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More to Live for: Health investment responses to expected retirement wealth in Chile

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A poorly understood but important way that economic conditions influence health is through the incentives that they create for health investments. In this paper, we study how individuals' current health investments respond to changes in expected future wealth, focusing on Chile's 1981 public pension. We compile detailed administrative pension data linked to a rich household panel survey, and we then exploit discrete breaks in the reform's impact on expected pension wealth across cohorts of Chileans using a fuzzy regression kink design to estimate how health behavior, preventive health care use, and chronic disease diagnoses respond to changes in expected pension wealth. Consistent with theoretical predictions, we find that greater expected pension wealth increases the use of medical services – and in turn, the detection of chronic diseases. More generally, our results provide new empirical evidence of forward-looking behavior consistent with the life-cycle and permanent income hypotheses.

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Más (razones) para vivir (mejor): Reacción de las inversiones en salud ante cambios en la riqueza de pensiones esperadas en Chile

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En este trabajo estudiamos como se ven afectadas las decisiones sobre inversión en salud que realizan los individuos en el presente, ante cambios en la riqueza que esperan recibir en el futuro, explotando una reforma al sistema de pensiones chileno ocurrida en 1981. Para esto utilizamos una encuesta longitudinal que contiene detallada información socio-económica y de salud complementada con datos administrativos relativos a sus ahorros previsionales. Dado que la reforma previsional tuvo un impacto distinto sobre los ahorros previsionales de individuos de diferentes cohortes, es posible utilizar un diseño de regresión discontinua difusa para estimar el efecto de cambios en la riqueza de pensiones esperada sobre comportamientos de salud, uso de servicios de salud preventiva y diagnóstico de enfermedades crónicas. Nuestros resultados muestran que una mayor riqueza esperada incrementa el uso de servicios médicos y, consecuentemente, la detección de enfermedades crónicas. Estos resultados son consistentes con teorías como la hipótesis del ciclo vital y la hipótesis del ingreso permanente.

1 | INTRODUCTION

A large body of research links long-term economic growth to population health improvement (Pritchett and Summers, 1996). However, the precise ways in which economic growth improve health are complex.[1] A common research focus is the role of contemporaneous consumption (nutrition and use of medical care, for example) in health production. More poorly understood, but potentially critical mechanisms linking economic growth and population health are the incentives that economic growth creates for good health.

Economic insights dating to the life cycle hypothesis (Modigliani and Brumberg, 2005) and the permanent income hypothesis (Friedman, 1957) suggest that such incentives may be important. Forward-looking individuals anticipating greater future wealth have stronger incentives for longevity because, all else equal, they have "more to live for". Put differently, the utility derived from an extra year of life is greater because additional material resources allow higher consumption.[2] [3] Although we are unaware of studies that empirically examine how health investments respond to changes in expected future wealth, these findings suggest such behavioral responses may be important.

Alternatively, a growing literature in behavioral economics suggests that the structure of decision-making about long-term health investments may be less responsive to changes in future wealth - or even unresponsive altogether. A central phenomenon in this literature is present bias, and a key distinction is between naïve and sophisticated present bias - a distinction that depends on awareness of one's present bias (Kremer et al., 2019). While those with naïve present bias would not adjust their health behavior in response to a shock to expected pension wealth, those with sophisticated present bias would if they were able to find suitable means of managing it (through commitment devices, etc). Another is biased beliefs: there are a number of plausible ways that one could develop incorrect mental models about health. Those with (strongly) biased beliefs would not adjust their health behavior in response to an expected pension wealth shock, while those with less biased beliefs would. Although changing one's health investment in response to a future wealth shock does not require full rationality or complete information, such a response would be inconsistent with naïve present bias or substantially biased beliefs - but consistent with an incentive effect of economic development.

To estimate how forwarding looking health investments respond to expected future wealth, we exploit a large public pension reform introduced by the Chilean government in 1981, converting its Defined Benefit (DB) system into a Defined Contribution (DC) one. To manage this transition, all new workers were mandated to enroll in the DC system, while existing affiliates of the DB system had the option of either remaining in the DB program until retirement or switching to the DC system. Under the DC system beneficiaries make contributions to individual accounts that would earn a rate of return until retirement. Those who switched to the new regime received a compensatory payment that transferred savings between both systems. Pension savings at retirement differ among individuals with distinct number of contributions to the DC system, as a result of the compound return in the individual pension accounts and the compensatory payment. Hence, the pension system reform produces exogenous differences on the expected pension savings at retirement among individuals of different cohorts.

[1] There is ongoing debate about the primary causes of mortality decline; economic gains may not be most important but undoubtedly matter (Preston (1975), McKeown (1976), Fogel (1994), Cutler and Miller (2005), Cutler et al. (2006)).

[2] This assumes that the cross derivative of consumption and health are positive and that imperfect capital and intertemporal markets do not allow households to borrow against their pension wealth.

[3] Moreover, Attanasio and Hoynes (2000) observe that accounting for the wealth-health relationship is required for appropriately estimating wealth-age profiles.

We compute Fuzzy Regression Kink Design estimates using detailed administrative data on a sample of the DC pension system's beneficiaries, called the "Historia Previsional de Afiliados" (HPA). Crucially for our purposes, the HPA is linked to a longitudinal survey, the "Encuesta de Protección Social" (EPS), that includes rich information on health outcomes.

Our results show that men increase the use of medical services, which in turn, rises the probability of being diagnosed with a preventable chronic disease, such as diabetes. Hence, we find evidence that men's health investments are forward looking in response to changes in their future pension savings.

The rest of the paper is organized as follows. Section 2 describes the Chilean pension system and its 1981 reform. In Section 3 we describe the data, the computation of the pension wealth and the empirical strategy. Section 4 presents evidence on the validity of the identification strategies, and estimates of the effect of changes in the expected pension wealth on health outcomes. Section 5 concludes the paper.

2 | THE CHILEAN PENSION SYSTEM

Prior to 1981, Chile had a Defined Benefit (DB) public pension program for formal sector workers. The contributions made by the workers to the pension program and the benefits obtained upon retirement depended on the industry and sector of occupation, and were highly heterogeneous. Contribution rates ranged between 16% and 23%. An overall estimation of the replacement rate was 47% among those entitled to receive a pension, while approximately half of their contributors did not receive a pension because they did not fulfil the required number of contributions during their working life (AAFP, 2014).[4]

Then, in 1981, Chile reformed its public pension program, converting its DB program into a Defined Contribution (DC) system. To manage this transition, all new workers were mandated to enroll in the DC system, while existing workers had the option of either remaining in the DB program until retirement or switching to the DC system. Under the DC program, every formal sector worker was required to contribute 10% of her monthly income into an individual account, which was managed privately by regulated Pension Fund Administrators (PFA). Until the year 2017 contributions were voluntary for the self-employed, and there are different schemes to make voluntary contributions. Individual accounts would earn a rate of return based on investment choices made by the PFA and the resulting market returns, growing until workers reached eligibility ages for retirement, 60 years old for women and 65 years old for men. Retirement is not mandatory in Chile at the minimum legal retirement age, and pensioners can continue working though further contributions to the DC system are not mandatory. When a beneficiary decides to claim pension benefits she has to choose between buying an annuity from an insurance company and keeping her savings in the PFA receiving monthly programmed withdrawals.

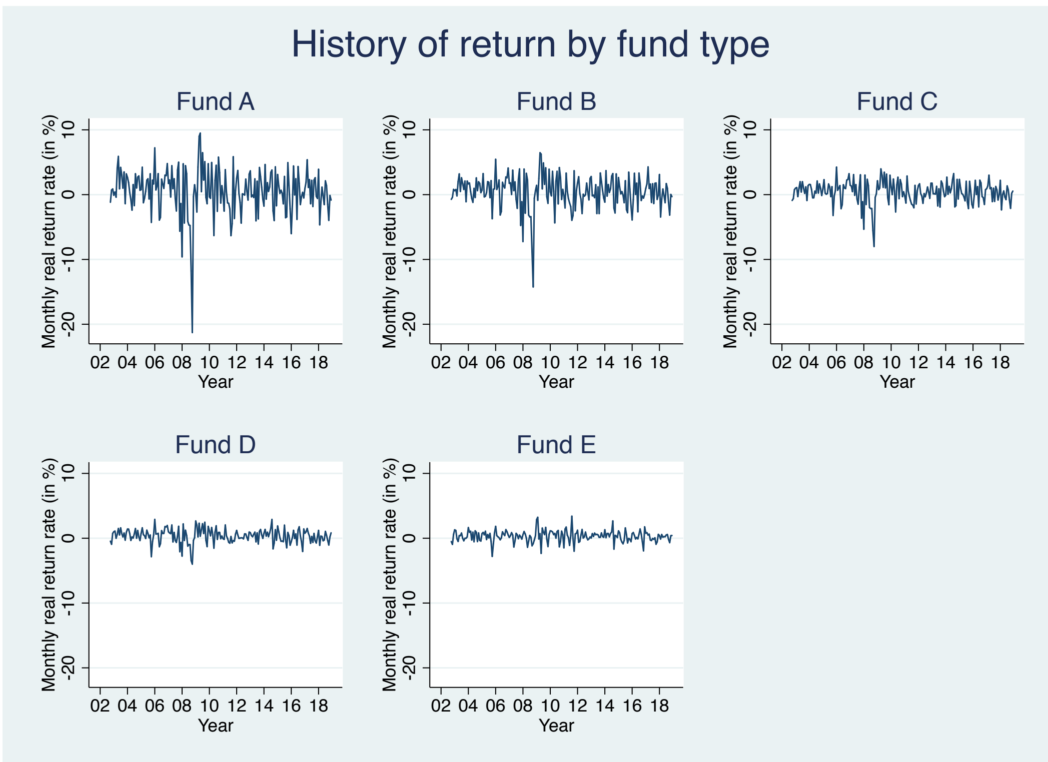
Affiliates of the DB system who switched to the new regime received a compensatory payment, known as the recognition bond, to transfer contributions made under the DB system to the individual accounts of the DC system. For a worker who has a density of contributions of 100%, the recognition bond is defined as the capital needed to receive a lifetime annuity equal to 80% of her taxable income prior to the reform. The value of the bond increases with the density of contributions, and it is higher for women for a given density of contribution and earnings. The recognition bond yields a 4% annual return, payed by the Government, from the date the individual is affiliated to the DC system to the

[4] Contributors of the DB system are entitled to pension benefits it they make at least 800 weeks of contributions, approximately 16 years, and make contributions at least half of the months between the first contribution to the pension system and the month of retirement.

date she reaches the legal required age for retirement.

The investment of pension savings is standardized, regulated, and monitored by the "Superintendencia de AFPs". Until 2002 there was a unique set of financial instruments approved by the regulator. Afterwards, the DC system expanded to become a multi-fund scheme. Specifically, beneficiaries were allowed to decide how to invest their account balances by choosing allocations across five different investment categories, varying in their degree of risk and expected return. PFAs are required to offer all five types of funds A-E, with fund A having the highest risk and highest expected return and fund E having the lowest risk and expected return. Figure 1 shows the evolution of returns by fund type from 2002 to 2018.

FIGURE 1



In general, Figure 1 shows the higher volatility of the riskier funds, and the drop in returns during the 2008's subprime crises that affected more severely the riskier funds. Average monthly returns from the beginning of the DC system until December 2018 are 0.47%, 0.41%, 0.17%, 0.35% and 0.26%, for type of funds A to E, respectively.[5]

3 | DATA, CALCULATION OF EXPECTED PENSION WEALTH (EPW), AND ESTIMATION

3.1 | Data

For our analysis, we use two rich, linked microdata sources. The first is Chile's Encuesta de Protección Social (EPS), or Social Protection Survey, with waves conducted in 2002,

[5]The reported average monthly returns are geometric means.

2004, 2006, 2009, and 2015.[6] The EPS is a nationally representative survey designed to measure socio-economic status and retirement behavior, broadly defined. Importantly, the EPS also contains detailed individual- and household-level information about health related behaviors (including physical activity, alcohol consumption, and smoking) as well as health care use (MD visits, vaccination, preventive health care such as diabetes and hypertension screening) and diagnosed diseases (cardiovascular conditions, cancer, and arthritis among others). This information is provided for all family members (the interviewee, who is typically the household head, the interviewee's partner, and children in the household). The EPS also contains information about labor market participation and job characteristics.

The second is a random sample of individuals in Chile's Pension System Administrative Records, called the "Historia Previsional de Afiliados"(HPA). The HPA sample includes information on affiliates to the DC system (working and retired, employees and self-employed, inactive and unemployed), and it includes monthly administrative data on earnings (only for formal sector employees), contributions, pension fund type, and accumulated pension savings from the time of pension program enrollment until December 2017. It also includes the information of the compensatory payment received by affiliates to the DC system that made contributions under the DB program. Moreover, we are able to link the individuals that were interviewed in the EPS with their information in the HPA.

We focus on individuals that are not retired at the time of the survey, and because retirement is endogenous, we do not consider individuals who are older than the minimum retirement age at the time of the survey (women aged 60+ and men aged 65+). We also drop individuals under age 25 at survey year to avoid having to predict education decisions and first entry into the labor market. Finally, we keep in our sample individuals born in the year 1949 or after because the number of individuals in older cohorts in the linked EPS-HPA is relatively small, producing a lot of dispersion in our computations and estimates.

Our final sample is an unbalanced panel with 31,856 observations that includes 6,542 men and 5,802 women born between 1949 and 1991. Table 1 shows descriptive statistics for this sample. The working sample is similar to the Chilean population in most dimensions but appears to have higher levels of education.[7]

[6] The EPS design introduced detailed information on health outcomes starting in 2004. For this reason we do not use the 2002 wave of the survey.

[7] We compare the statistics in our sample with those obtained using the most representative household survey of Chile, the CASEN. Results upon request.

TABLE 1 Descriptive Statistics by gender. Pooled observations.

	Male		Female	
	Mean	Stand. Error	Mean	Stand. Error
	(1)	(2)	(3)	(4)
Age	40.15	9.27	38.74	8.46
Categories of Relationship to Head of Household (proportion)				
1.Head of Household	0.75	0.43	0.33	0.47
2.Wife/Husband or cohabitant	0.01	0.12	0.42	0.49
3.Daughter/Son	0.18	0.38	0.20	0.40
4.Other	0.04	0.19	0.03	0.18
Proportion in couple	0.67	0.47	0.56	0.50
Number of children living at home	1.03	1.14	1.24	1.12
Categories of level of education completed (proportion)				
1.None	0.03	0.16	0.02	0.15
2.Elementary school	0.27	0.44	0.21	0.41
3.High school	0.60	0.49	0.66	0.48
4.Undregrad or higher	0.10	0.30	0.11	0.32
Proportion with al least good SRHS	0.79	0.40	0.71	0.45
Body mass index	26.65	3.92	26.49	4.81
Proportion physically incative	0.32	0.47	0.18	0.39
Proportion of smokers	0.41	0.49	0.34	0.47
Proportion diagnosed with asthma	0.02	0.14	0.03	0.18
Proportion diagnosed with hipertension	0.09	0.28	0.12	0.32
Proportion diagnosed with a mental condition	0.03	0.17	0.13	0.33
Proportion with highest level of risk aversion	0.62	0.49	0.69	0.46
Expected Pension Wealth (a)	95.61	59.35	48.60	37.75
Obs.	16818		15038	

Notes: (a) In thousands of dollars of December 2018.

3.2 | Computation of Individual-Level Expected Pension Wealth (EPW)

Using our linked EPS-HPA working sample we calculate the expected pension wealth (EPW) for every individual in the sample as the pension account balance at the minimum legal retirement age (60 for women and 65 for men).

For individuals that reached the legal retirement age before December 2017 we know their pension account balance at the year when they are entitled to pension benefits. But for those who retire after December 2017, we know the pension account balance at that month and we need to predict the stream of contributions to the pension account since January 2018 until the minimum legal retirement age, as well as the return to the investments. In particular, we compute the EPW using equations of the following general form:

$$
\begin{aligned}
EPW_i &= acc\_bal_{i,Dec-2017} * (1+return)^{n_a} + \sum_{s=1}^{S} cont\_am_{i,s} * (1+return)^{n_s} \\
&\quad + \mathbb{1}[i \epsilon DB] * rbond_i * (1+return)^{n_r}.
\end{aligned}
$$

$acc\_bal_{i,Dec-2017}$ is the value of the pension savings accumulated by December 2017; n_b is the number of months from January 2018 until the month-year the individual has the legal right to claim pension benefits; $return$ is the monthly rate of return of the pension fund that we set to be equivalent to the the annual rate of return for the recognition bond.[8] s indexes months in the working life of the individual, from $s = 1$ set to January 2018, until $s = S$, the month-year of retirement; $\mathtt{cont\_am}_{i,s}$ is the amount of the contribution to the pension system at month s; n_s is the number of months from the period a given contribution is made until retirement. $\mathtt{rbond}$ is the value of the recognition bond, the compensatory payment that transfers resources from the DB to the DC system, hence, it is only relevant for those individuals who ever contributed to the pension system (DB) before the reform; n_r is the number of months between the month-year the individual opts out to the DC system and the month-year of retirement.

To calculate the above formula we require assumptions on future monthly pension contributions (from January 2018 until retirement). Future contributions are predicted using OLS estimates, by gender, of the parameters of the following linear regression:

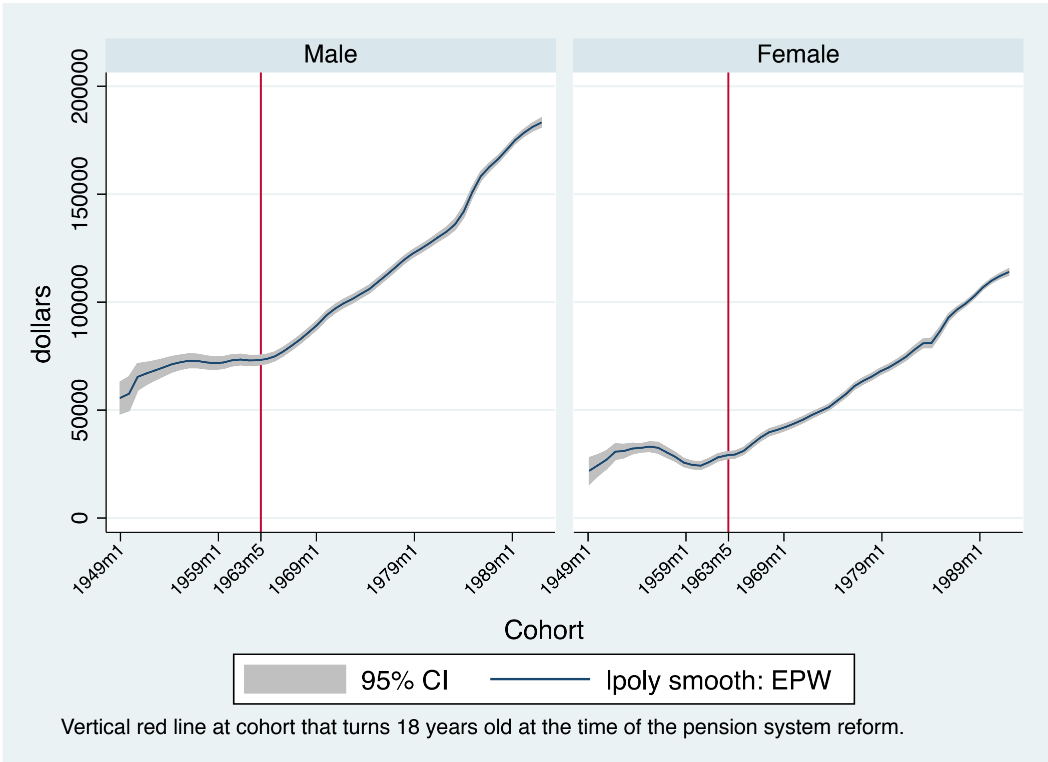
$$\begin{aligned} \mathtt{cont\_am}_{i,s} &= \beta_0 + \beta_1 * \mathtt{age}_{i,s} + \beta_2 * \mathtt{age}_{i,s}^2 + \beta_3 * \mathtt{cohort}_i + \beta_4 * \mathtt{cohort}_i^2 \\ &\quad + \beta_5 * \mathtt{age}_{i,s} * \mathtt{cohort}_i + u_{i,s}, \end{aligned}$$

where we measure age in moths and, consequently, individuals born in the same month-year belong to the same cohort.

Figure 2 shows local polynomial smoothing of the computed EPW. There is a clear change in the slope of the EPW by the time of the pension system reform. Specifically, the EPW is almost flat for individuals born before May-1963 and has a positive slope for cohorts born after that month. May-1963 is the first cohort for which all individuals were enrolled to the DC system by mandate, because they turned 18 years old the month-year the pension reform was implemented.[9] The kink in the EPW is more evident for men than it is for women. The almost zero slope in the EPW before the change in the regime is mostly explained by the recognition bond. The positive slope in the EPW for cohorts that started working under the DC system is the consequence of compound return in the individual pension accounts and increase in earnings due to economic growth. The kink found in the EPW motivates the use of a Fuzzy Regression Kink Design (FRKD) to estimate the effect of interest.

[8]The annual rate of return of the recognition bond was set by law to be equal to 4%.
[9]18 years old is the minimum age for employment without restrictions in Chile.

FIGURE 2 Local polynomial smoothing of the computed EPW by cohort and gender.



In what follows we explain why we consider the kink in the EPW to be exogenous to the individual. We start with the description of the compensatory payment established by the chilean legislation to transfer contributions made under the DB program to the individual accounts of the DC pension regime, because it is the main force behind the kink in the EPW. Affiliates to the DB program were entitled to receive the recognition bond if they made at least twelve contributions to the pension system between May-1976 and April-1981. The formula to compute the recognition bond is:

$$rbond = (income \times 0.8 \times 12) \times \frac{density/12}{35} \times gender\_weight,$$

where $income$ is the average over the income corresponding to the last twelve contributions to the DB pension system made between July-1974, and June-1979; $density$ is the number of monthly contributions made to the DB system until April-1981; $gender\_weight$ is equal to 10.35 if the affiliate is a man, and 11.36 if she is a woman.

The resulting recognition bond is higher for affiliates with higher income, that made a higher number of contributions to the DB pension system, and for a given income and number of contributions, it is higher for female than for male.

Now, we procede to explain how the recognition bond determines the value of the EPW by cohort using the set of graphs in Figure 3. In Panel A we plot the EPW at the time of retirement computed under the following assumptions: all affiliates make monthly contributions to their individual pension accounts from the month they turn 18 years old until retirement; the amount of the contribution is the same for everybody during all their working life; the rate of return of the pension savings is always equal to 4% annual;[10] there is

[10]The value of the monthly contribution is set to be equal to the average contribution (by gender) reported in

no transfer of funds between the DB program and the DC system. Given those assumptions, the EPW is exactly the same for all individuals that were enrolled to the DC system by mandate, that is those who were born after May-1963. Affiliates who started working before the introduction of the DC system make fewer contributions to their individual accounts and, consequently, their account balance at retirement is smaller.

We can think of an alternative scenario with the same assumptions for contributions and rate of return, but with a "fully fair" recognition bond that would result in the same value of the EPW for all individuals. In this scenario the EPW would be a flat line. Hence, taking out of the computation of the EPW the variation in the amount of the monthly contributions induced by economic growth and individual choices, all the variation across cohorts in the EPW is given by the value of the recognition bond.

In Panel B we maintain the assumption on contributions and rate of return and sum up to the resulting EPW a recognition bond computed under the following assumptions: the income is the same for all individuals; the density is a negative function of the cohort; the probability of being entitled to receive the recognition bond is the same for all individuals.[11] In this exercise, the value of the recognition bond is not determined by individual decisions, and reflects only the design established by law. The result is a kink in the EPW at the cohort born in May-1963.

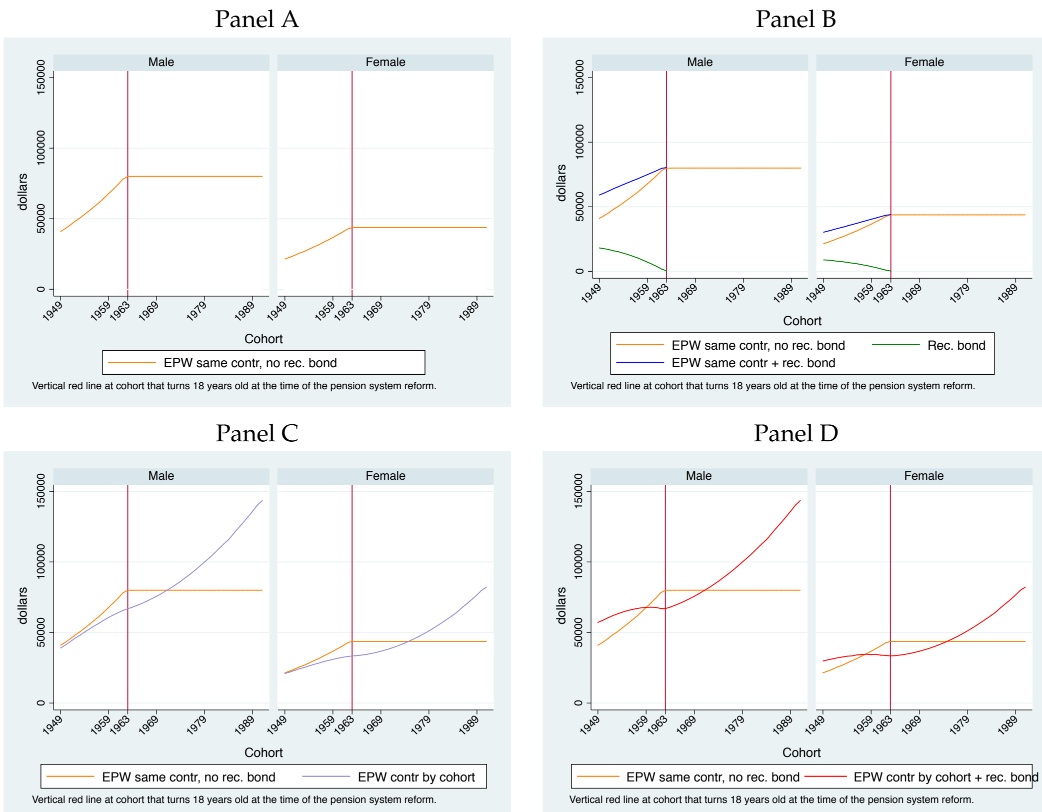
In Panel C, we introduce cohort variation to the contributions used to compute the EPW and go back to the initial scenario of no compensatory payment. In particular, we compute contributions using a polynomial of order two in age and cohort. All variation introduced in the computed EPW is solely induced by economic growth and the change in the pension system, and for this reason it is exogenous to the individual. We cannot identify a clear change in the slope of the EPW by the time of the pension reform.

Finally, in Panel D, we sum up the EPW with economic growth showed in Panel C, to the recognition bond depicted in Panel B. The shape of this exogenous version of the EPW is pretty similar to the EPW computed considering individual decisions, showed in Figure 2. Hence, we conclude that the kink in the EPW is independent of individuals' decisions, and mostly driven by the pension system reform.

the HPA.

[11] The value of the income is set to be equal to the average monthly income (by gender) of individuals born before May-1963, using income observed in the HPA between May-1981 and Dec-1982. The density is the result of multiplying the potential working life until the change in the pension system by the average probability of contributing to the pension system of individuals born before May-1963 (computed using contributions observed in the HPA between May-1981 and Dec-1982). The probability of being entitled to receive the recognition bond is set to be equal to the average probability of receiving the bond (by gender) among individuals in the HPA

FIGURE 3 Exogeneity in the EPW kink.



3.3 | Econometric Strategy

We aim to estimate the following general equation:

$$H_{it} = h(EPW_i, cohort_i, t, u_{it}, \theta)$$

where i indexes individuals, $t = 2004, 2006, 2009,$ and 2015 indexes waves of the EPS survey. H_{it} is the health related outcome variable, EPW_i is the expected pension account balance at the time of retirement, $cohort_i$ is the year-month at which individual i was born, t are year fixed effects, and θ is a vector of parameters to be estimated.

In this equation the EPW may be endogenous because of both reverse-causality between H_{it} and EPW_i, and the presence of unobserved variables u_{it} that explain health outcomes and that are potentially correlated with the wealth measure.

Our identification strategy is based on the exogenous differences produced by the pension system reform on the EPW among individuals of different cohorts. We use a Fuzzy Regression Kink Design (FRKD) exploiting the fact that the endogenous explanatory variable, the EPW, at some point determined by other explanatory variable, the cohort of the individual, changes its slope exogenously. Similar to the Regression Discontinuity Design (RDD), the FRKD uses the kink at both sides of a cutoff point to assign the observations to one level or other of the endogenous variable, as if the assignment was random.

The identification assumptions and inference of the FRKD are discussed in Card et al. (2012) and Card et al. (2015). These papers formally present the Regression Kink Design (RKD) as follows. Consider the estimation of the effect of changes in a regressor B, that is a non-deterministic function of a third variable V, on an outcome Y, as described in the following equation:

$$Y = y(B, V, U). \tag{1}$$

In our analysis Y is a health outcome, B is the EPW, V is the cohort of the individual, and the kink occurs when cohort is equal to May-1963. This is the first cohort for which all individuals were enrolled to the DC system by mandate, because they turned 18 years old the month-year the pension reform was implemented. We use a fuzzy RKD in which B is not a deterministic function of V, either because of unobserved inputs in the formula, or measurement errors in V or B:

$B^* \equiv B + U_B, \qquad V^* \equiv V + U_V, \qquad \text{and } U_V = GU_{V'}.$

where G is a dummy that equals zero with probability $\pi(V, U, U_B, U_{V'})$. With probability $\pi > 0$ we observe the true value of V, and with probability $1 - \pi$ we observe $V + U_V$. In our analysis B, the EPW, is not uniquely determined by the age of the individual, that in turn through the default rule determines de return of the fund, but it is also a function of the current pension account balance, and the estimated future stream of contributions to the pension account from the current period until retirement.

An additive version of the equation (1) is:

$$Y = \tau B + g(V) + \epsilon,$$

where B is a deterministic (and continuous) function of V (sharp RKD) with a kink at V = 0. Then, if $g(V)$ and $\mathbb{E}[\epsilon|V = v]$ have derivatives that are continuous in v at $v = 0$, then:

$$\tau = \frac{\lim_{v_0 \to 0^+} \frac{d\mathbb{E}[Y|V=v]}{dv}\Big|_{v=v_0} - \lim_{v_0 \to 0^-} \frac{d\mathbb{E}[Y|V=v]}{dv}\Big|_{v=v_0}}{\lim_{v_0 \to 0^+} b'(v_0) - \lim_{v_0 \to 0^-} b'(v_0)}$$

In the fuzzy RKD:

$$\tau = \frac{\lim_{v_0 \to 0^+} \frac{d\mathbb{E}[Y|V^*=v^*]}{dv^*}\Big|_{v^*=v_0} - \lim_{v_0 \to 0^-} \frac{d\mathbb{E}[Y|V^*=v^*]}{dv^*}\Big|_{v^*=v_0}}{\lim_{v_0 \to 0^+} \frac{d\mathbb{E}[B^*|V^*=v^*]}{dv^*}\Big|_{v^*=v_0} - \lim_{v_0 \to 0^-} \frac{d\mathbb{E}[B^*|V^*=v^*]}{dv^*}\Big|_{v^*=v_0}} \tag{2}$$

Calonico et al. (2014) discuss estimation and inference of FRKD using non parametric (local) models. The precision and robustness of FRKD estimates using non parametric methods depend strongly on sample size. Although we have a number of observations that is appropriate for parametric estimation, it is not high enough for non parametric methods. For this reason we use the parametric version of the FRKD estimates.

The numerator in equation (2) can be estimated using the following model:

$$\mathbb{E}[Y|V = v] = \alpha_0 + \sum_{p=1}^{P} [\alpha_p (v - k)^p + \beta_p (v - k)^p * D], \tag{3}$$

where $|v - k| < h$, and h is the bandwidth chosen. In this case, k is the kink point. D is an indicator function of $v > k$, $D = \mathbb{1}[v > k]$. The numerator of the RKD estimate is the coefficient $\hat{\beta}_1$. The denominator is the derivative of the B function at the kink.

Card et al. (2012) also show that the structural estimator of τ in the fuzzy RKD can be directly estimated by regressing Y on linear (or quadratic) terms in $(v-k)$ and $(v-k)*D$, but leaving out the "main effect" D, and replacing the interaction term $(v-k)*D$ with B and using $(v-k)*D$ as the excluded instrument in a two stage least squares (2SLS) procedure. That is, the model to be estimated by 2SLS is:

$$\mathbb{E}[Y|V=v] = \alpha_0 + \sum_{p=1}^{P} [\alpha_p (v-k)^p + \beta_{p+1}(v-k)^{p+1} * D] + \tau * EPW, \tag{4}$$

where the endogenous variable EPW is instrumented with $(v-k)*D$.

4 | RESULTS

4.1 | Validity of the Fuzzy Regression Kink Design

For the FRKD to identify the effect of interest it is crucial to show the existence of a change in the slope of the EPW, at the cohort that separates individuals that could be enrolled in the DB system and chose to switch to the DC system, from individuals enrolled by mandate in the DC system. Figure 2 in Section 3.2 shows graphical evidence on the existence of the kink. We formally test the change in the slope of the EPW by estimating equation (3) replacing Y (health outcome) with B (EPW) as dependent variable, and using a polynomial of order 2 and OLS. Estimates are reported in Column (1) of Table 2, and are significant at the 1% level for males and non significant for women. Hence, the FRKD is appropriate to estimate the effect of changes in EPW on men's health investment choices.

TABLE 2 Existence of a kink in the slope of the EPW and predetermined outcomes.

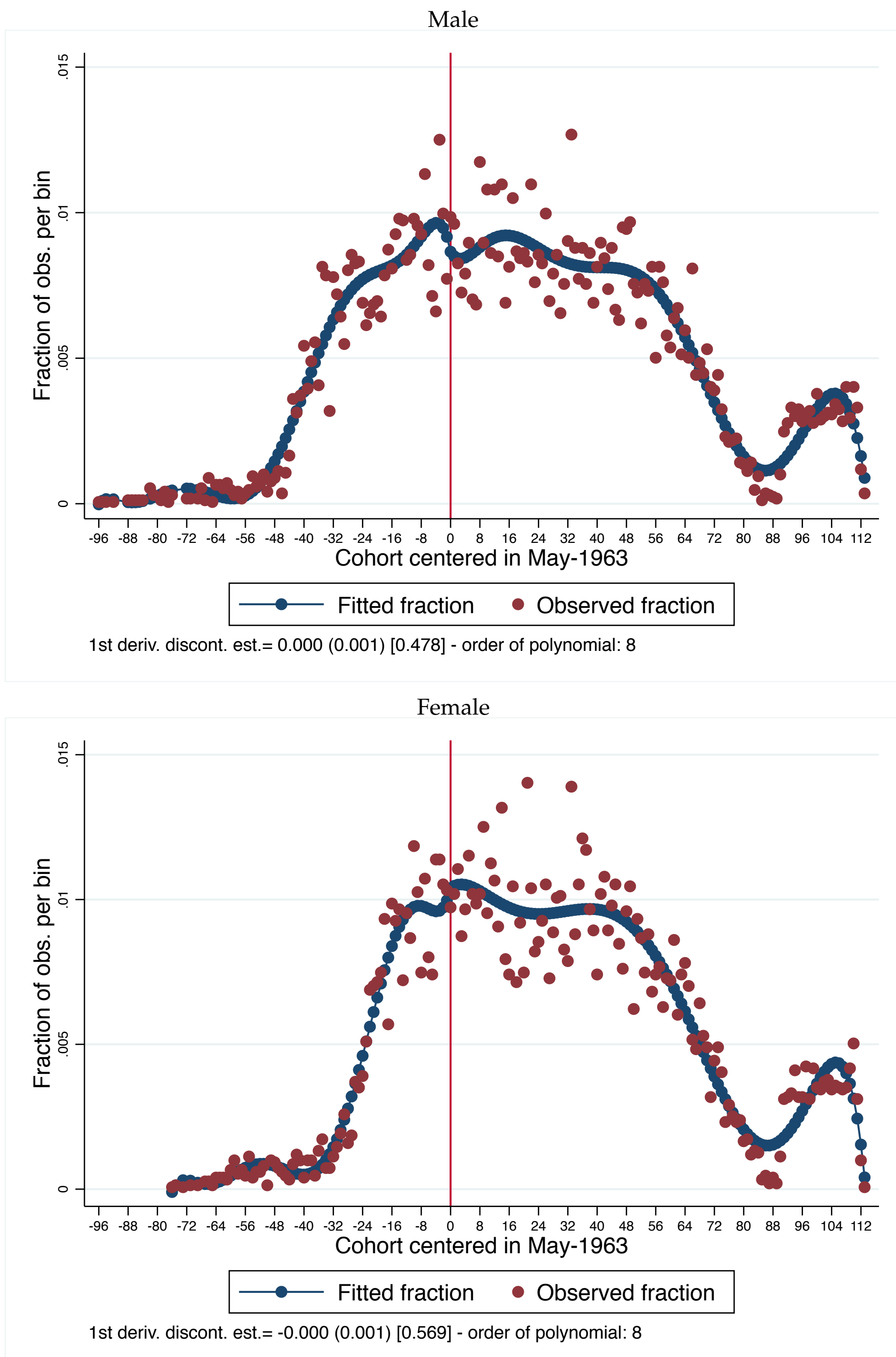
	EPW	Born in metro area	High school completed	Signed labor contract
Male	(1)	(2)	(3)	(4)
Slope at cut off	0.003	-.0003	0.0008	0.00007
	(0.001)***	(0.0009)	(0.0008)	(0.0005)
Obs	16818	16114	16818	11937
Female				
Slope at cut off	0.002	-.0009	0.0006	0.0009
	(0.001)	(0.001)	(0.0009)	(0.0008)
Obs	15038	14480	15038	8670

The slope at cut off is the variable $(v-k)*D$ as described in equation (3). Covariates: polynomial of order 2 in cohort and linear temporal trends. Standard errors in parenthesis clustered at the individual level. *** significant at 1%,** significant at 5%,* significant at 10%. Binary outcomes: Born in metro area, High school completed, (has) Signed labor contract.

The first identifying assumption of the FRKD resembles the RDD assumption of no manipulation of the assignment variable. In the FRKD this condition holds if the slope of the distribution function of the assignment variable V is continuous at the kink. In our sample, we need to show that the frequency distribution of individuals by cohort has a smooth slope around the cohort born in May-1963. To validate this assumption we regress the frequency of observations by cohort on a polynomial in cohort, allowing the degree of the polynomial to be at most of degree 8. We use Akaike's information criteria to choose the order of the polynomial that has a better goodness of fit, and test, in the chosen specification, the continuity of the slope at the threshold.[12] Figure 4 depicts fitted distributions, and reports the values of the test statistics with the corresponding standard errors in parentheses and p-value in brackets. We do not find evidence of a discontinuity in the slope of the distribution of women and men at the kink.

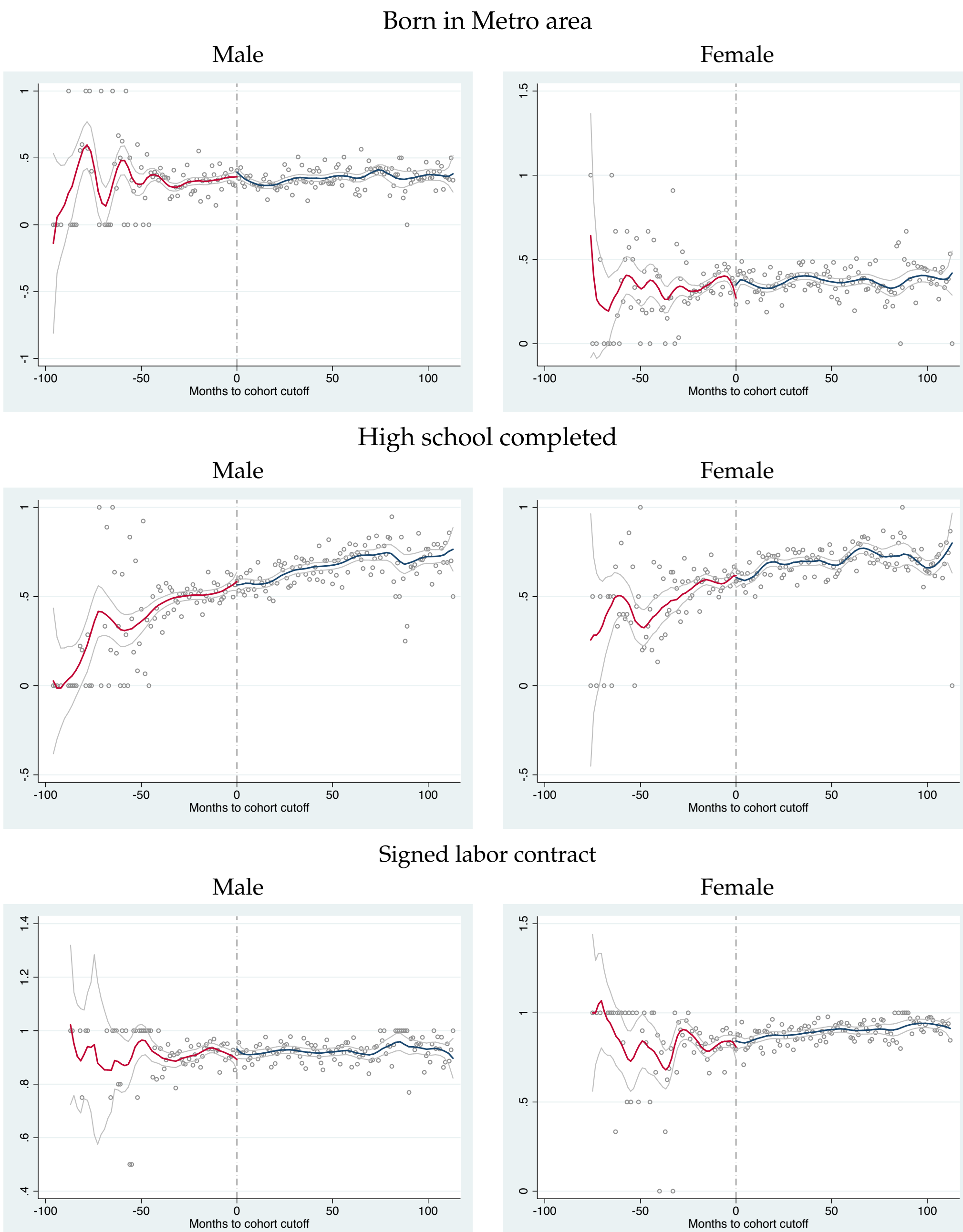
[12] We use a bin of 3 months for the distribution of cohort.

FIGURE 4 Frequency of observations by cohort.



The second assumption for the identification of the FRKD is that individuals are assigned at both sides of the change in the slope of the EPW as if the assignment was random. To validate this assumption we provide evidence that the individuals born before or after May-1963 are similar in predetermined observable characteristics because the slope in the distributions of such characteristics is smooth at the cutoff point. Figure 5 show graphical evidence on the smoothness of predetermined characteristics at the threshold. We formally tested the existence of a kink in predetermined characteristics by estimating equation (3) using OLS. Results are reported in Columns (2) to (4) of Table 2. For all characteristics we rule out the existence of the kink.

FIGURE 5 Distribution of predetermined observable characteristics.



Graphs obtained using kernel weighted local polynomial smoothing, with ROT bandwidth and polynomial of order 2. We use a bin of 3 months for the distribution of cohort.

4.2 | FRKD Estimates

In Tables 3 to 5, we present parametric FRKD estimates of the effect of changes in the EPW on several health related outcomes, by gender. We separate the health outcomes in three groups: preventive health care use (Table 3), diagnoses of health conditions (Table 4), and health related behaviors (Table 5). The outcomes in the three groups are binary variables, and we use linear probability models in all cases. For each group of health outcomes, in the last column of its correspondent table, we include an index to summarize the information provided. The indexes are constructed using principal component analyzes with tetrachoric correlation coefficients.

The regressions for binary outcomes are parametrized to be interpreted as follows: a 1% increase in the EPW changes the probability of the outcome in ... percentage points. The interpretation for indexes is: a 1% increase in the EPW changes the value of a given index in ... points. At the bottom of each table we report the mean of the outcomes (in percentage) and of the indexes (in level).

In what follows we discuss results only for men, since we do not have a convincing identification strategy for women. Overall, we found a positive effect of increases in EPW on men's use of preventive health care, more diagnoses of preventable chronic deseases, and no evidence of statistically significative changes in health related behaviors.

With an increase of 1% in the EPW, the probability of having Cholesterol, Diabetes, and Hypertension screenings goes up 0.607 pp (percentage points), 0.614 pp, and 0.657 pp, respectively. Considering the mean of each outcome, these changes represent an increase of approximately 2% in the screening probabilities and in the index of preventive health care use. These effects are statistically significant at the 10% level.

The probability of being diagnosed with diabetes rises 0.273 pp when the EPW increases in 1%. This represents an increase of approximately 8.8% in the incidence of diabetes. The index of diagnosed conditions goes up approximately 3.5%. These effects are statistically significant at the 5% level.

The estimates on health related behaviors are too imprecise to be interpreted.

TABLE 3 FRKD estimates of the effect of EPW on **preventive health care**. *Question: In the last two years, did you receive/have you been tested for...?*

	Prostate	Influenza vac.	Cholesterol	Diabetes	Hyperten.	...	Index
Male	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Marginal Effect	0.16	0.431	0.607	0.614	0.657		0.011
	(0.25)	(0.288)	(0.355)*	(0.337)*	(0.36)*		(0.006)*
F-stat	6.084	6.230	5.876	6.077	5.813		5.762
Obs	8018	8112	8114	8108	8108		7956
Mean of outcome	12.069	19.046	31.071	27.937	28.258		0.543
	Pap	Influenza vac.	Cholesterol	Diabetes	Hyperten.	Breast RX	Index
Female	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Marginal Effect	0.124	-.266	0.252	0.006	0.151	0.272	-.001
	(0.291)	(0.675)	(0.651)	(0.605)	(0.649)	(0.384)	(0.006)
F-stat	3.140	1.171	1.164	1.122	1.075	3.322	2.661
Obs	14841	7582	7586	7591	7589	3634	3595
Mean of outcome	63.854	28.967	44.850	41.077	39.062	33.862	0.678

Marginal effects are 2SLS estimates of linear models. Covariates: polynomial of order 2 in cohort and linear temporal trends. Standard errors in parenthesis clustered at individual level. *** significant at 1%,** significant at 5%,* significant at 10%.
Binary outcomes: Prostate (screening), Influenza vacc. (vaccination), Cholesterol (screening), Diabetes (screening), Hypertension (screening), Pap (test) and Breast RX.
Mean of binary outcomes in %.
Continuous outcome: Index includes all binary outcomes.

TABLE 4 FRKD estimates of the effect of EPW on **health conditions**. *Question: In the last two years, have you been diagnosed with...?*

	Asthma	Hypertension	Diabetes	Heart	Arthritis	Kidney	Mental	Index
Male	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Marginal Effect	0.064	0.313	0.273	0.124	-.109	0.09	0.064	0.003
	(0.066)	(0.193)	(0.134)**	(0.076)	(0.093)	(0.061)	(0.067)	(0.002)**
F-stat	8.642	8.461	8.494	8.474	8.569	8.361	8.636	8.247
Obs	16789	16785	16785	16796	16788	16773	16807	16692
Mean of outcome	2.062	8.479	3.068	1.932	1.697	1.484	3.069	0.086
Female								
Marginal Effect	0.04	0.24	-.118	-.164	0.335	-.057	0.365	0.003
	(0.183)	(0.368)	(0.212)	(0.167)	(0.321)	(0.125)	(0.378)	(0.003)
F-stat	2.151	2.103	2.123	2.075	2.106	2.270	2.110	2.323
Obs	15020	15007	15013	15011	15012	15001	15034	14916
Mean of outcome	3.208	11.837	4.438	2.253	3.950	1.779	12.414	0.154

Marginal effects are 2SLS estimates of linear models. The instrument is $(\nu - k) * D$ as described in equation (4). Covariates: polynomial of order 2 in cohort and linear temporal trends. Standard errors in parenthesis clustered at individual level. *** significant at 1%,** significant at 5%,* significant at 10%.
Binary outcomes: Asthma, Hypertension, Diabetes, Heart disease, Cancer, Arthritis, Kidney failure, and Mental Illness.
Mean of binary outcomes in %.
Continuous outcome: Index includes all binary outcomes.

TABLE 5 FRKD estimates of the effect of EPW on **health behaviors**.

	Smoke	Alcohol	Phy. active	Visited MD	Index
Male	(1)	(2)	(3)	(4)	(5)
Marginal Effect	0.303	0.248	0.212	-.015	-.004
	(0.273)	(0.23)	(0.195)	(0.173)	(0.003)
F-stat	8.675	8.649	8.488	11.918	8.749
Obs	16777	16773	16691	12787	16633
Mean of outcome	40.320	60.447	32.523	41.367	0.61
Female					
Marginal Effect	0.884	0.442	0.065	0.23	-.009
	(0.711)	(0.401)	(0.263)	(0.25)	(0.007)
F-stat	2.268	2.253	2.228	3.463	2.360
Obs	15017	15017	14938	11076	14907
Mean of outcome	33.292	28.800	18.652	63.314	0.91

Marginal effects are 2SLS estimates of linear models. The instrument is $(\nu - k) * D$ as described in equation (4). Covariates: polynomial of order 2 in cohort and linear temporal trends. Standard errors in parenthesis clustered at individual level. *** significant at 1%,** significant at 5%,* significant at 10%.
Binary outcomes: Smoke (*Do you smoke?*), Alcohol (*Do you drink alcohol?*), Phy. active (*Do you do physical activity?*), Visited MD (*Did you visited an MD in the last two years?*).
Mean of binary outcomes in %.
Continuous outcome: Index (doesn't drink+doesn't smoke+does physical activity)

4.3 | Robustness of the FRKD estimates

We present results of testing the null hypothesis of a zero average effect on pseudo outcomes that should not be affected by the pension system reform, in Panel A of Table 6. We use the outcomes previously chosen to analyze the balance of observable predetermined characteristics at both sides of the kink: an indicator for being born in the Metropolitan area, an indicator for having completed secondary school, and an indicator of having a signed contract. We did not find evidence of statistically significant effects of increases in EPW on pseudo outcomes.

Additionally, we test for the existence of an effect on health outcomes at non-kink points. Results are shown in Panel B of Table 6. We test for the existence of effects at the median point in the subsample of observations to the left (Oct-1958) and to the right (Oct-1972) of the true kink (May-1963). As outcomes we use the index of preventive health care and the index of diagnosed conditions. We did not find evidence of statistically significant effects of increases in EPW on health outcome indexes at non-kink points.

TABLE 6 Specification tests on the FRKD.

Panel A	Born in metro area	High school completed	Signed labor contract
Male	(1)	(2)	(3)
Marginal Effect	-.098	0.257	0.02
	(0.317)	(0.269)	(0.136)
F-stat	7.169	8.455	8.911
Obs	16114	16818	11937
Mean of outcome	33.452	60.174	91.374
Female			
Marginal Effect	-.546	0.291	1.366
	(0.829)	(0.493)	(3.518)
F-stat	1.331	2.182	0.137
Obs	14480	15038	8670
Mean of outcome	36.292	64.921	86.349

Panel B	Index of preventive health care use		Index of diagnosed conditions	
	Left subsample	Right subsample	Left subsample	Right subsample
Male	(1)	(2)	(3)	(4)
Marginal Effect	0.004	0.025	-.002	0.015
	(0.006)	(0.063)	(0.008)	(0.042)
F-stat	1.370	0.184	1.838	0.19
Obs	5473	11160	2374	5582
Mean of outcome	0.61	0.61	0.543	0.543
Female				
Marginal Effect	-.005	0.006	-.009	0.015
	(0.005)	(0.008)	(0.011)	(0.016)
F-stat	2.182	1.639	1.461	1.143
Obs	3626	11281	938	2657
Mean of outcome	0.91	0.91	0.678	0.678

Marginal effects are 2SLS estimates of linear models. The instrument is $(\nu - k) * D$ as described in equation (4). Covariates: polynomial of order 2 in cohort and linear temporal trends. Standard errors in parenthesis clustered at individual level. *** significant at 1%,** significant at 5%,* significant at 10%.
Binary outcomes: Born in Metropolitan area, High school completed, and having a Signed labor contract.
Mean of binary outcomes in %.
Continuous outcomes: Index of preventive health care use and index of diagnosed conditions

5 | CONCLUSIONS

A poorly understood but important way in which economic circumstances could influence health is through the incentives that they create for health investments. Most of the literature is focused on the the role of contemporaneous income and wealth in health production. In this paper we provide evidence that current health investments respond to changes in expected future wealth of men in Chile. An increase of 1% in the expected pension wealth is associated with a 2% rise in the use of preventive health care, and a 3.5% rise in the diagnoses of preventable chronic diseases. Specifically, we find statistically significant effects on the probability of having cholesterol, diabetes, and hypertension screenings, and on the probability of being diagnosed with diabetes. Our results should be interpreted as Local Average Treatment Effects, mostly driven by men between 40 and 50 years of age. Considering that the legal retirement age for men in Chile is 65, our findings correspond to health investment reactions to expected pension wealth changes over a horizon of between 15 and 25 years.

Further research has to be done to study similar effects on women. In Chile, labor market participation of women is below the average among OECD countries. Thus, the relevant measure of available resources for female at the time of retirement may not be their own pension savings but the household expected pension wealth. The availability of information at the household level would allow the analysis of health investment responses to changes in expected wealth by gender, and also it would open the possibility of studying complementarities and bargaining processes within the household.

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