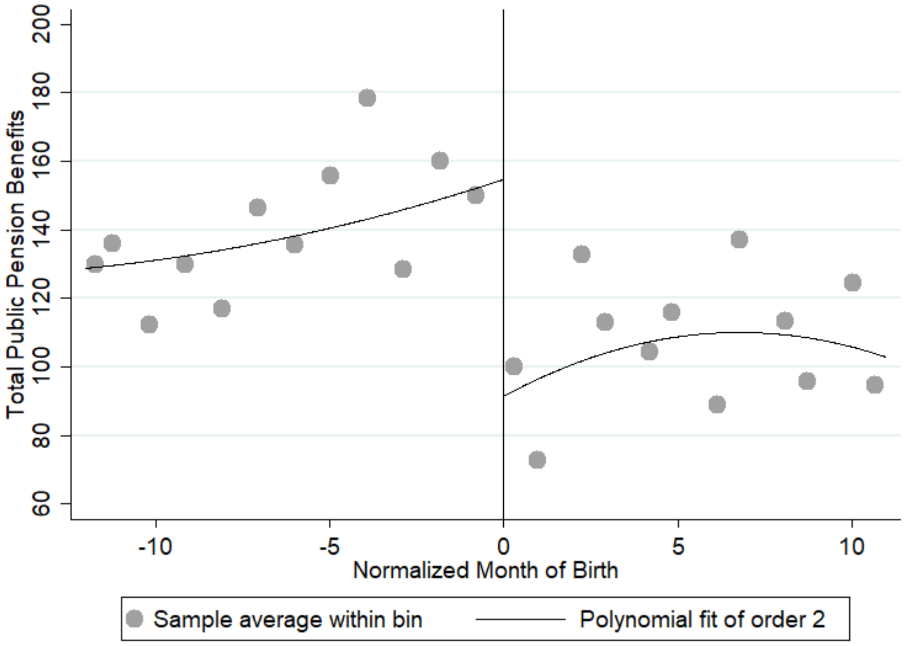
A. Appendix Figures

Figure A1: Fraction of Self-Employed Persons by Year



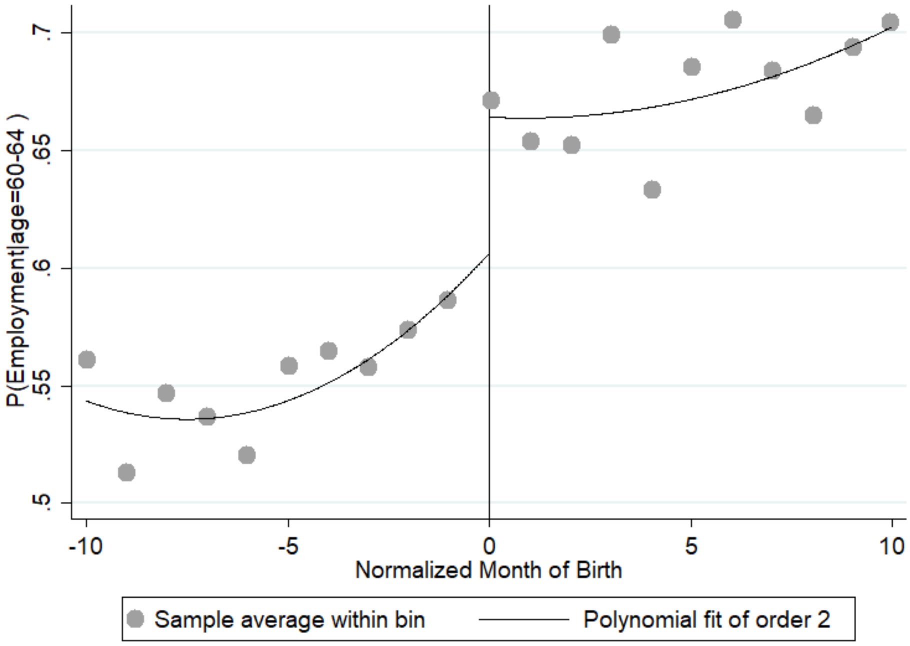
Notes: The figure plots the fraction of self-employed persons by year. The vertical dashed lines correspond to increases in the eligibility age for EPI flat-rate benefits. The eligibility age was raised from 60 to 61 in 2001, from 61 to 62 in 2004, from 62 to 63 in 2007, from 63 to 64 in 2010, and from 64 to 65 in 2013.

Figure A2: RD Estimates on the Total Public Pension Benefits (Quadratic Function)



Notes: The figure plots the average male total annual EPI benefits at the critical ages by month of birth. The solid lines on the panel correspond to quadratic fitted values. For other details, see the notes to Figure 4 in the main paper.

Figure A3: RD Estimates on Male Employment (quadratic function)



Notes: The figure plots the average probability of employment for males at the critical ages by month of birth. The solid lines on the panel correspond to quadratic fitted values. For other details, see the notes to Figure 5 in the main paper.

Validity Tests

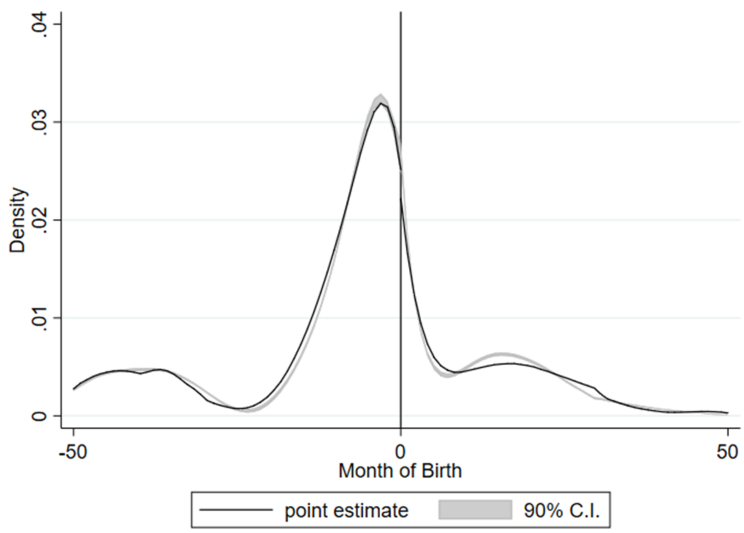
Manipulation

The underlying assumption of an RDD is that the running variable is continuous and individuals cannot manipulate the running variable. This condition is tested based on the methods in McCrary (2008). Appendix Figure A4 graphically depicts the density of the running variable (month of birth) for males, and there is no spike around the cutoff. The p-value of the manipulation test specified by McCrary (2008) is 0.27, indicating no statistical evidence of systematic manipulation of the running variable.

Soothness of Predetermined Covariates

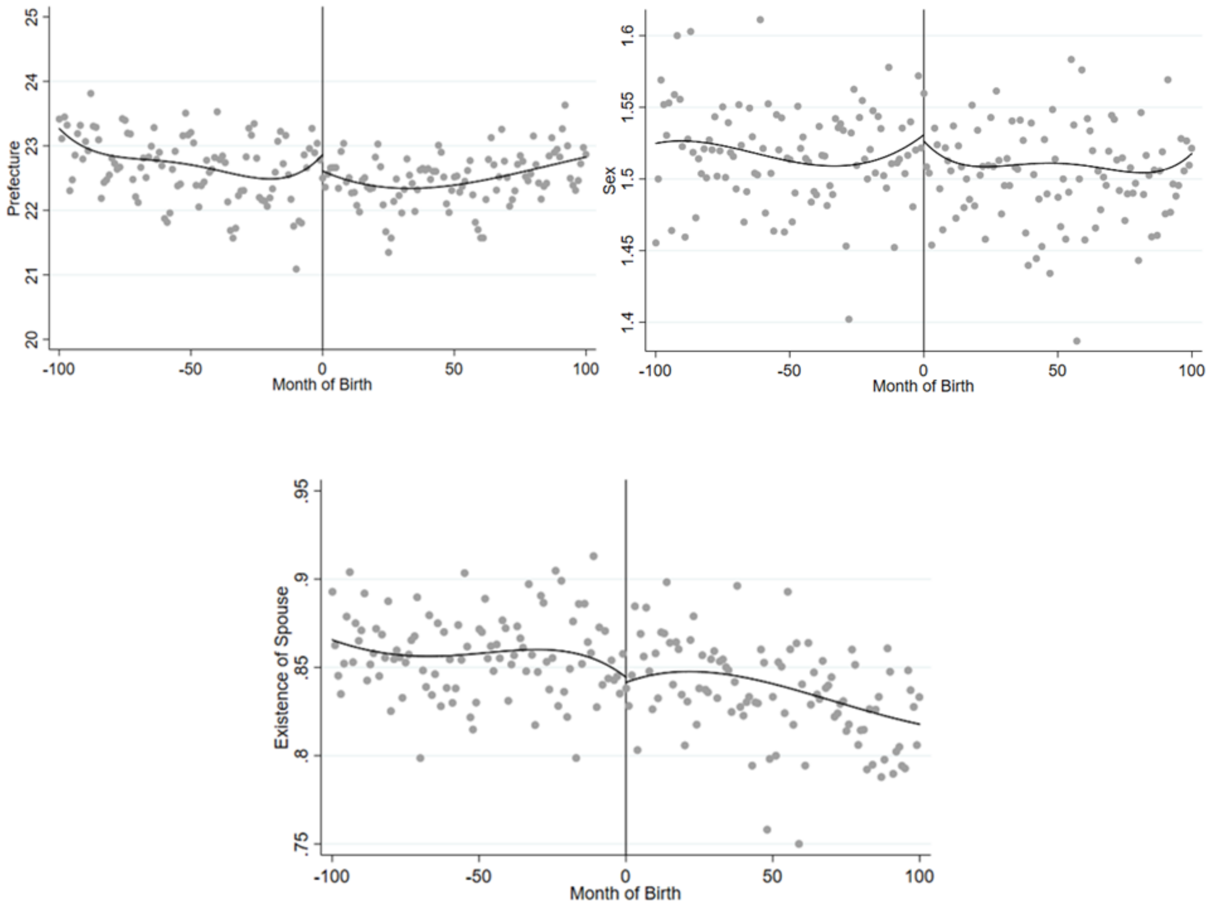
I also check for the smoothness of the predetermined covariates around the cutoff. Because the predetermined variables are determined before the public pension reform, eligibility for the public pension benefit should not affect them. Appendix Figure A5 plots the predetermined covariates (area, gender, and spouse) along the running variable, and there is no discontinuity around the cutoff. The p-values of the null hypothesis, that the variable is continuous, are 0.60, 0.71, and 0.50, respectively, providing evidence for the smoothness of the predetermined covariates.

Figure A4: Density of Month of Birth



Notes: The figure plots the density of the running variable. The p-value of the manipulation test specified by McCrary (2008) is 0.27.

Figure A5: Predetermined Covariates



Notes: The figures plot the means of the predetermined covariates along the running variable at the critical age 60. The upper-left figure plots the means of the 47 prefectures where individuals live. The upper-right figure plots the mean gender (1:male, 2: female) of individuals. The bottom figure plots the mean probability of having a spouse. The p-values of the null hypothesis that the variable is continuous around the cutoff are 0.60, 0.71, and 0.50, respectively.

B. Appendix Tables

Table B1: Comparison of Public Pension Reforms in Developed Countries

Country	Eligibility age	Start year	End year	Discontinuity in eligibility age around the cutoff
Japan	60 → 65	2001	2013	1 year (every three years from 2001 to 2013)
US	65 → 67	2003	2027	2 months (every year from 2003 to 2009) 2 months (every year from 2021 to 2027)
Germany	65 → 67	2012	2029	1 month (every year from 2012 to 2023) 2 months (every year from 2023 to 2029)
UK	65 → 67	2018	2027	1-4 months (from Dec 2018 to Oct 2020) 1 month (every month from Apr 2026 to Mar 2027)
Italy	66 → 67	2012	2019	3 months (in 2012) 4 months (in 2016) 5 months (in 2019)
France	65 → 67	2016	2022	The age of the full-rate pension is gradually increasing from 65 to 67 between 2016 and 2022.
Canada	65 (→ 67)	2012	2029	The federal government reversed the reform in 2015.

Notes: The figure shows the comparison of ongoing public pension reforms and full retirement ages for males in the G7 countries.

Table B2: Anticipatory Years Between Announcement and Implementation by Cohort

Birth cohorts	Years between announcement and implementation
1941.April-	
1942.April-	+1
1943.April -	+3
1944.April-	+4
1945.April-	+6
1946.April-	+7
1947.April-	+9
1948.April-	+10
1949.April-	+12

Notes: The table shows the anticipatory years between the announcement and implementation dates relative to the oldest cohorts.

Table B3: RD Estimate Interacted with Anticipatory Periods (Controlling for Age)

Dependent variable:	Employment at the critical ages
RD Estimate	0.109***
	[0.013]
RD*Years between announcement	-0.008***
and implementation	[0.001]
Mean of the dependent variable	0.60
Impact (average effect without anticipatory effect)	18.2%
Impact (heterogeneous effect per year)	1.3%

Notes: The parameter is the result of a local linear RD of Equation 1 in the main paper for the male employment at the critical ages by additionally controlling for age. The treatment dummy is interacted with the years between the announcement and implementation. The anticipatory periods change with birth dates, as in Appendix Table B2. The regression uses the local linear RD with a triangular kernel and minimizing mean squared error. Robust standard errors are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level. For other details, see the notes to Table 1 in the main paper.

Table B4: Heterogeneity: Comparison of the Separate DID Estimates of Labor Supply

	Control: Females
Panel A: Eligibility Age 60→61	
Employment at 60	0.027**
	[0.011]
Panel B: Eligibility Age 61→62	
Employment at 61	0.024***
	[0.009]
Panel C: Eligibility Age 62→63	
Employment at 62	0.005
	[0.008]
Panel D: Eligibility Age 63→64	
Employment at 63	0.000
	[0.009]
Panel E: Eligibility Age 64→65	
Employment at 64	0.001
	[0.010]

Notes: The table shows a comparison of the DID estimates of male labor supply in response to increasing the male EPI flat-rate eligibility age by one year; the control group is females. Panel A reports the effect of increasing the pensionable male age from 60 to 61 in 2001. Panel B reports the effect of increasing the pensionable male age from 61 to 62 in 2004. Panel C reports the effect of increasing the pensionable male age from 62 to 63 in 2007. Panel D reports the effect of increasing the pensionable male age from 63 to 64 in 2010. Panel E reports the effect of increasing the pensionable male age from 64 to 65 in 2013. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level. For additional details, see the notes to Table 1 in the main paper.

Table B5: Changes in Labor Demand

	RD Estimate
Panel A: Reform in 2001	
Total number of employees in a firm	92.45
	[76.87]
Panel B: Reform in 2004	
Total number of employees in a firm	77.82
	[100.07]
Panel C: Reform in 2007	
Total number of employees in a firm	98.42
	[74.07]
Panel D: Reform in 2010	
Total number of employees in a firm	-91.05
	[135.20]
Panel E: Reform in 2013	
Total number of employees in a firm	19.22
	[106.36]

Notes: The table shows a comparison of the RD estimates of the changed in labor demand in response to increasing the male EPI flat-rate eligibility age by one year. Panel A reports the effect of increasing the pensionable male age from 60 to 61 in 2001. Panel B reports the effect of increasing the pensionable male age from 61 to 62 in 2004. Panel C reports the effect of increasing the pensionable male age from 62 to 63 in 2007. Panel D reports the effect of increasing the pensionable male age from 63 to 64 in 2010. Panel E reports the effect of increasing the pensionable male age from 64 to 65 in 2013. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level. For additional details, see the notes to Table 1 in the main paper.

Table B6: RD Estimates by Age by Cohort

	(1)Employment	(2)Aggregate savings
Panel A: Older Affected Cohort		
Anticipatory response	0.00	15.71
	[0.01]	[43.23]
Implementation (critical age)	0.09***	35.49
	[0.03]	[131.96]
Delayed response	-0.02	30.97
	[0.02]	[99.95]
Panel B: Younger Affected Cohort		
Anticipatory response	0.00	92.20*
	[0.01]	[55.11]
Implementation (critical age)	-0.04	7.16
	[0.03]	[126.20]
Delayed response	0.01	
	[0.06]	

Notes: The table shows the RD estimates of Equation 1 in the main paper for the various outcomes indicated in the column header at various ages by cohort. Panel A shows the result for the older affected cohort born after April, 1941, and Panel B shows the result for the younger affected cohort born after April, 1949. *Anticipatory response* reports the pooled RD estimate at the ages between announcement and implementation. *Implementation* reports the RD estimate at the critical age at policy implementation. *Delayed response* reports the RD estimate at the ages after policy implementation. The data for savings for younger affected cohorts were not collected in years after policy implementation. Robust standard errors are reported in brackets. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Additional Heterogeneous Analysis

Heterogeneity by Family Structure

Panel A in Appendix Table B7 reports the comparison of the RD estimates of labor supply between single males, males living with their spouses, males living with their parents, males living with their children, and males living with their grandchildren. The RD estimate is higher for males living with their dependents; the estimate for single males is lower and statistically insignificant, whereas the estimates for males living with their dependents are higher and statistically significant. In other words, males living with dependent family members responded to the negative income shock more than single males. The estimated result is consistent with economic theory; consumption is less elastic for individuals with dependents, leading to higher labor supply responses for those groups. In sum, the table provides evidence of a heterogeneous labor supply across family structures.

Heterogeneity by Education

Panel B in Appendix Table B7 reports the treatment coefficient interacted with the educational levels. Some papers, such as Hanel and Riphahn (2012) and Mastrobuoni (2009), argue that educational background differentially affects the magnitude of labor supply responses. However, the coefficient of the interaction term is close to zero and not statistically significant, suggesting that there is little differential behavioral response across educational levels.

Table B7: Additional Heterogeneous Analysis

	RD Estimate
Panel A: Heterogeneous Labor Supply by Family Structure	
Single male	0.00
	[0.04]
Married male with spouse	0.05***
	[0.01]
Male with parent(s)	0.07***
	[0.03]
Married male with child(ren)	0.07***
	[0.02]
Married male with grandchild(ren)	0.09**
	[0.04]
Panel B: Heterogeneous Labor Supply by Education	
RD*Education	-0.001
	[0.006]

Notes: The table analyzes the heterogeneous labor supply response by family characteristics (Panel A) and educational level (Panel B). In Panel A, the estimates report the local linear RD estimates from separate regressions of Equation 1 in the main paper for male employment at the critical ages by subsample. The subsamples consist of single males, married males living with spouses, males living with their parent(s), males living with their child(ren), and males living with their grandchild(ren). In Panel B, the parameter is the result of a local linear RD regression of Equation 1 in the main paper for male employment at the critical ages with the interaction term, where the treatment status is interacted with educational levels. The educational variable takes a value of one if an individual is a junior high school graduate, two if an individual is a high school graduate, three if an individual is a vocational school graduate, four if an individual is a junior college graduate, five if an individual is a university graduate, and six if an individual has a postgraduate degree. The regressions employ the local linear RD with a triangular kernel. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level. For additional details, see the notes to Table 1 in the main paper.

Placebo Tests

Individuals Not Participating in EPI

There could be confounding policy changes or factors that only influence cohorts affected by the pension reform. Many potential factors, such as macroeconomic conditions, private pensions, and time trends, could have differentially affected employment status for two birth cohorts around the cutoff. My underlying assumption is that these factors would have affected the employment status less significantly in my running variable (month of birth) as compared to the sharp discontinuity caused by the negative income shock experienced by the cohorts born after the cutoff relative to the cohorts born before the cutoff. To investigate this, I run an RD with the same birth cutoff but for those who were not enrolled in EPI. Because the public pension reform only affected people who were enrolled in EPI, this test functions as a placebo test. As shown in Panel A in Appendix Table B8, the affected cohorts did not respond any more greatly to raising the pensionable age than the non-affected cohorts. Thus, other policy changes and factors should not confound my identification.

Response Before the Announcement

I also investigate the individual labor supply response prior to the announcement of the public pension reform. Because individuals could not anticipate the policy change before the announcement, a differential response between affected cohorts and non-affected cohorts before the announcement would violate my identification strategy. Panel B in Appendix Table B8 shows the behavioral response in labor supply for both the treatment and control cohorts prior to the announcement. The RD estimates before the announcement are not statistically significant, suggesting affected individuals did not respond any more significantly than non-affected cohorts prior to the announcement.

Placebo Cutoffs and Cohorts

I also implement a placebo test for the same critical age but different placebo cutoffs. Because this public pension reform only affected specific cohorts separated by the true birth cutoff, there should not be a jump in the placebo cutoffs. Panel C in Appendix

Table B8 shows the result of the placebo tests, and the RD estimates are all statistically insignificant, suggesting no discontinuous effect on the placebo cohorts.

Placebo Tests for Labor Demand Side

It is also possible that a change in firms' labor demand could affect the quantity of labor supplied by individuals. However, firms' characteristics, such as number of total employees, occupations, and the ratio of regular employees do not change significantly around the eligibility cutoff for public pensions, as shown in Panel D in Appendix Table B8. The results of the placebo tests suggest that the effect of labor demand is limited.

Placebo Tests for Other Outcome Variables

I also implement the above placebo tests for other outcome variables in addition to labor supply. Even if labor supply passes the above placebo tests, a discontinuity for other labor market outcomes may suggest a systematic difference between the treatment and control cohorts; however, Panel E in Appendix Table B8 rules out this possibility. Specifically, earnings, savings, consumption, and health status also pass the above placebo tests, lending credibility to my research design.

Table B8: Placebo Tests

	RD Estimate
Panel A: Individuals Who Are Not Enrolled in EPI	
Non-eligible persons	-0.030
	[0.036]
Panel B: Response before Announcement	
Two years before the announcement	-0.020
	[0.032]
One year before the announcement	-0.003
	[0.039]
Panel C: Placebo Cohorts and Cutoffs	
Before April 1939 vs After April 1939	0.051
	[0.053]
Before April 1937 vs After April 1937	-0.014
	[0.060]
Panel D: Labor Demand Side	
Number of employees	15.89
	[63.40]
Occupations (12 categories)	-0.21
	[0.19]
Regular employees	0.03
	[0.02]
Panel E: Other Outcomes	
Earnings	62.94
	[55.89]
Consumption	-54.62
	[34.39]
Savings	128.52
	[146.57]
Health	-0.11
	[0.11]

Notes: The table shows the result of the placebo tests. Panel A reports the RD estimates for male labor supply, where the sample is restricted to males not enrolled in EPI. Panel B reports the RD estimates for male labor supply prior to the announcement of raising the eligibility ages for EPI benefits. Panel C reports the RD estimates for male labor supply at age 60 with placebo birth cutoffs (April 1939 and April 1937). Panel D reports RD estimates for demand-side labor outcomes. The dependent variable for the second row is occupation, which is categorized into 12 job categories defined by the Ministry of Health, Labor, and Welfare. The dependent variable for the third row is the dummy variable, which takes a value of one if an individual is a regular employee and a value of zero otherwise. The dependent variable for the third row is the number of employees in a firm where an individual worked. Panel E shows the RD estimates of the placebo cutoff tests (April 1937) for different outcome variables. For additional details, see the notes to Table 1 in the main paper.

Robustness Tests

In Section V of the main paper, I have already shown that the RD estimates are robust to the chosen polynomial, kernel, and optimal bandwidth. Here, I present the following additional robustness tests to show that my estimated results are quantitatively robust with regard to other specifications.

Non-Parametric Estimates by Bandwidth

Panel A in Appendix Table B9 shows the sensitivity analysis by length of bandwidth. The first row presents the RD estimates within 5, 10, 15, and 20 months. All the estimates are similar in magnitude and statistically significant at the 1% level across a range of bandwidths, providing results consistent with the estimates.

Inclusion of Covariates

Panel B in Appendix Table B9 shows the RD estimates with additional predetermined covariates. The inclusion of covariates should not affect the estimated discontinuity under the non-manipulation assumption. The RD estimates of the covariates' adjustment (area and spousal age) show results consistent with the baseline.

Other Possible Trends

Panel D in Appendix Table B9 considers other potential trends than the male pension reform. Other potential trends or factors that confound employment could affect the estimates. One such possible factor is improved health, which may cause older workers to work longer. However, I did not find a systematic trend of improved health for elderly persons during the reform of the public pension. In fact, I run RDD by controlling for health, but the RD estimate and the estimate for the interaction term with the years of anticipation did not change notably. Another potential factor that could affect the employment of elderly people is macroeconomic conditions. If recent cohorts have experienced more economic expansions compared with older cohorts, and if these economic conditions have differentially affected each cohort, then the RD estimates could be influenced. However, although the Japanese economy experienced more expansions (122 months) and fewer recessions (25 months) during the male pension reform (January 2001-

December 2013), the turning points of the economy did not exactly match the cutoffs for each cohort, as shown in Appendix Table B10. I also run RDD by controlling the economic condition, but the RD estimate and the estimate for the interaction term with the years of anticipation did not change notably, discounting the possibilities of these explanations.

Table B9: Robustness Tests: Sensitivity Analysis

	RD Estimate
Panel A: Non-Parametric Estimates by Bandwidth	
Bandwidth=5 months	0.071***
	[0.021]
Bandwidth=10 months	0.072***
	[0.015]
Bandwidth=15 months	0.082***
	[0.013]
Bandwidth=20 months	0.092***
	[0.012]
Panel B: Inclusion of Covariates	
with covariate (area)	0.071***
	[0.023]
with covariate (spouse)	0.071***
	[0.023]
Panel C: Functional Forms and Kernels	
Linear RD with a uniform kernel	0.069***
	[0.022]
Linear RD with a triangular kernel	0.071***
	[0.025]
Quadratic RD with a uniform kernel	0.075***
	[0.027]
Quadratic RD with a triangular kernel	0.079***
	[0.030]
Panel D: Other Trends	
Including health controls	0.061***
	[0.023]
-Interaction term with years of anticipation	-0.005***
	[0.002]
Including economic condition	0.070***
	[0.016]
-Interaction term with years of anticipation	-0.006***
	[0.001]

Notes: The table shows the results of the sensitivity analysis of the RD estimates. Panel A reports local linear RD estimates on male labor supply at the critical ages with different bandwidth lengths. Panel B reports a local linear RD estimate on male labor supply at the critical ages with the covariates (geographic area and spousal age). Panel C reports the baseline estimates in Table 1 for comparison. Panel D reports the RD estimates of the treatment dummy interacting with the periods between the announcement and implementation in Table 5, including health and economic condition variables. Robust standard errors are in parentheses. Statistical significance is indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level. For additional details, see the notes to Table 1 in the main paper.

Table B10: Turning Points of Economic Trends and Cutoffs of the Pension Reform

Birth cohorts	Cutoffs (MOF + Critical Age)	Economic Trends
1st cohort (04/1941-03/1943)	04/2001	Recession: 11/2000-01/2002
2nd cohort (04/1943-03/1945)	04/2004	Expansion: 01/2002-02/2008
3rd cohort (04/1945-03/1947)	04/2007	Recession: 02/2008-03/2009
4th cohort (04/1947-03/1949)	04/2010	Expansion: 03/2009-03/2012
5th cohort (04/1949-)	04/2013	Recession: 03/2012-1/2012
		Expansion: 11/2012-10/2018

Notes: The table shows the key cutoffs of the pension reform by cohort and economic trends.

C. Data Appendix

C.1 Data Access

I use data from *The Comprehensive Survey of Living Conditions* from 1986 through 2015 to analyze the effect of raising the eligibility age for public pensions on the labor market. As of the data application date,[1] the data from 1986 through 2015 were available. The data are administered by the Ministry of Health, Labor, and Welfare. The aggregated data are publicly available,[2] but the use of the micro-data (household-level data) was restricted to government-affiliated personnel or researchers who were commissioned by the government by the Japanese Statistics Law, Article 33.[3] Due to this law, the data cannot be disclosed to third parties and cannot be used for other purposes. To obtain the data, individuals must apply for data access to the Ministry officials in charge of the data. In the application process, applicants must submit a detailed research proposal, a list of variables of interest, and other application formats defined by the Statistics Bureau, the Japanese Ministry of Internal Affairs and Communications.[4] Upon request, I can provide the contact address and am willing to further assist persons interested in the data.

Table C1: List of Variables by Questionnaire

Questionnaire	Variables	Questionnaire	Variables
Household	Residential areas	*Income*	Earnings
	Household ID		Pension benefits
	Family member ID		Private pensions
	Family structure	*Health*	Hospitalization
	Consumption		Hospital visits
	Relationship		Worry or stress
	Gender		Subjective symptoms
	Age		Other health problems
	Working status	*Savings*	Amount of savings
	Regular employee (yes/no)		
	Job categories		
	Firm size		
	Hours (days) worked		
	Pension status		
	Education		
	Year of birth		
	Month of birth		

Notes: The table shows the list of main variables by questionnaire.

C.2 Creation of the Dataset

I took three steps to analyze the effect of the public pension reform on the labor market using the data. First, the data are household-level data, whereas my primary variable of interest is individual-level labor supply. To see the effect of the reform on individuals, I decomposed the original household-level data into individual-level data, remaining the original unique household IDs.

Second, the data consist of five questionnaires: the household questionnaire, income questionnaire, health questionnaire, savings questionnaire, and long-term care questionnaire. Table C1 presents the list of variables by questionnaire. The household questionnaire is the main questionnaire and provides individual characteristics for each household member. The other questionnaires provide additional information on incomes, health, savings, and long-term care. In my analysis, I did not use the long-term care questionnaire, because long-term care is beyond the scope of this paper. All data files were provided by year by questionnaire, and I combined the files by questionnaire by year using unique household IDs, residential areas, and years and months of birth.

Finally, all the data supplied by the Ministry are provided in the form of text files. Unfortunately, the raw text files are not organized and cannot be imported into statistical software as they are. To analyze the data using statistical software, I created additional files by year and questionnaire, telling the software how to read the data.

After following these steps, I am left with 8,040,105 observations. Because treatment status depends on age, gender, and enrollment in EPI, the main sample is restricted to males aged 60-64 who are not self-employed persons and are eligible for EPI. Unless otherwise indicated, I use data from the resulting 169,066 observations throughout the paper. Table C2 shows the summary statistics. Regarding the spousal analysis, I use 148,081 observations.

There are several advantages of using this dataset. It enables me to analyze the dynamics of individual behavioral responses after the announcement through implementation. Furthermore, because the original data are household-level data, it is also possible to study spillover effects within family members. Finally, the comprehensive information

Table C2: Descriptive Statistics for the Main Variables

	Full Sample		Analysis Sample	
Variable	Mean	St. dev	Mean	St. dev
Main Outcome				
Probability of working	0.73	0.44	0.56	0.49
Other Outcomes				
Public pension benefit (10,000 yen)	131.14	97.75	161.65	98.22
Earnings (10,000 yen)	376.52	328.37	371.22	326.99
Savings (10,000 yen)	640.49	767.56	843.62	892.43
Consumption (10,000 yen)	345.32	432.81	328.85	376.91
Hospitalized (1:Yes, 0:No)	0.02	0.12	0.02	0.14
Subjective symptoms (1:Yes, 0:No)	0.31	0.46	0.38	0.48
Hospital visit within one month (1:Yes, 0:No)	0.38	0.49	0.55	0.50
Health problem affecting daily life (1:Yes, 0:No)	0.11	0.31	0.15	0.36
Worry or stress (1:Yes, 0:No)	0.48	0.50	0.40	0.49
Individual and Family Characteristics				
Male	0.49	0.50	1	0
Age	42.32	22.68	61.96	1.41
Married	0.55	0.50	0.88	0.33
Number of family members	3.65	3.63	2.92	2.70
Number of observations	8,040,105		169,066	

Notes: The table reports the means and standard deviations of the main variables for my full sample and analysis sample. The full sample consists of individuals of all ages. The analysis sample consists of males aged 60-64 who are not self-employed and are eligible for EPI. The data source is the Japanese Ministry of Health, Labor and Welfare.

on individual lives enables me to estimate not only the average effect of pension reform on older workers' labor supply, but also heterogeneous effects and effects on previously under-analyzed margins.

D. Theoretical Model

In this section, I construct a simple life cycle model without uncertainty and use it to derive optimality conditions and further understand predictions of the effect of Japanese public pension reform on retirement choices. This design is similar to those of Hurd, Michaud and Rohwedder (2012) and García-Miralles and Leganza (2021).

D.1. Model Setup

Consider individuals as making decisions throughout continuous time (from time 0 to time T) regarding consumption, c_t, and the timing of retirement, $t = R$. Workers receive constant wages $y_t = y$ from $t = 0$ until time $t = R$. Individuals receive public pension benefits $b_t(R)$ after retirement, depending on the retirement age. $b_t(R)$ is defined by $b_t(R) = \alpha(R)\phi(y)$, where α is an actuarial factor and adjusts benefits depending on when they were received, and $\phi(y)$ is a benefit at the normal retirement age. The present value of public pension wealth is given by $B(R) = \alpha(R)\phi(y)\int_0^{T-R} e^{-rt}dt = \alpha(R)\phi(y)\xi(R)$, where r shows a real interest rate.

Individuals gain utility separately from consumption and leisure. Utility from consumption is given by $u(c_t)$, and utility from retirement is given by $u(c_t) + \Gamma$, where Γ captures the utility gain from leisure in retirement. Individuals have the rate of time preference ρ. The constrained optimization problem for individuals is as follows:

$$\max_{R,\{c_n\}_0^R} \int_0^R e^{-\rho t}u(c_t)\,dt + \psi(a_R + B(R), R) \tag{1}$$

$$s.t. \quad \dot{a_t} = ra_t + y_t - c_t \quad \text{and} \quad a_0 = 0$$

where a_t denotes assets at time t, and the individual starts with zero assets. Meanwhile, $\psi(a_R + B(R), R)$ is a post-retirement indirect utility such that:

$$\psi(a_R + B(R), R) = \max_{R,\{c_n\}_{n=R}^T} \int_R^T e^{-rt}(u(c_t) + \Gamma)dt \tag{2}$$

$$s.t. \quad \dot{a_t} = ra_t - c_t \quad \text{and} \quad a_T \geqslant 0$$

D.2. Optimal Conditions

We can derive the optimal conditions by taking the first-order conditions of Equation 1 and 2 with respect to consumption:

$$\frac{u''(c_t)}{u'(c_t)}\dot{c_t} = \rho - r \tag{3}$$

Hence, if we assume $\rho = r$, then individuals perfectly smooth their consumption and consume a constant fraction of lifetime resources. Similarly, we can derive the following optimal condition for retirement by taking the first-order condition:

$$u'(c_R) \times (y + B'(R)) = \Gamma \tag{4}$$

The left-hand side of Equation 4 represents the marginal financial benefit from delayed retirement converted into utility. The right-hand side represents the marginal cost of leisure that is forgone by delayed retirement. Thus, individuals should time retirement so that the marginal benefit from delaying retirement equals the marginal cost.

D.3. Theoretical Predictions in the Japanese Pension Reform

The simple model given above provides indications of individual behavior in response to the Japanese public pension reform. In this setting, the major change is an increase in the eligibility age for flat-rate benefits, which causes a shift in public pension wealth from ages 60 to 61, 61 to 62, 62 to 63, 63 to 64, and 64 to 65, as in Figure 3. This negative public pension wealth shock due to the decrease in $B(R)$ induces individuals to work longer in order to satisfy the optimal condition of Equation 4.

Furthermore, this situation also induces a negative liquidity shock for the affected cohorts at the critical age, as shown in Figure 1. However, at the optimum, individuals perfectly smooth consumption and consume a constant fraction of life time wealth in each period as in Equation 4. In order to consume at this constant pace, individuals with constrained liquidity will be more likely to work at the critical age, as defined by the timing of the shock.

Thus, the model predicts that the affected cohorts should delay retirement in response to the pension reform. These predictions are consistent with my empirical results.

Notes

[1]The data application date was May 28th, 2017.

[2]The aggregated data are available at e-Stat, which is the portal site of the Japanese Government Statistics (https://www.e-stat.go.jp/en).

[3]The Japanese Statistics Law, Article 33 can be accessed from the following link (https://elaws.e-gov.go.jp/search/elawsSearch/elawssearch/lsg0500/detail?lawId=419AC0000000053) (in Japanese).

[4]The guidelines of the Statistics Law, Article 33, are also available at the website of the Ministry.

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