Pension Privatization, Behavioral Responses, and Income in Old Age: Evidence from a Cohort-Based Reform*

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*The views expressed here are those of the authors and do not necessarily represent the views of the Federal Reserve System or its staff.

Introduction

- Retirement pension systems are a large component of social insurance
- Debate regarding the design
  - Benefit generosity and link to contributions, public/private, defined benefits/contributions, etc
  - Concerns about financial sustainability and incentives

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- Debate regarding the design
  - Benefit generosity and link to contributions, public/private, defined benefits/contributions, etc
  - Concerns about financial sustainability and incentives
- Frequent proposal: **switch from public PAYG to private capitalization with retirement accounts** ("privatization")
  - Often with intention to make system more financially sustainable and incentivize work (among others)
  - Many countries have followed these recommendations and privatized their social security systems (Orenstein, 2013)
  - But little evidence on the effects
- **This paper:** study effects of partial privatization on workers' behavior and income in old age

This paper (Uruguayan reform)

- Traditionally PAYG with DB system, concerns about financial sustainability in the 90s
- **Reform in 1996 partially privatized the system**
  - Part of contributions goes to PAYG and part goes to individual capitalization accounts managed by pension funds
  - Pension is part government and part rent from private account
    - (some details and caveats)

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    - (some details and caveats)
- To gradually roll new system in, cohort-based discontinuity:
  - DOB $\leq$ April 1st 1956 $\rightarrow$ remain in exclusively PAYG system ("transition" system, similar to the previous system)
  - DOB $>$ April 1st 1956 $\rightarrow$ switch to new mixed system ("mixed" or "two-pillar" system)

  $\rightarrow$ **RD design**:
    - Compare trajectories of people born within a few days from the cutoff DOB (employment, retirement, earnings, etc)

Preview of results I: workers' responses (SKIP)

Significant responses to privatization, even far from retirement:

1. **Employment rates**
   - No significant differences in employment early on
   - More likely to be employed later on if in system with retirement accounts ($\approx$ 4pp)
     - » Due to lower prob of retiring early, concentrated among low SES and those with disabilities

$\rightarrow$ Postponing retirement among those who tend to retire earlier

2. **Earnings**
   - Large increase in earnings in the first few years after reform if in system with retirement accounts ($\approx$ 20%), narrows over time
   - Compelling evidence of lower tax evasion

$\rightarrow$ Stronger contribution-benefit link $\Rightarrow \downarrow$ tax evasion when young

- Consistent with predictions from standard models of retirement and evasion decisions

Preview of results II: income in old age (SKIP)

Income in old age:

- No significant differences in income and poverty
  - (although caveats with labor supply and age)
- But some opt-in for reversal to PAYG-DB system
  - Did not choose profitable retirement savings option
  - Earnings profiles that favor DB formulas from PAYG
  - Contributed less in the early good interest rate years

$\rightarrow$ Similar incomes, but privatization can be detrimental to some

- Can explain some of the push to de-privatize in recent decades

Related literature and contribution I

The effects of privatizing social security: often GE models to simulate macro effects (Auerbach and Kotlikoff, 1985; Feldstein, 1995; Kotlikoff, 1996; Nishiyama and Smetters, 2007; Fuster et al., 2007; Hosseini and Shourideh, 2019)

- Many privatizations but no compelling empirical literature yet

→ **Main contribution:** empirical evidence on workers' responses and income in old age (first paper)

  - Prev. evidence on labor supply and pension incentives only on public PAYG and mostly in old age (e.g. Gelber et al., 2016; Brown, 2013; Liebman et al., 2009; Manoli and Weber, 2016; Fetter and Lockwood, 2018; French et al., 2022)

  → **Contribution:** long trajectory of workers' responses, even far from retirement (key part of argument by proponents of reform)

- Mostly focused on rich countries (few exceptions, e.g. Moreno, 2022)

  → **Contribution**: analyze effects in a middle-income country (other margins of response are more relevant (e.g. informality, evasion) and pension reform has been more pressing) List

Related literature and contribution II

Tax evasion:

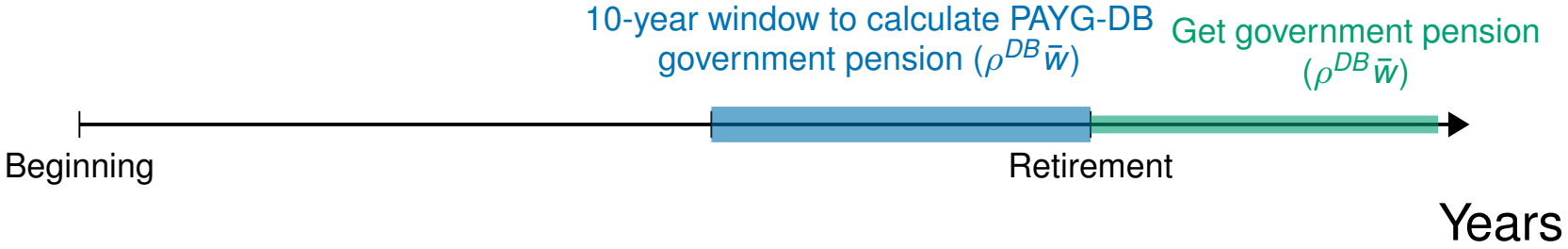
- Vast and growing literature on compliance at firm-level (e.g. Bachas and Soto, 2021; Naritomi, 2019; Pomeranz, 2015) and individual-level (e.g. Londoño-Vélez and Ávila-Mahecha, 2021)
- Specifically **earnings underreporting** (much less studied)
- Evidence of collusive underreporting in developing countries (Feinmann et al., 2022) and that it can be related to pension regulations (Dean et al., 2022; Kumler et al., 2020)
  - → **Contribution:** compelling evidence that underreporting and workers' retirement savings incentives are closely related

Also taxation and labor supply (Martinez et al., 2021; Sigurdsson, 2019; Tortarolo et al., 2020; Kleven and Schultz, 2014; Tazhitdinova, 2020; Bergolo et al., 2022)

Outline

Stylized conceptual framework Full model

Old PAYG-DB only (born up until April 1st 1956)



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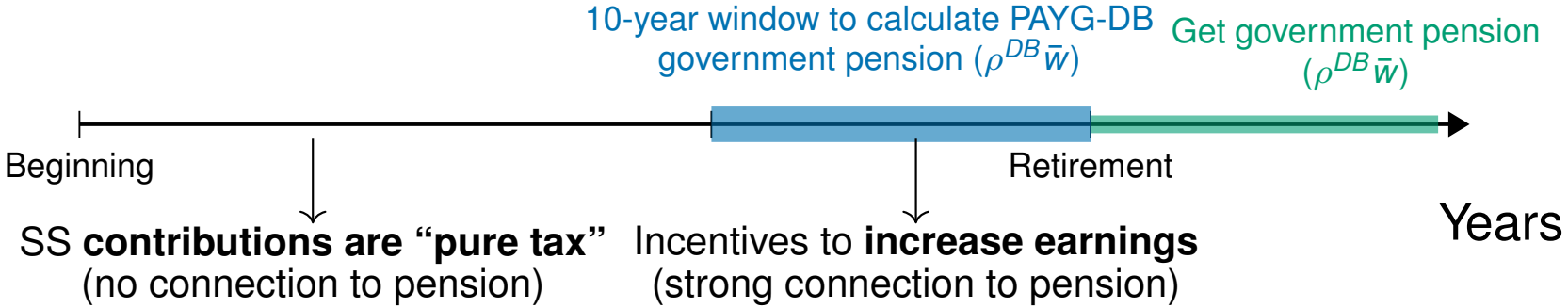

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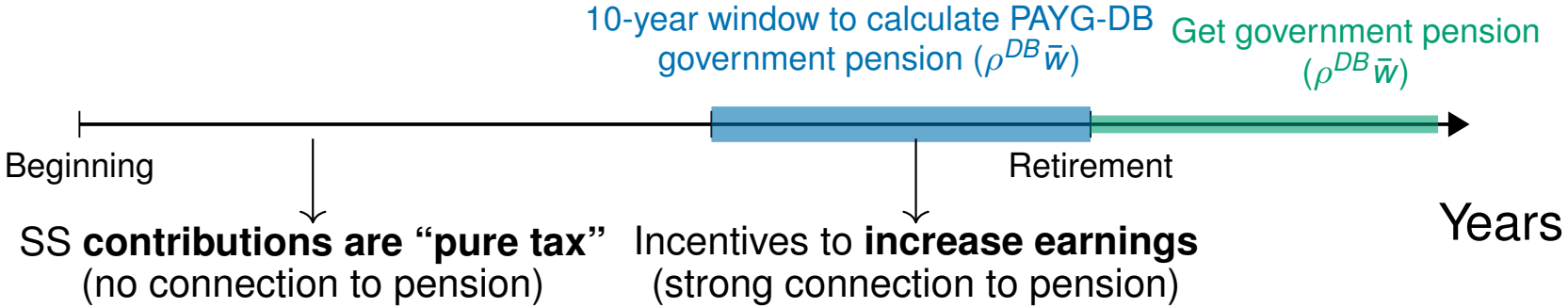

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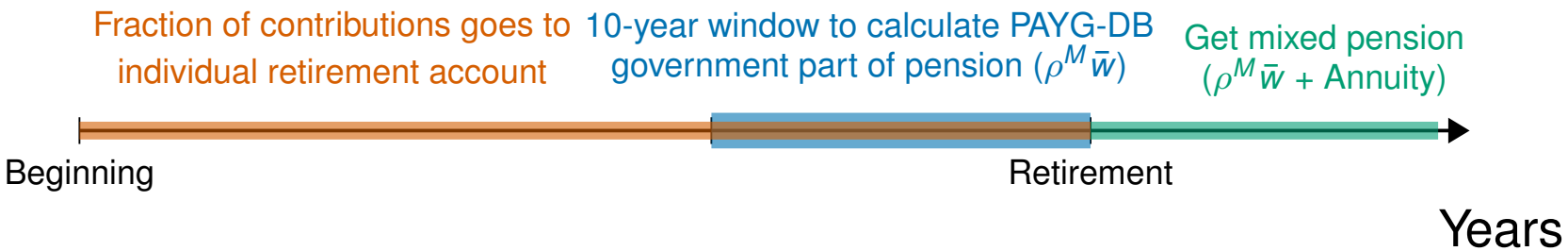

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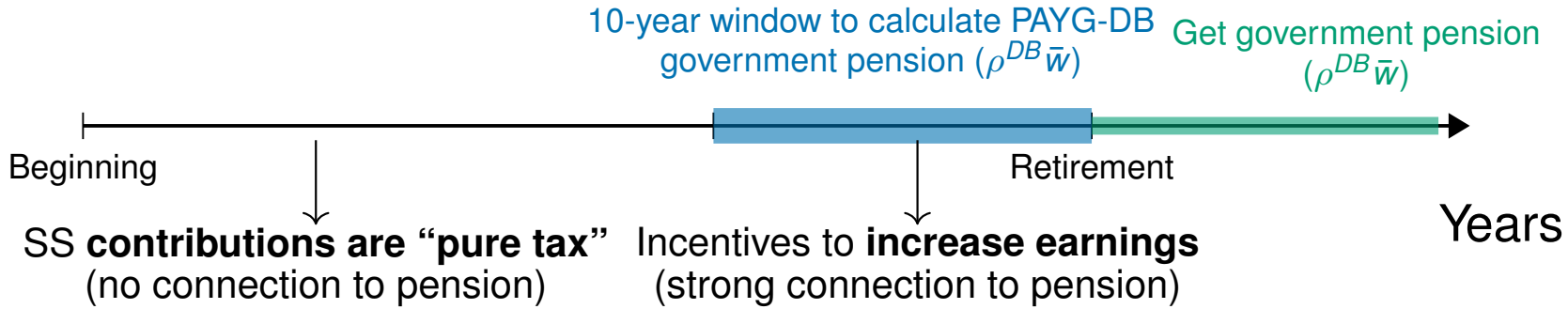

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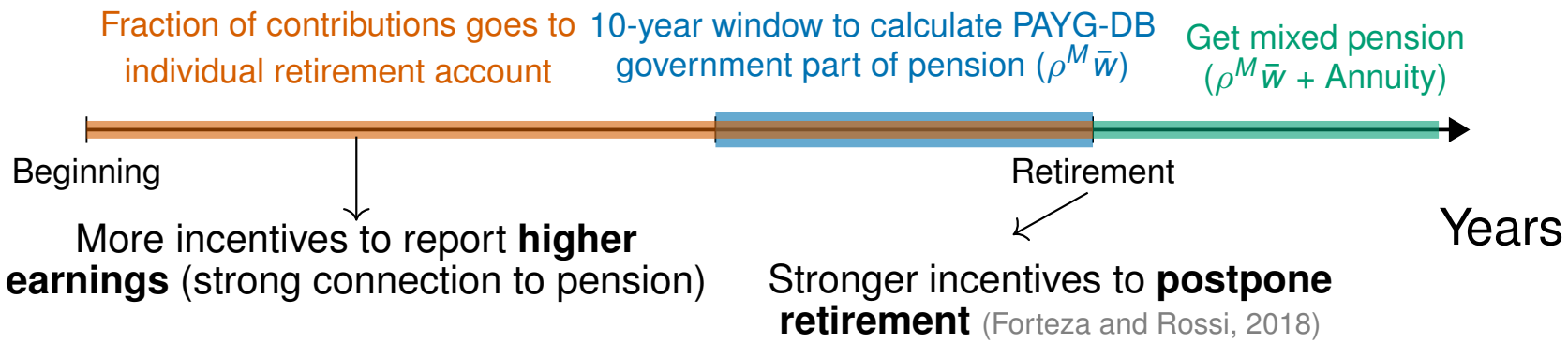

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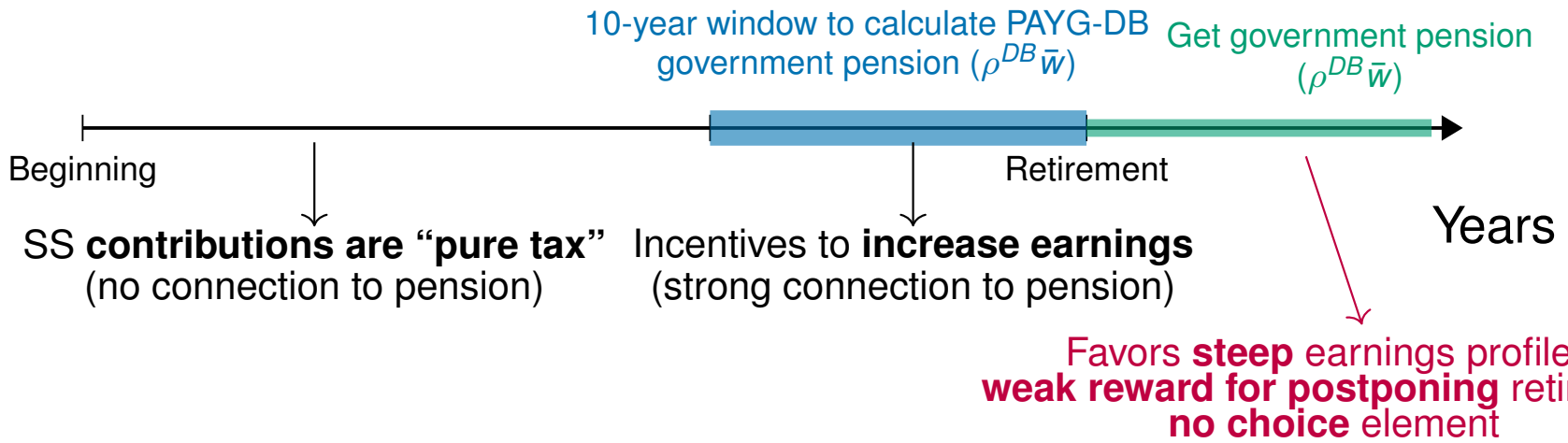

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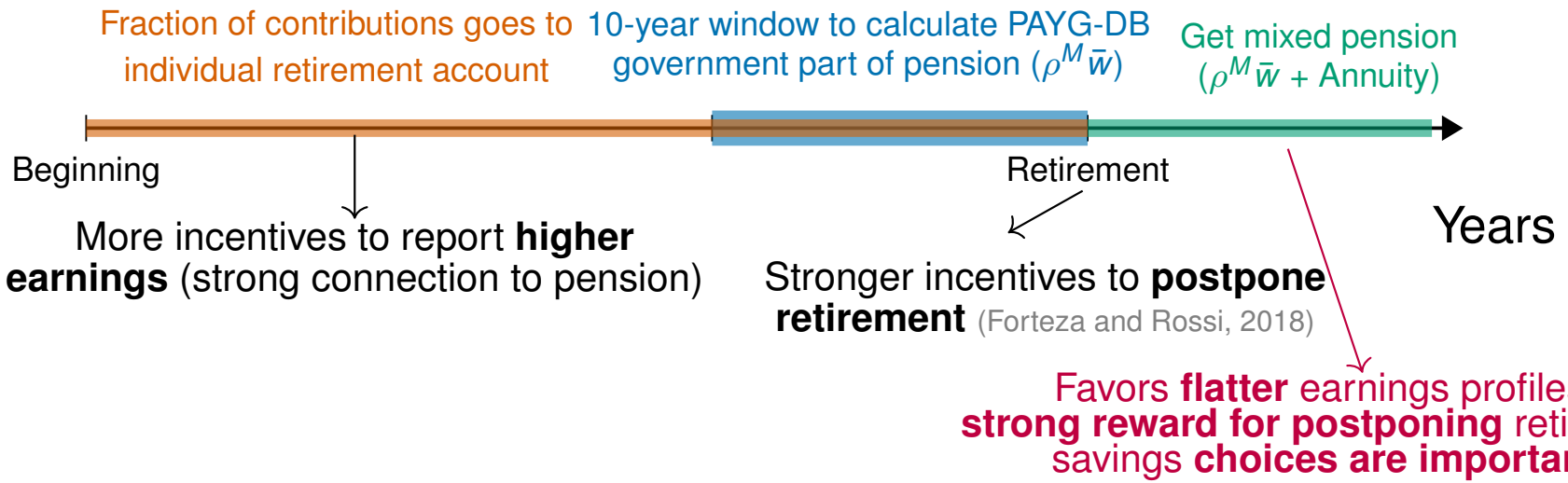


Outline

Data

1. Admin records from the SS administration Summary stats
   - All formal workers from 1997-2013 (employment, earnings, days/hours worked, firm stuff, etc) $\rightarrow$ daily DOB Details
2. 2011 census data Summary stats
   - All population, any type of employment, retirement, additional variables for heterogeneity $\rightarrow$ monthly DOB
3. Income tax data Summary stats
   - 50% sample from all income tax returns from 2009-2016 (yearly earnings, pension income) $\rightarrow$ daily DOB Details
4. Retirement accounts data Summary stats
   - All ret. accounts for key cohorts from 1997-2022 (opening and closing date, balance, contributions, etc) $\rightarrow$ daily DOB
5. Complementary measures from main labor-force HH survey (informality, tax evasion, sector-level earnings profiles)

Econometric Strategy

- Exploit discontinuity of implementation based on date of birth with sharp RD design

$$Y_i = \alpha + \beta \mathbb{1}\{DOB_i > Cutoff\} + f(DOB_i) + \varepsilon_i$$

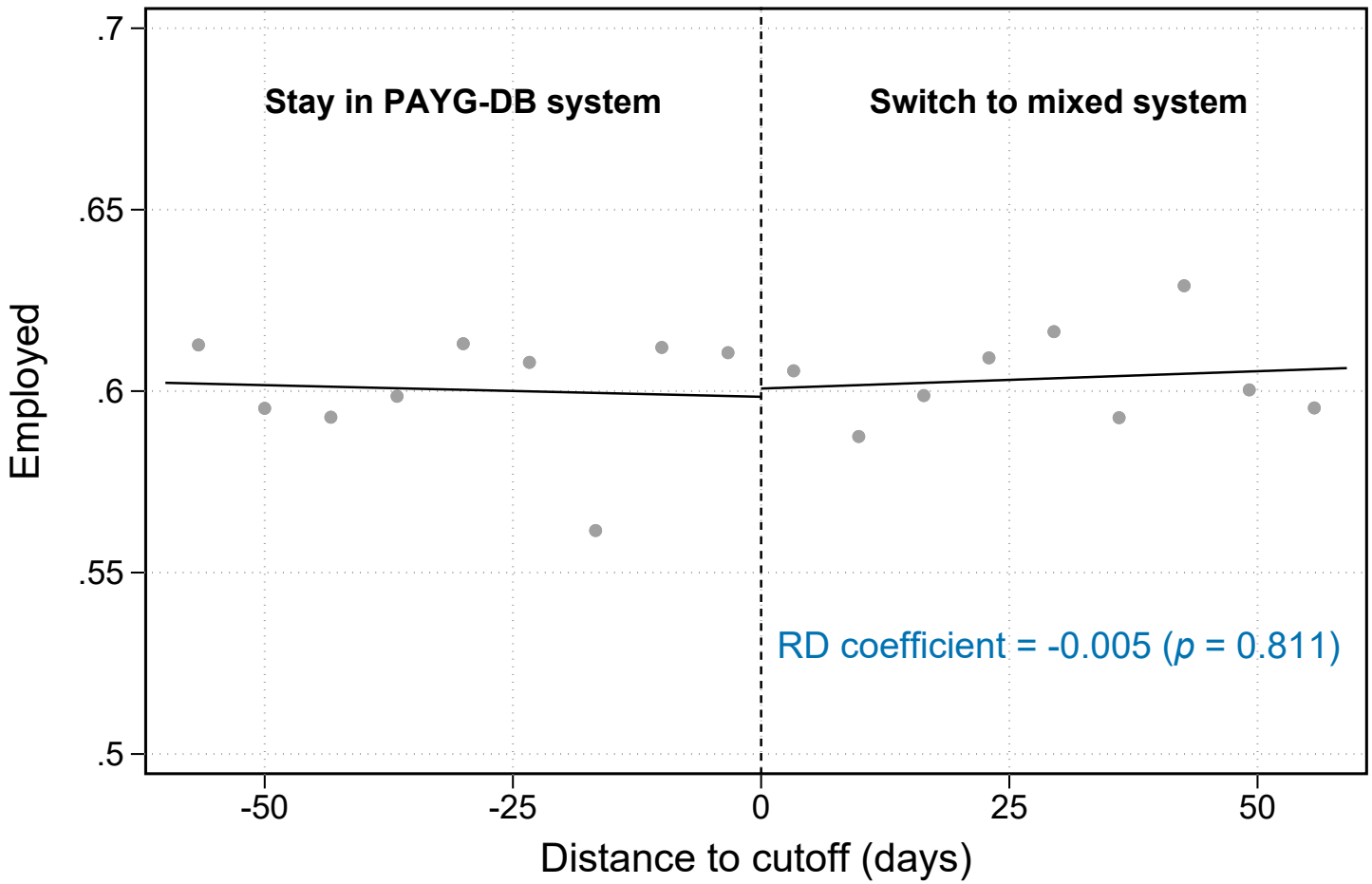
- β is the ITT parameter of interest First stage
- Running variable is discrete with mass points, use Local Randomization approach (Cattaneo et al., 2019)
  - DOB non-manipulable Density around cutoff Manipulation test
  - Show several specifications for robustness
- Show placebos with people born year before/after
- Outcomes: employment, salaries, retirement, days/hours worked, pension benefits, account is active, etc

Outline

RD - Employment rate

Short-term response:

Figure: RD - Employed (1997-2000, Ages 41-44)



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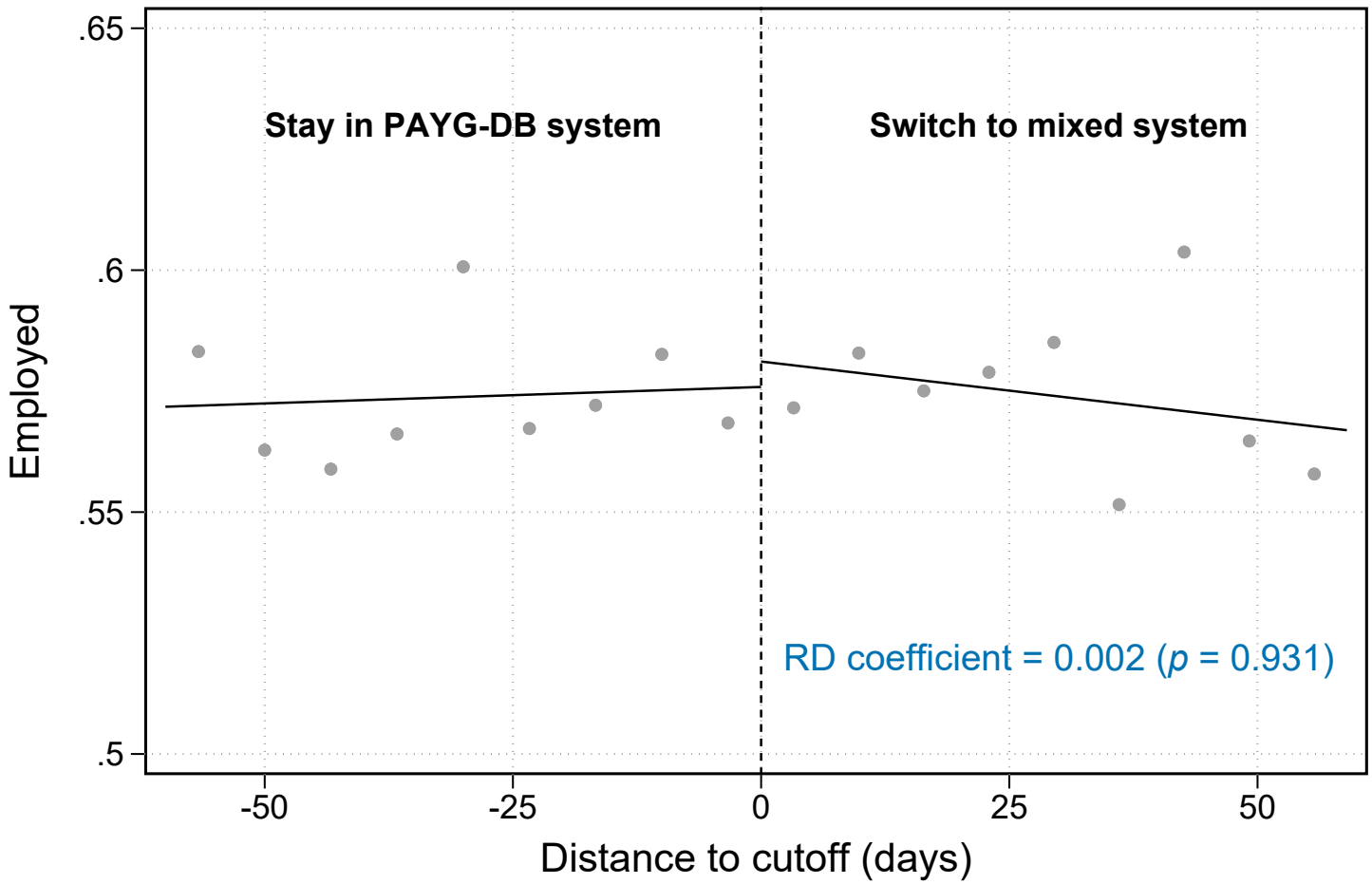
Medium-term response:

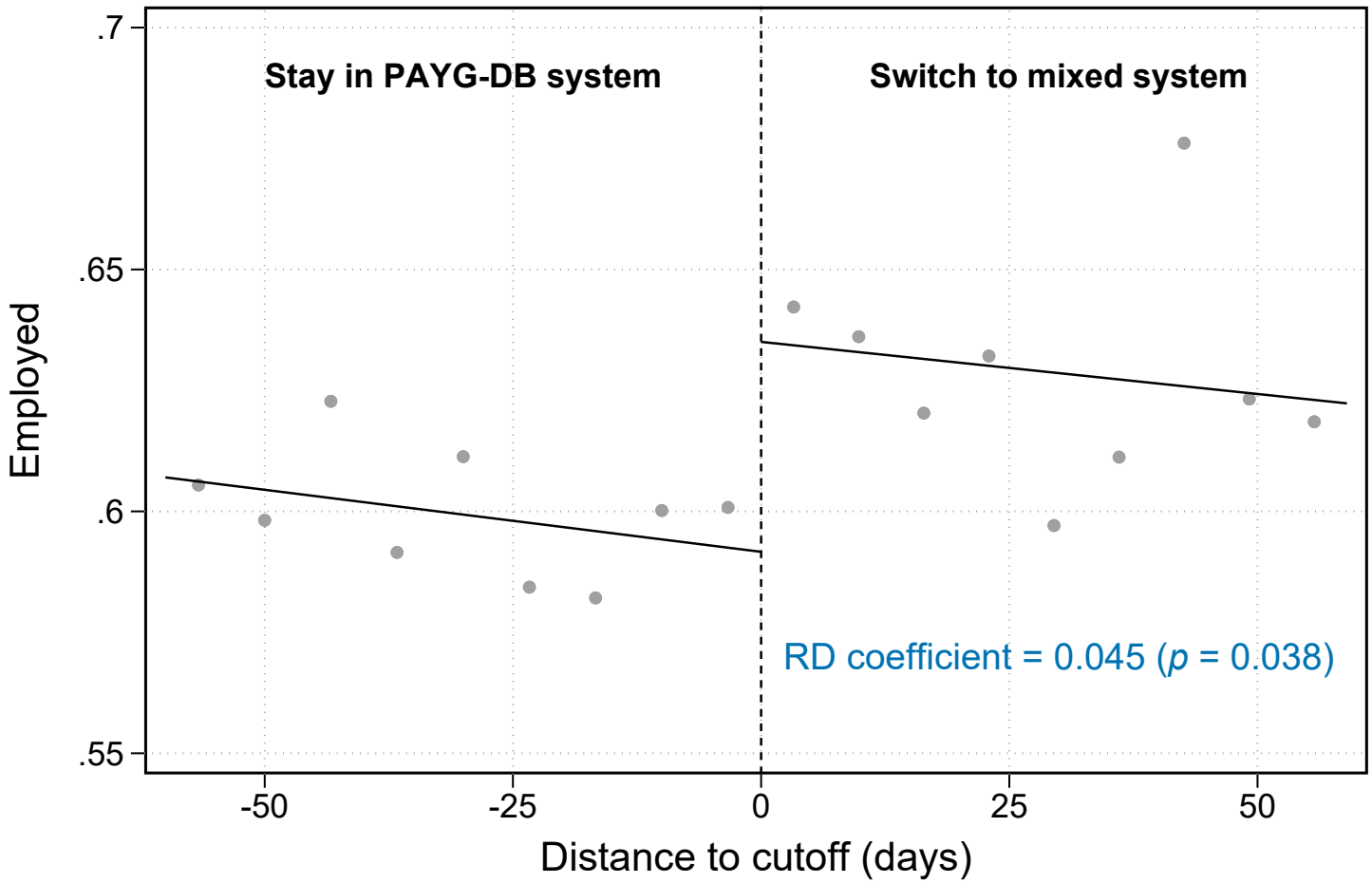
Figure: RD - Employed (2005-2008, Ages 49-52)



RD - Employment rate

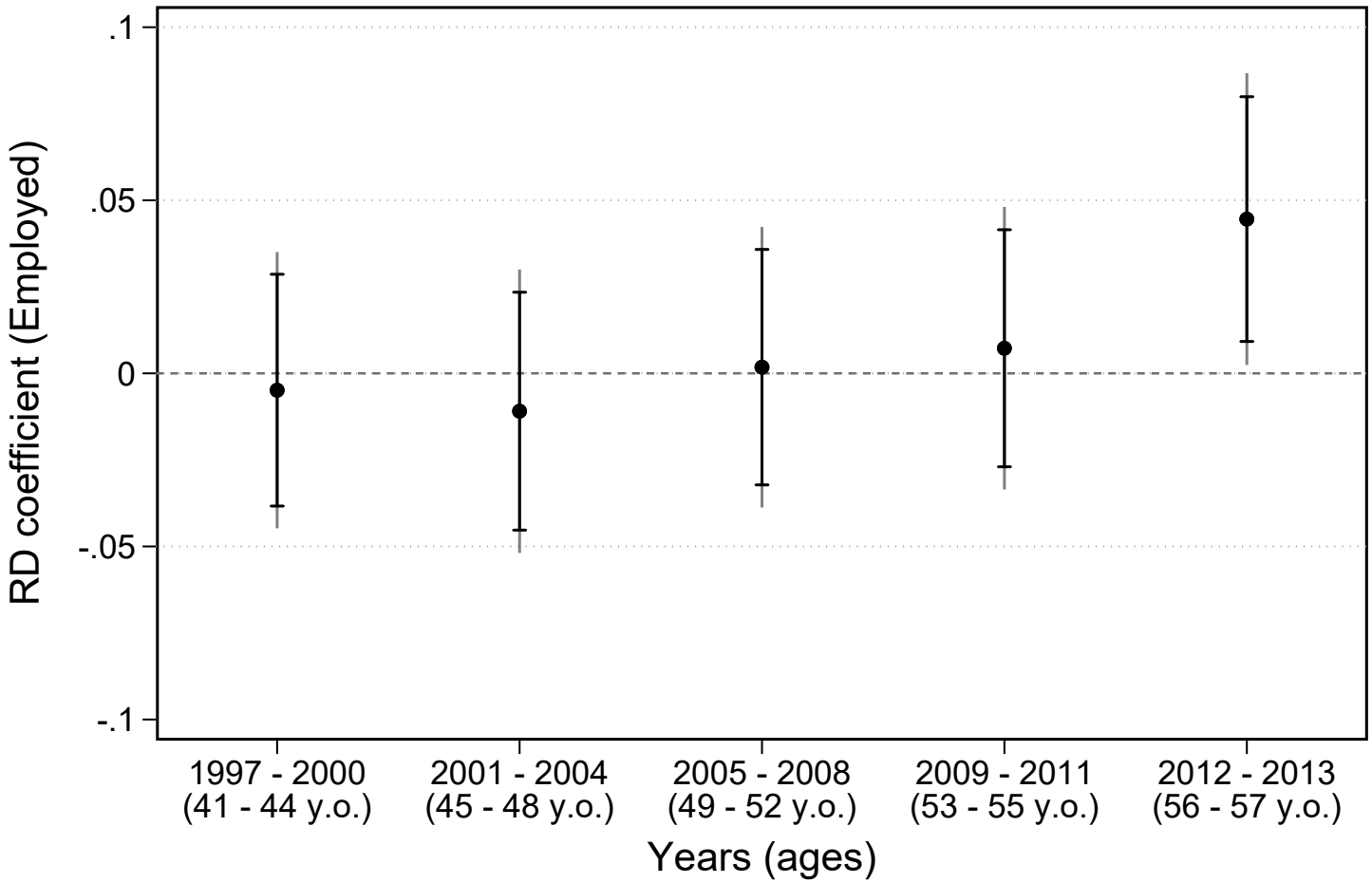
Long-term response: All years 1997 through 2013

Figure: RD - Employed (2012-2013, ages 56-57)



Time series plot of RD coefficients (employed)

Figure: RD time series (employed)



Not much action early on, higher prob of employed later on

Different specifications | Compared with placebos

Census heterogeneity

Table: Effect on employment and retirement heterogeneity

	=1 if employed				=1 if retired			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mixed system	0.0216*	0.0424**	0.0134	0.0301*	-0.0204**	-0.0351**	-0.0118	-0.0235*
	(0.0124)	(0.0178)	(0.0127)	(0.0181)	(0.00970)	(0.0141)	(0.00972)	(0.0142)
High SES		0.138***		0.118***		-0.0598***		-0.0449***
		(0.0173)		(0.0172)		(0.0138)		(0.0137)
Mixed system × High SES		-0.0448*		-0.0326		0.0338*		0.0235
		(0.0248)		(0.0247)		(0.0194)		(0.0193)
Disability			-0.383***	-0.356***			0.282***	0.272***
			(0.0364)	(0.0368)			(0.0394)	(0.0399)
Mixed system × Disability			0.100*	0.0860			-0.109*	-0.103*
			(0.0565)	(0.0568)			(0.0566)	(0.0572)
Constant	0.649***	0.583***	0.670***	0.611***	0.174***	0.202***	0.157***	0.180***
	(0.00872)	(0.0125)	(0.00887)	(0.0128)	(0.00692)	(0.0102)	(0.00687)	(0.0102)
Observations	5799	5743	5749	5742	5799	5743	5749	5742

More effect for low SES and substantially higher for people with mild disabilities RD Plots | RD het plots | Constr. SES index | Note on heterogeneity

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Takeaways from employment responses

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- Little effect on prob of employed early on
- Slight increase closer to retirement
- Mostly lower probability of having retired early
  - Consistent with model and intuition: capitalization can create incentives to postpone retirement

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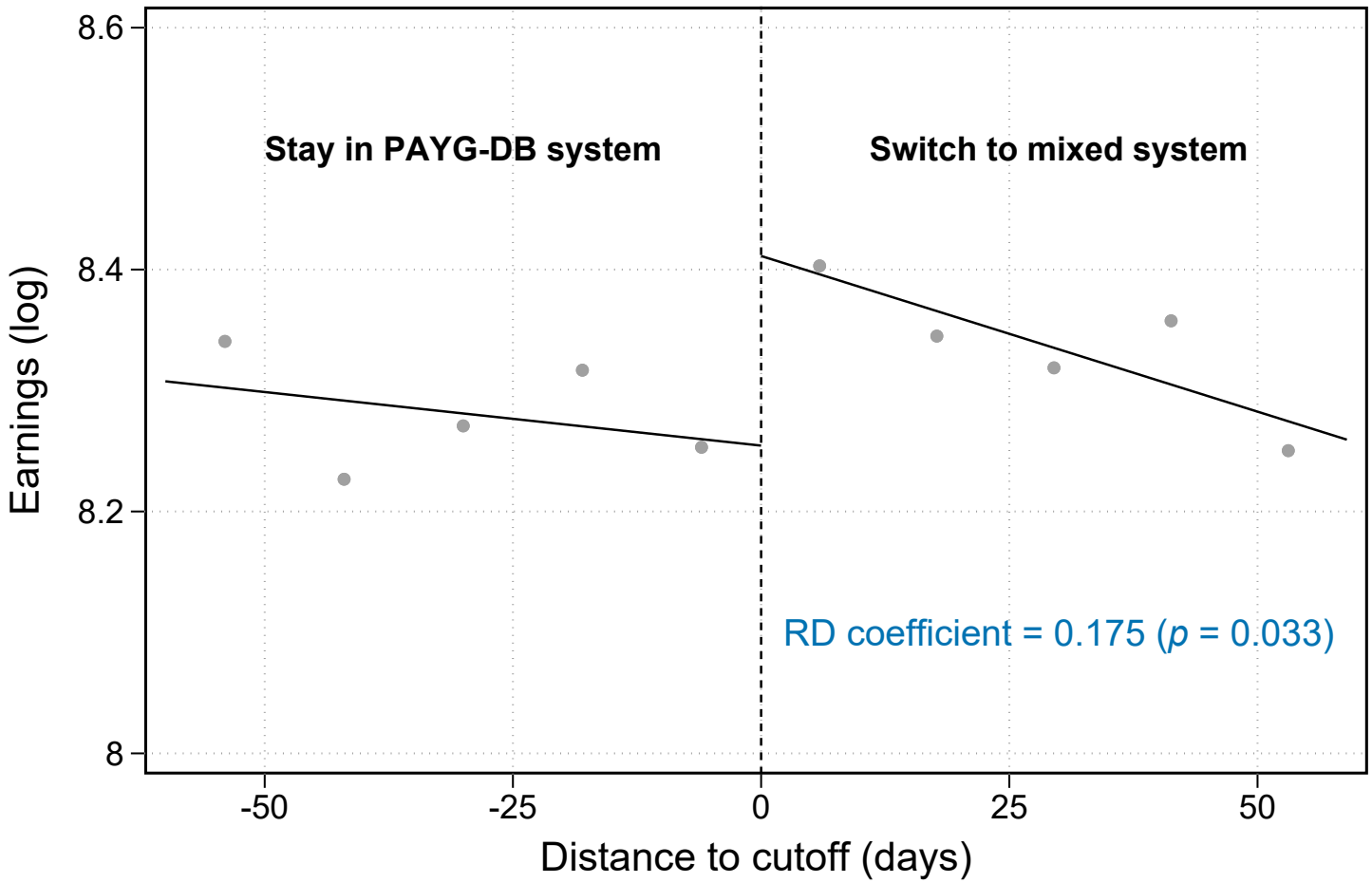
- Slight increase closer to retirement
- Mostly lower probability of having retired early
  - Consistent with model and intuition: capitalization can create incentives to postpone retirement
- Heterogeneity:
  - More effect for low SES people
  - Large effect for people that experience some mild disability
    - » Both predictors of early retirement
  - $\rightarrow$ Privatization leads to postponing retirement among those who tend to retire early
- **Next:** earnings responses

RD - Earnings

Short-term response:

Figure: RD - Earnings (1997-2000, Ages 41-44)



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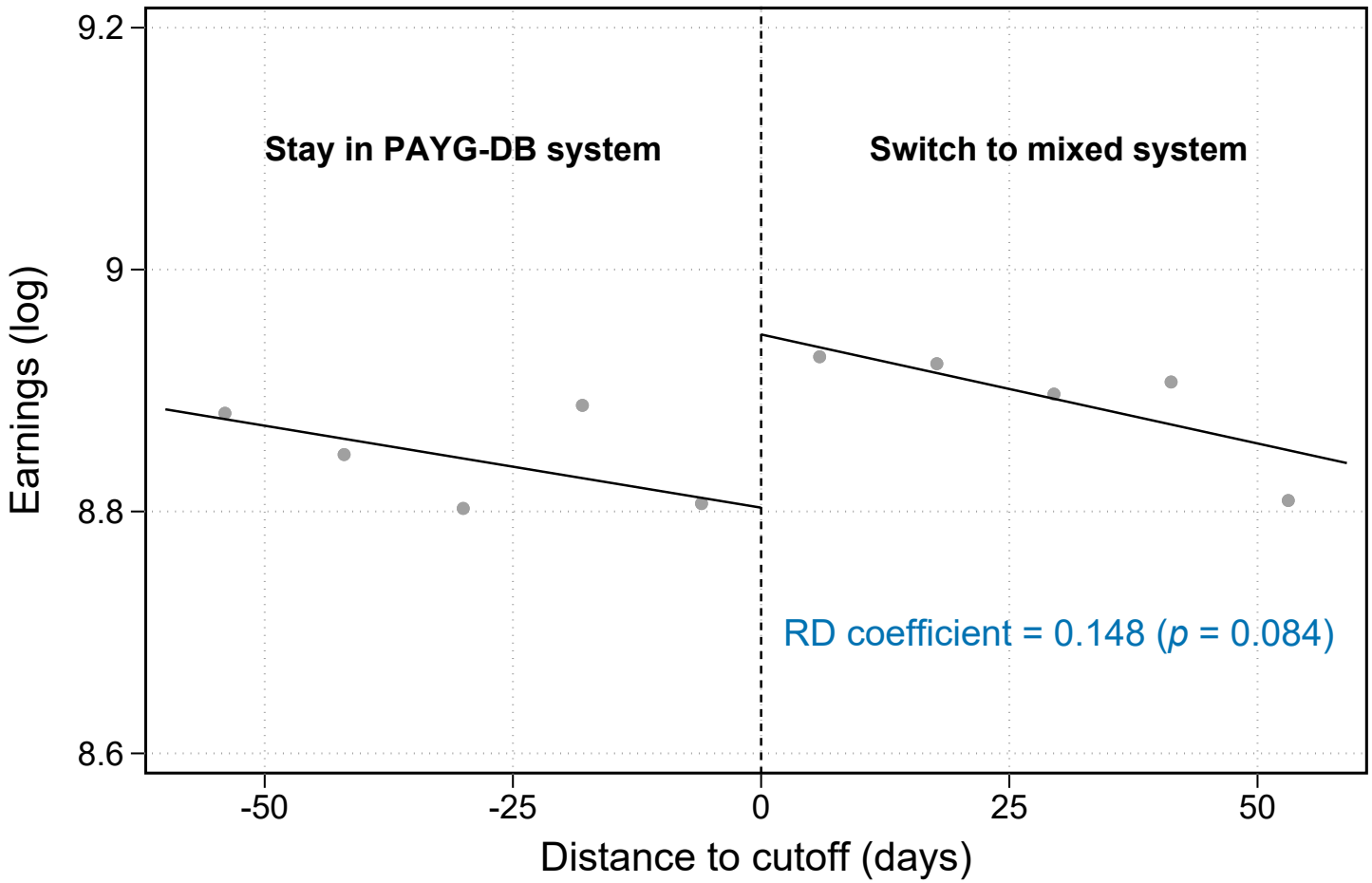

RD - Earnings

Long-term response: All years 1997 through 2013

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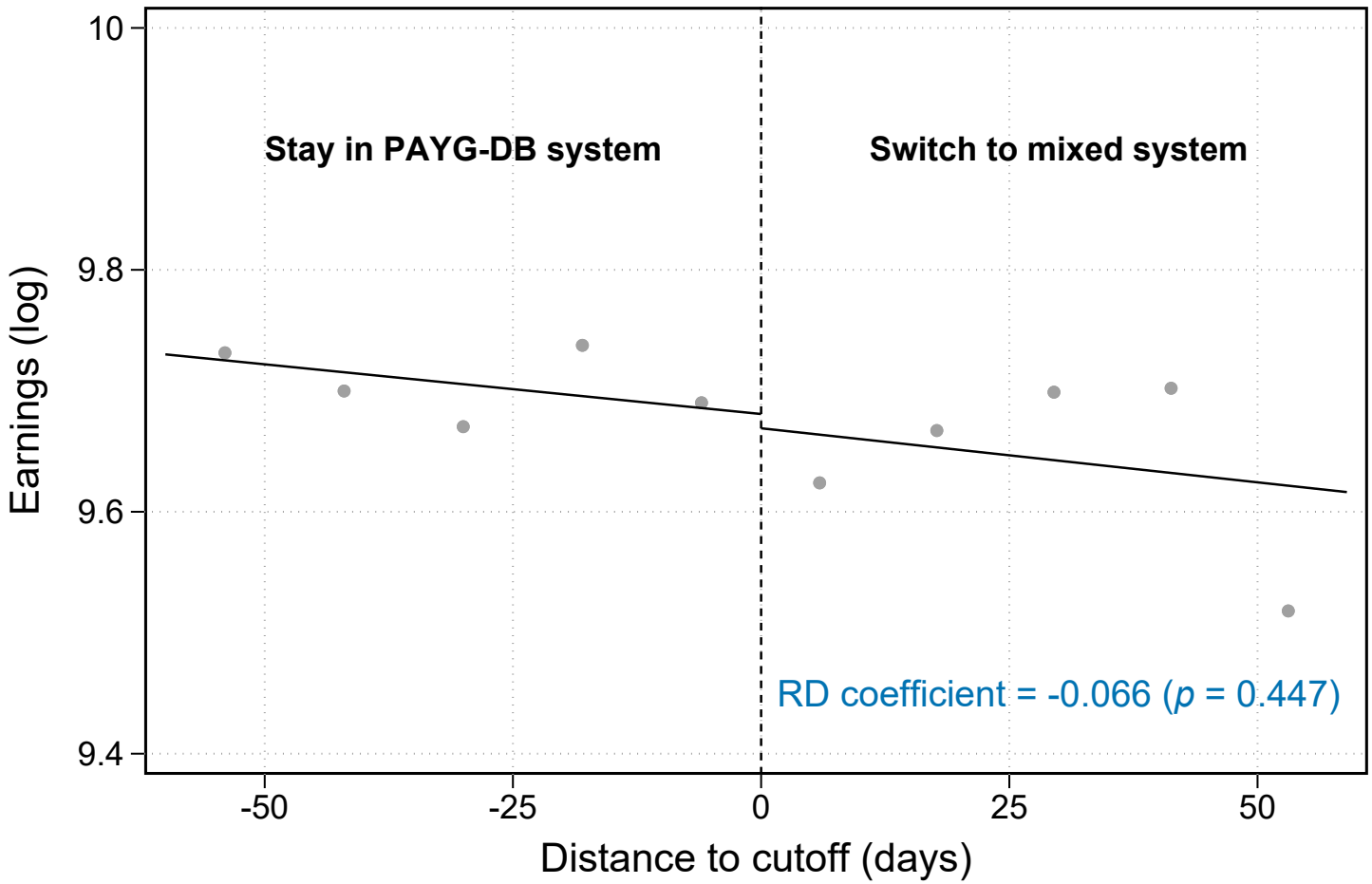
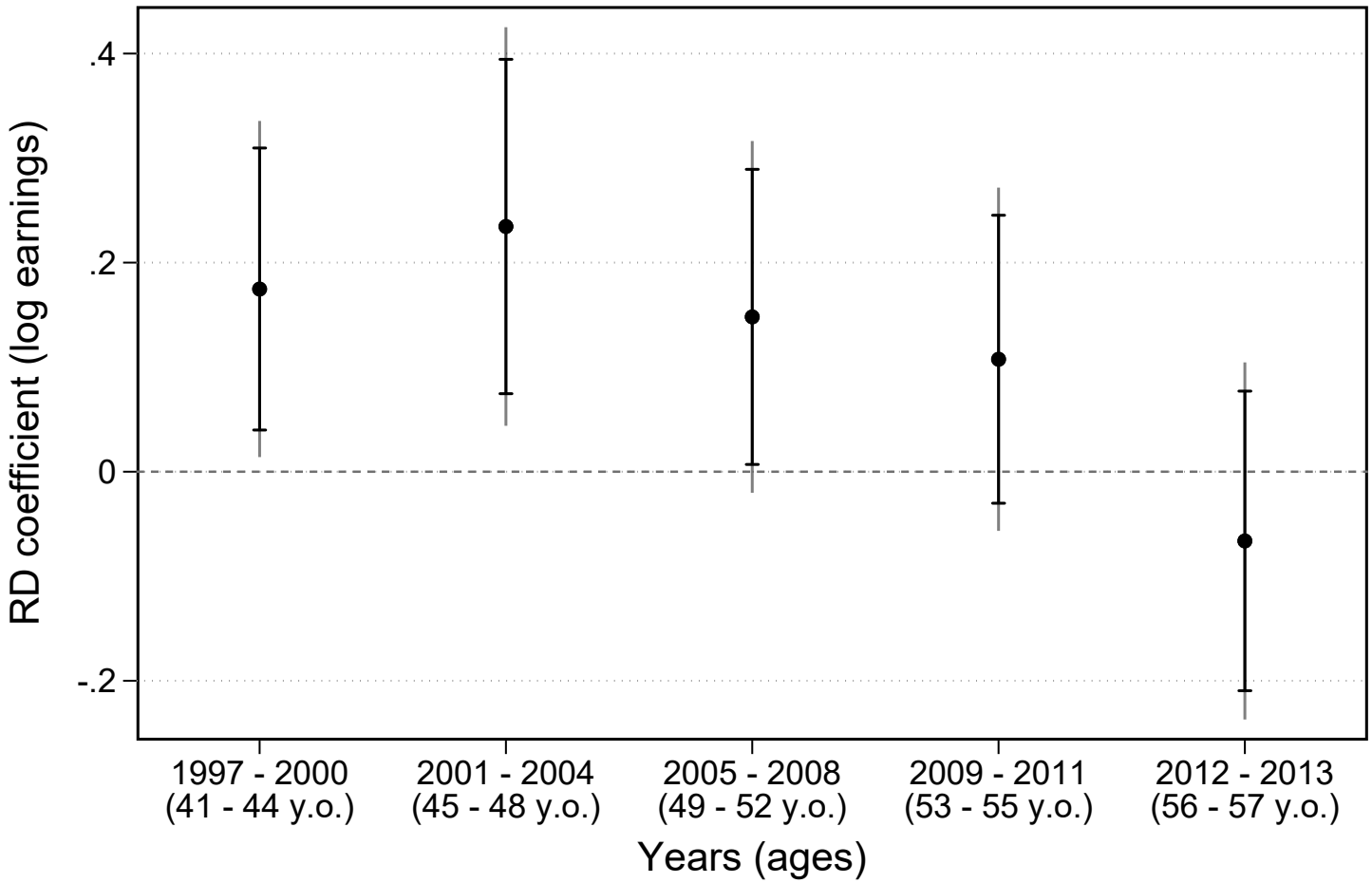


Time series plot of RD coefficients

Figure: RD time series (earnings)



Higher earnings for ret. accounts system early on, fades over time

All years 1997 through 2013 | Different specifications | Compared with placebos

So far on earnings responses:

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- Substantial effect on salaries early on that fades over time
  - Increase in early years consistent with model and intuition: capitalization creates more incentives to increase income early on (SS contributions are “pure tax” for PAYG-DB workers)

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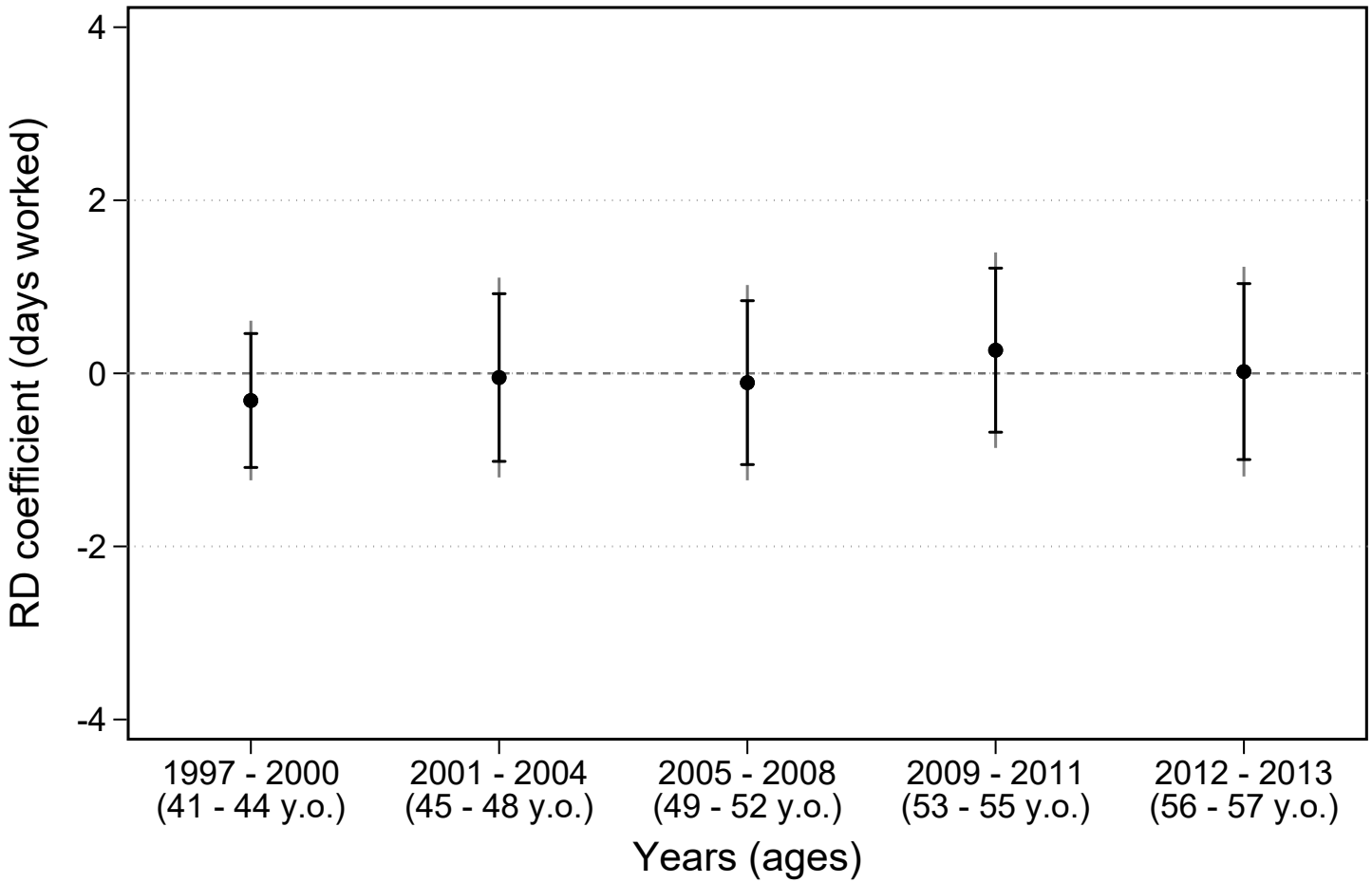
- **Next**: real labor supply response or tax evasion? Look at:
  - Days and hours worked (measures of real effort, imperfect but predictive of earnings Correlations)
  - Public-sector workers (where there's less underreporting Survey evidence)
  - Firm owners and self-employed (who can underreport more)
  - Sectors where informality and underreporting are more widespread

Time series plot (days worked)

Figure: RD time series (days worked)

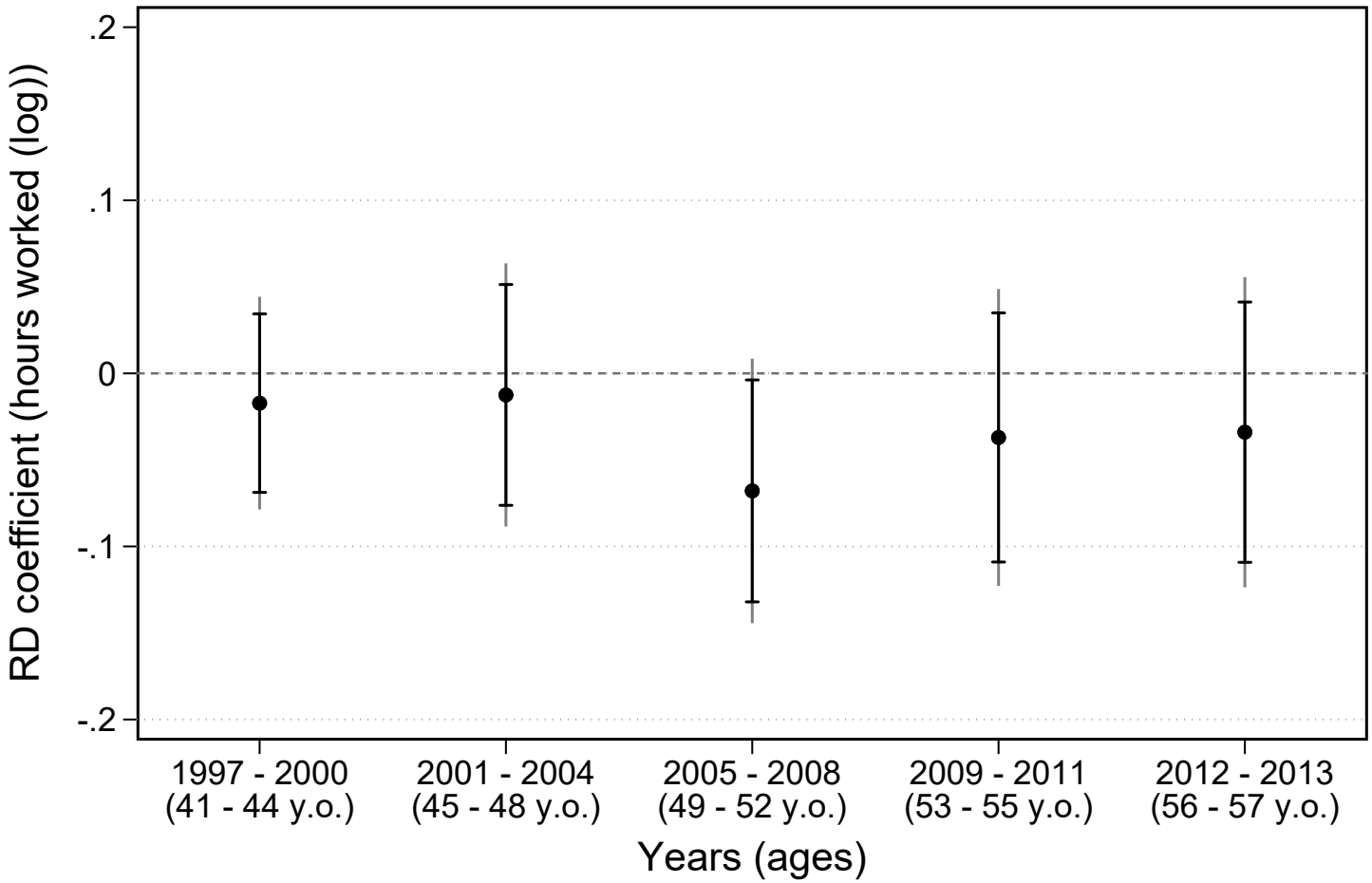


Effect not driven by days worked (suggesting real response less likely)

All plots Back

Time series plot (hours worked)

Figure: RD time series (hours worked)



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Time series plot (salary - public vs private)

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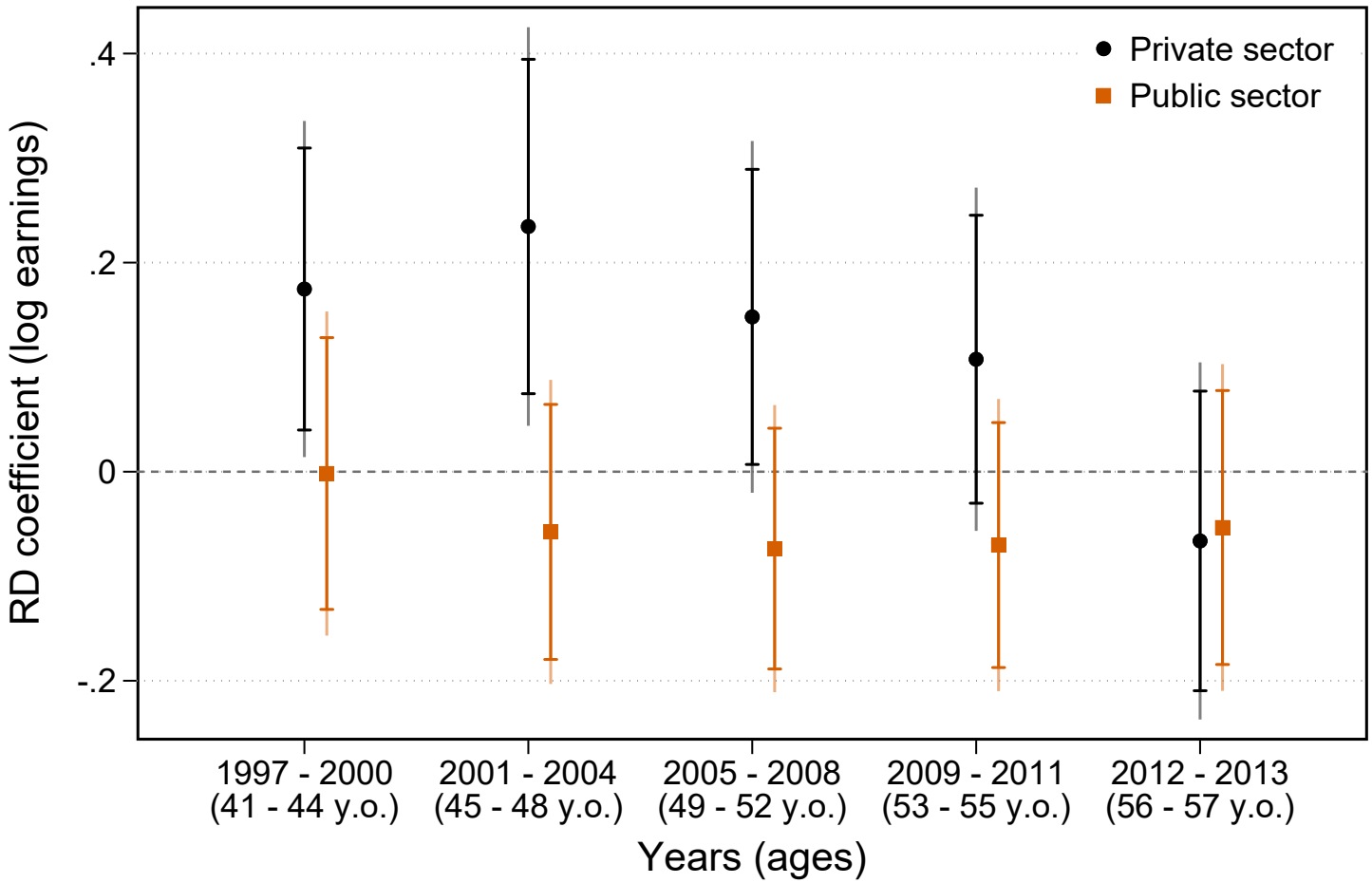
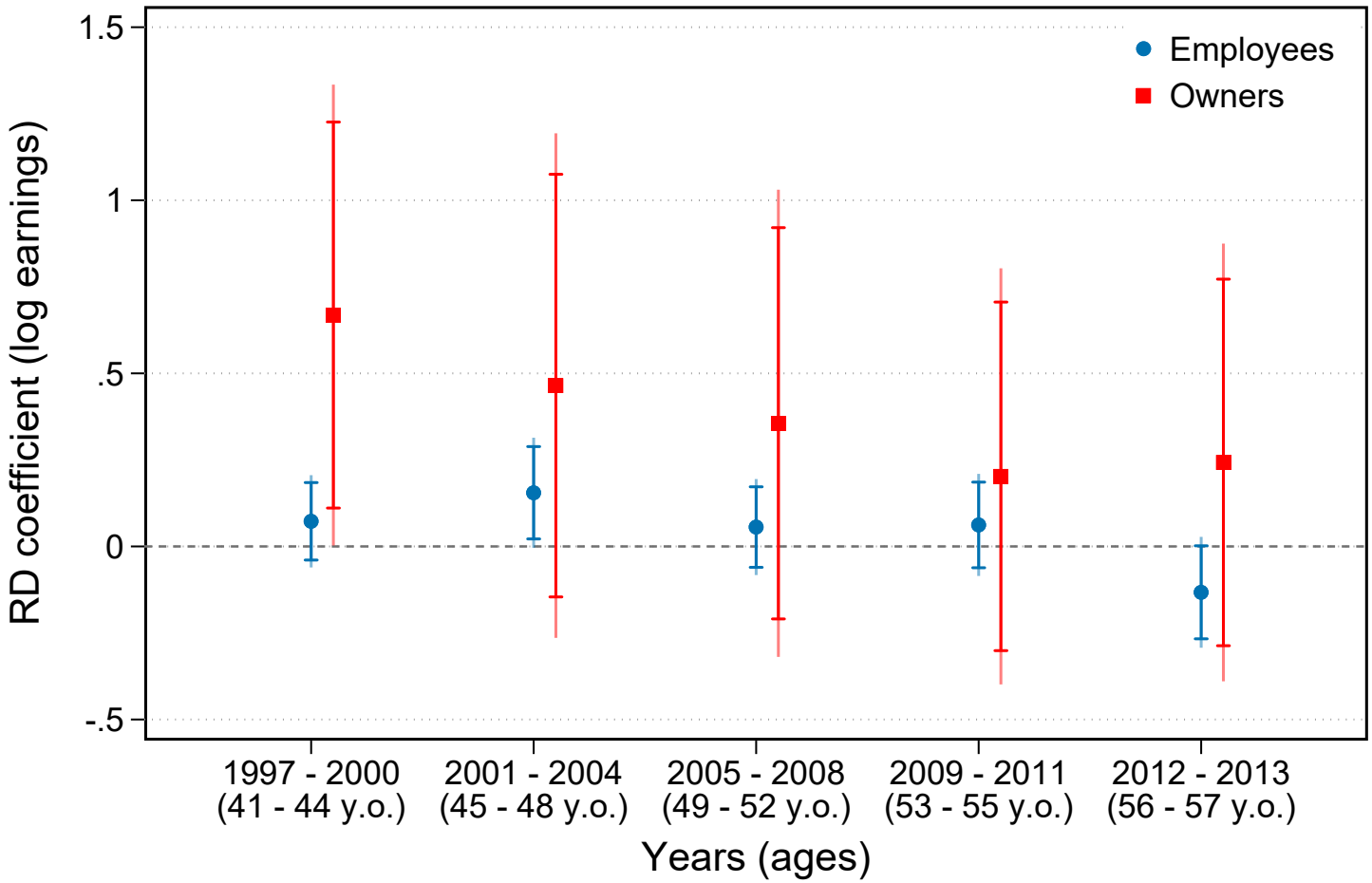


No effect for public-sector workers (where there's less underreporting) All plots

Time series plot (salary - owners vs employees)

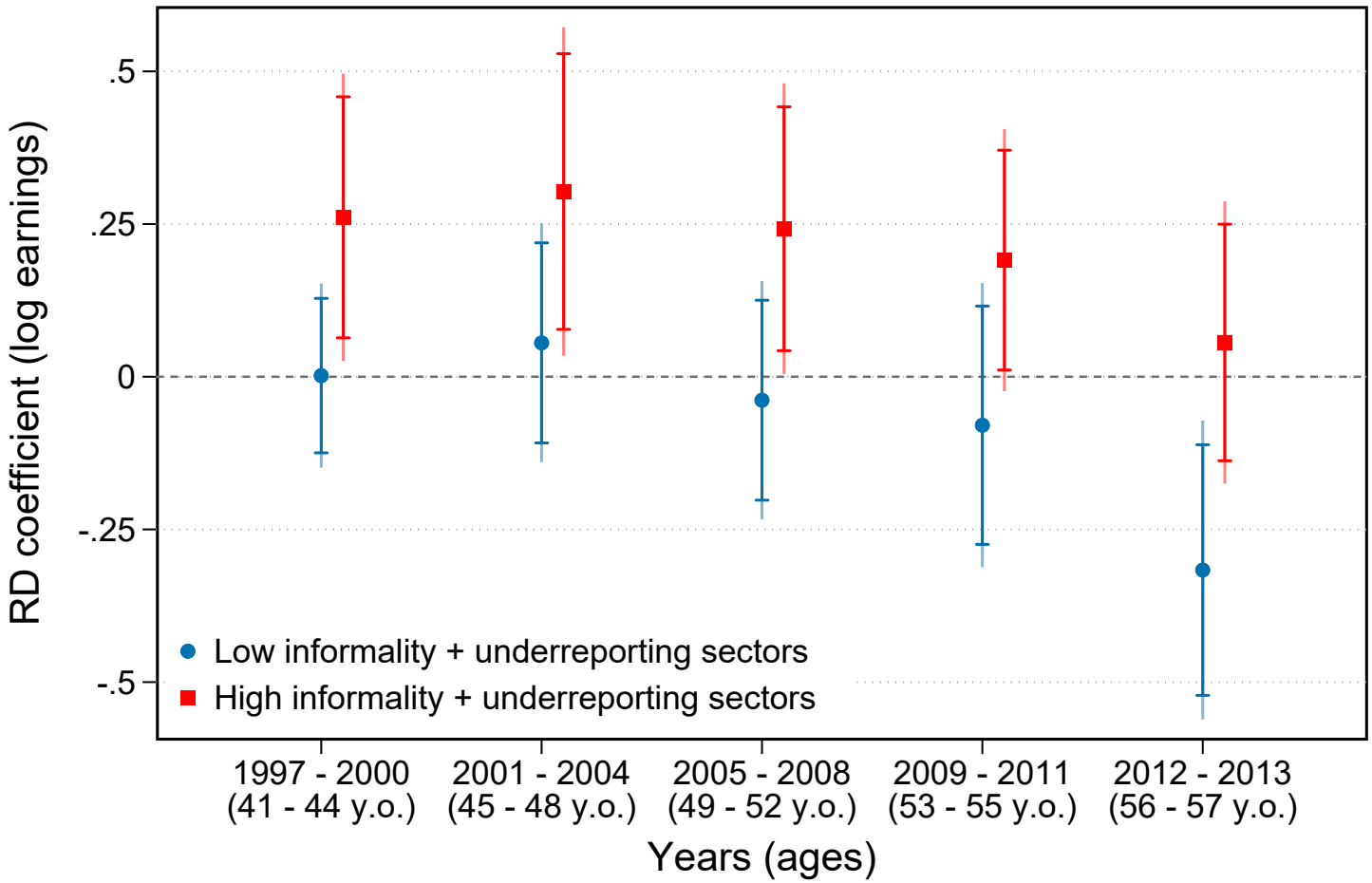
Figure: RD time series (salary - owners vs employees)



Substantially more effect for owners and self-employed (who underreport more) All plots

Time series plot (salary - sector informality)

Figure: RD time series (salary - sector informality)



Effect driven by sectors with high informality and underreporting

All plots | Informality by sector | Employees only

Takeaways on earnings responses

- Retirement accounts system induces a large increase in reported earnings that fades away over time
- Find compelling evidence that lower evasion drives it
- Why fade out?
  - PAYG-DB workers increasing their salaries as they reach their 10-year window (Dean et al., 2022)
  - Collective Bargaining re-introduced starting in 2005 (harder to set your own wage) (Mazzuchi, 2009)
  - Income underreporting goes down across the board starting around 2008 (prob a bit related to this reform, but also broader trend) Data
  - Non-random selection in who remains employed later on (lower SES and those with mild disabilities)

Takeaways on workers' responses

- Significant effect of privatization on workers' behavior
  - $\uparrow$ employment in old age ($\approx$ 4pp, concentrated among low wealth and disabilities)
  - $\uparrow$ earnings early on ($\approx$ 20%, seems $\downarrow$ tax evasion)
    - » Can use this to get some dimension of elasticities (with some assumptions) Detail
- Consistent with intuition and conventional models
  - (although mechanism on earnings seems to be mostly tax evasion) Jump to end

Robustness checks

- Manipulation of running variable? (those born after cutoff changing to born before)
  - No, DOB non-manipulable Manipulation test
- Cutoff set at special date? (very different people left on each side?) (e.g. Buckles and Hungerman, 2013)
  - No, discontinuity introduced for first time ever in the 1996 SS reform (Forteza and Rossi, 2018) and no overlap with other cutoffs
  - No pre-reform data, but placebos with those born in year before/after show no such patterns Placebos
  - Census observables balanced around cutoff Census balance
- Specific window? No, robust to other windows Other windows
- Significance due to random discontinuities? Unlikely, arbitrary placebo cutoffs show no such patterns Additional placebos Jump to end

Outline

Income in old age

- So far we've seen workers' responses to privatization while active (40s and 50s)
  - Significant responses: higher earnings when young, more likely to be employed later on
- What about income in old age? $\rightarrow$ challenging analysis:
  - Ideally more time would pass (people are 66 now) and more data
  - Compensation policies since 2014, particularly reversals in 2017, can confound effects
  - Different labor supply across groups

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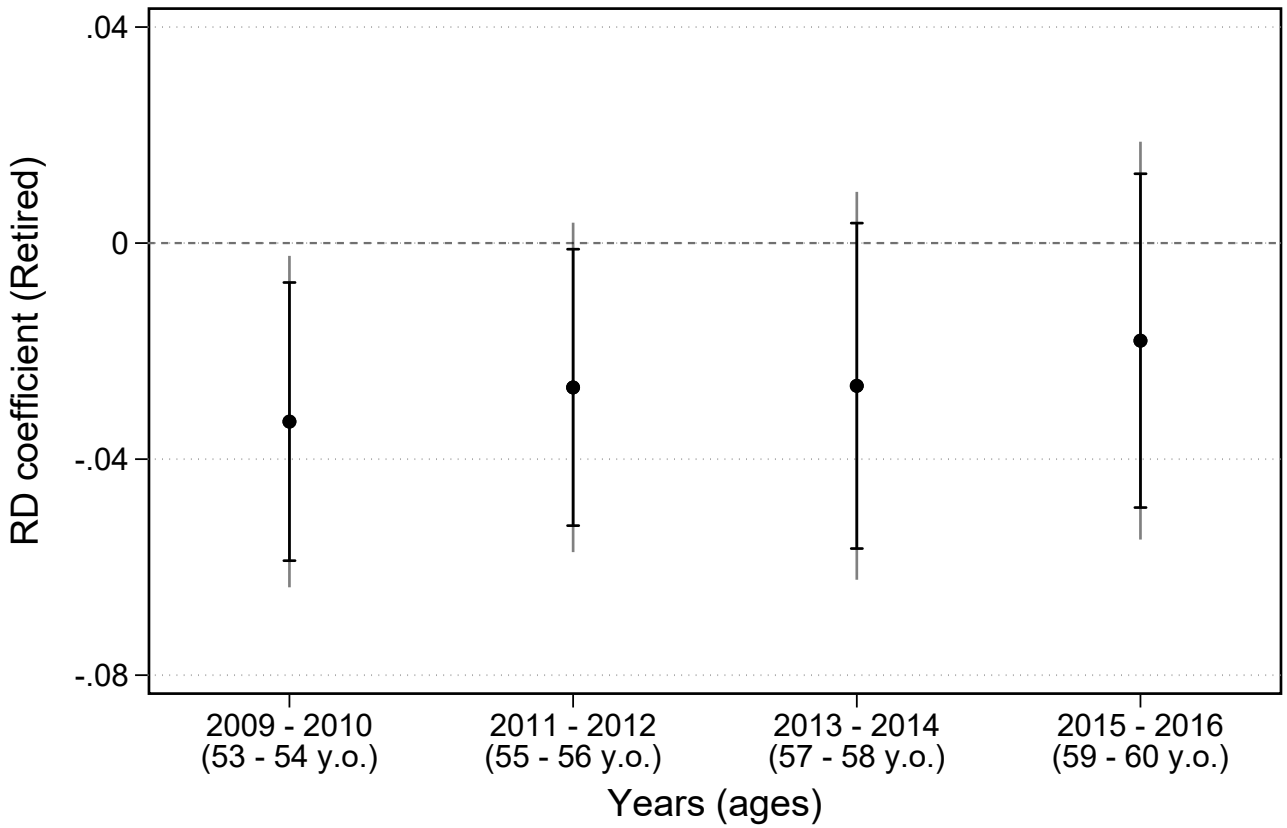
  - Compensation policies since 2014, particularly reversals in 2017, can confound effects
  - Different labor supply across groups
- **Now**: Analysis of income in old age until year 2016 (pension + earnings, prior to reversals, until 60 years)
  - Ultimately, how much money do people have around early retirement ages? (includes differences in labor supply and pension income)

Time series plot of RD coefficients

Figure: RD time series - Retired

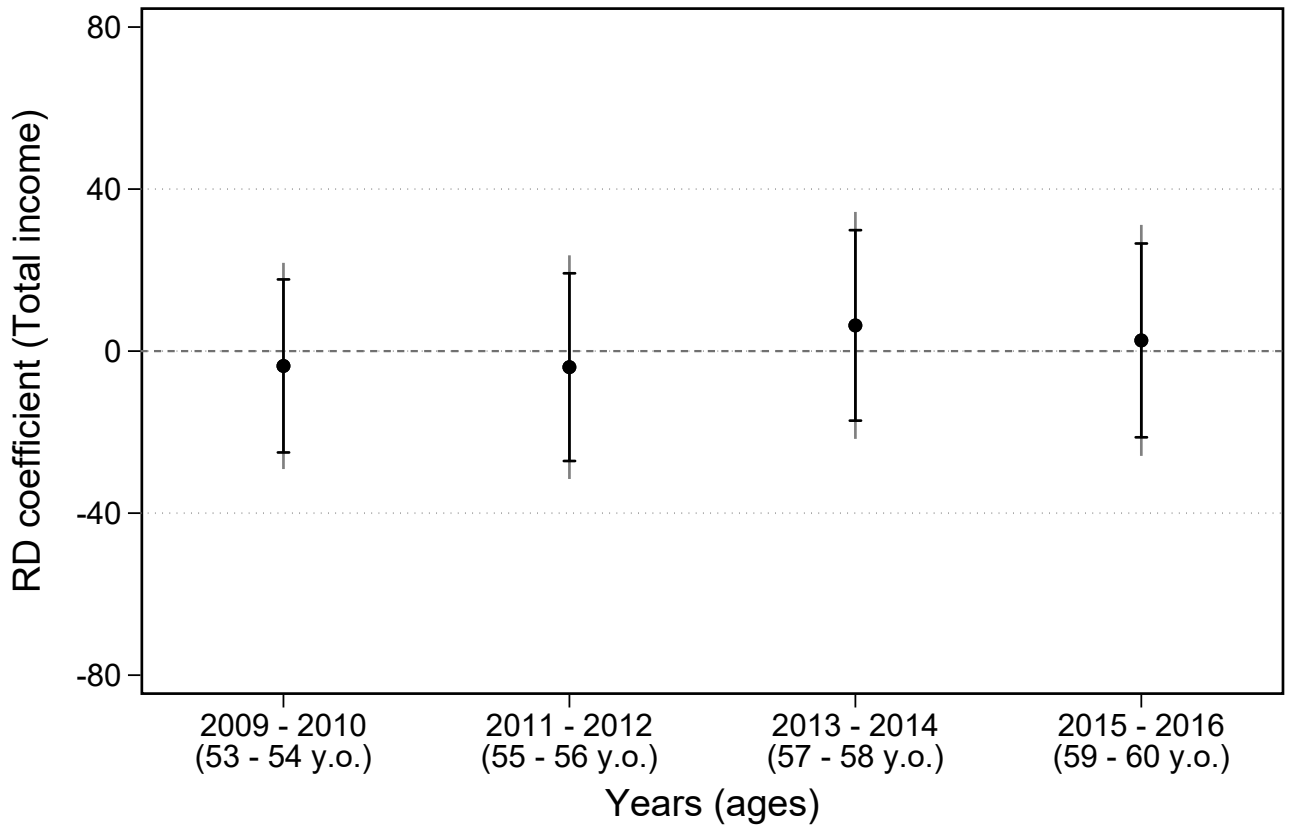


- Retirement rates are more similar by 2016 2016 plot

Compared with placebos | Different specifications | All years plots

Time series plot of RD coefficients

Figure: RD time series - Pension + earnings

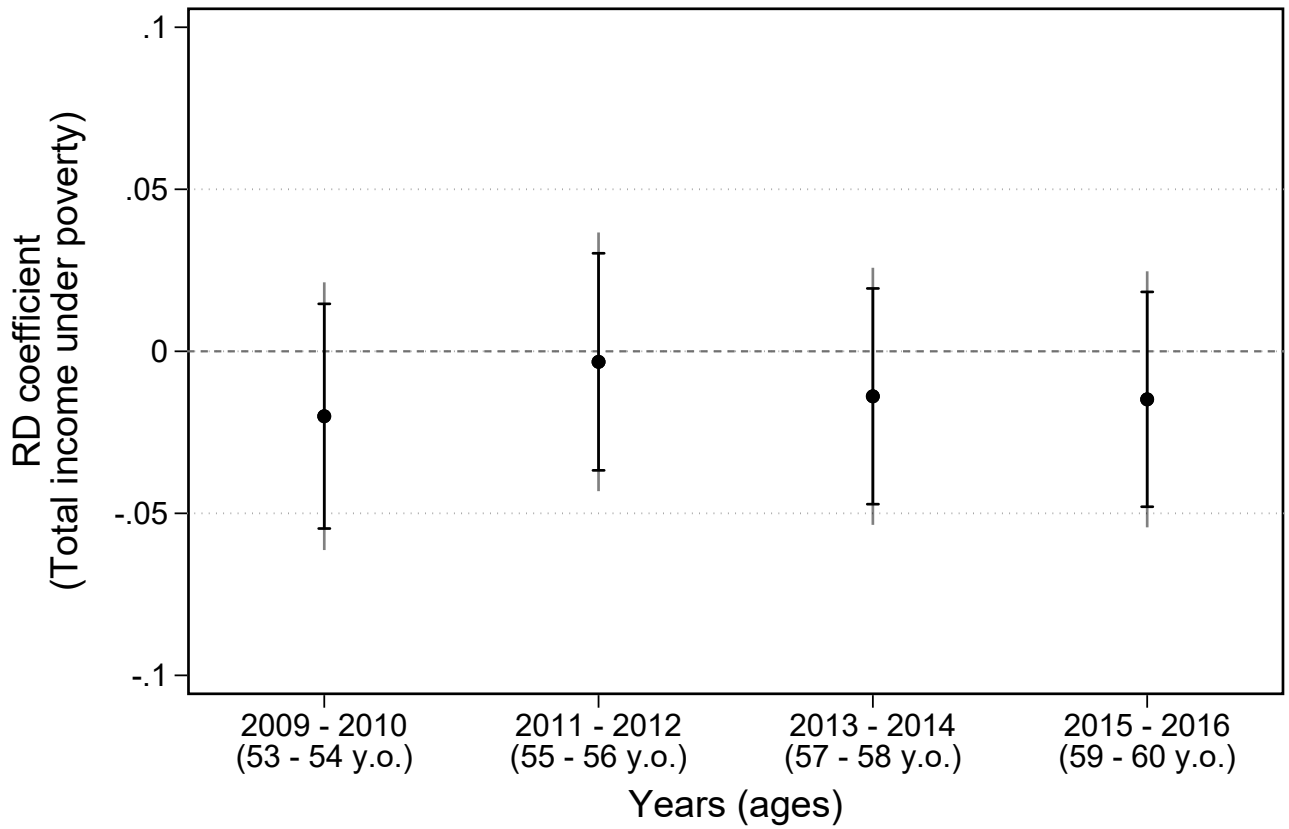


- No significant differences in total income in old age

Compared with placebos | Different specifications | All years plots

RD time series

Figure: RD time series - pension + earnings under poverty



- No significant differences in being below poverty line

Compared with placebos | Different specifications | All years plots

Takeaways from income in old age

- Little differences on income in old age for first few years of potential retirement
  - Pension + earnings combines effects of employment responses and potential effects on pension income
  - Similar result if we look at pensions only (conditional on being retired) Figures
- Although retirement rates are more similar by 2016, potential labor supply differences:
  - Maybe reform losers keep on postponing retirement and winners are able to retire earlier
- No stark patterns that lead to strong conclusions
- **Next:** study reversal option in 2017 to see "revealed preference" for PAYG-DB system Jump to main figure

Reversals

- Minor law in 2014 (not super interesting for analysis)
- **Law in 2017** allowed for reversals for those assigned new system
  - Only for people aged 50 or more by April 1st 2016 (so born up until April 1st 1966) $\longrightarrow$ the "Fifty-Somethings" Law
  - Part of wave of reversals in Latin America

Reversals

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- **Law in 2017** allowed for reversals for those assigned new system
  - Only for people aged 50 or more by April 1st 2016 (so born up until April 1st 1966) $\longrightarrow$ the "Fifty-Somethings" Law
  - Part of wave of reversals in Latin America
- Information campaign to encourage people to analyze their situation
  - Consultation with SSA to estimate pension benefits under each regime
  - Can choose to remain in mixed system or choose old system at 90% of benefits, decision is definitive
  - Even allowed people who had already retired under mixed system to reverse
    - » If choose to reverse, it's as if they had never had a ret. account (transfer fund to govt. and get unfunded DB pension only)

Salience

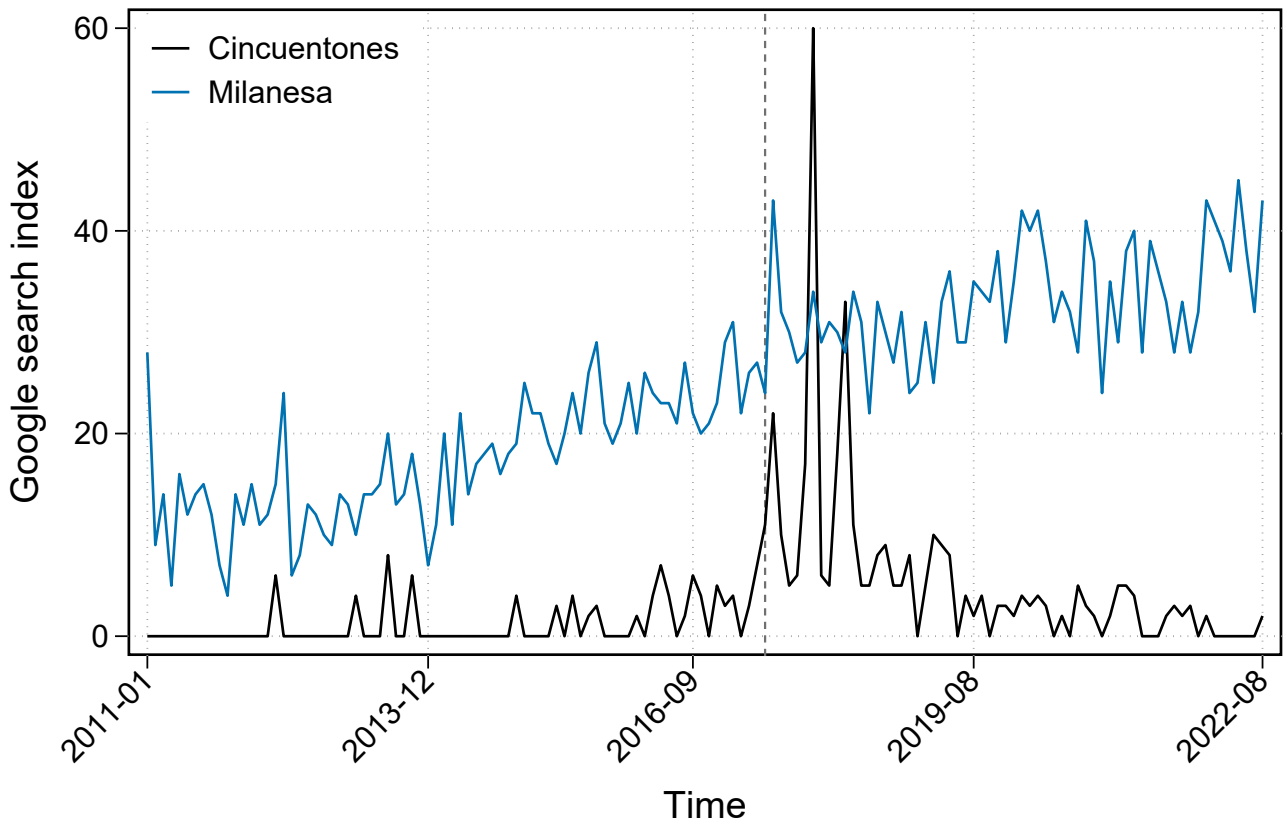
Covered in the news

Figure: News coverage

Salience

Highly salient

Figure: Google trends - “Cincuentones” and “Milanesa”

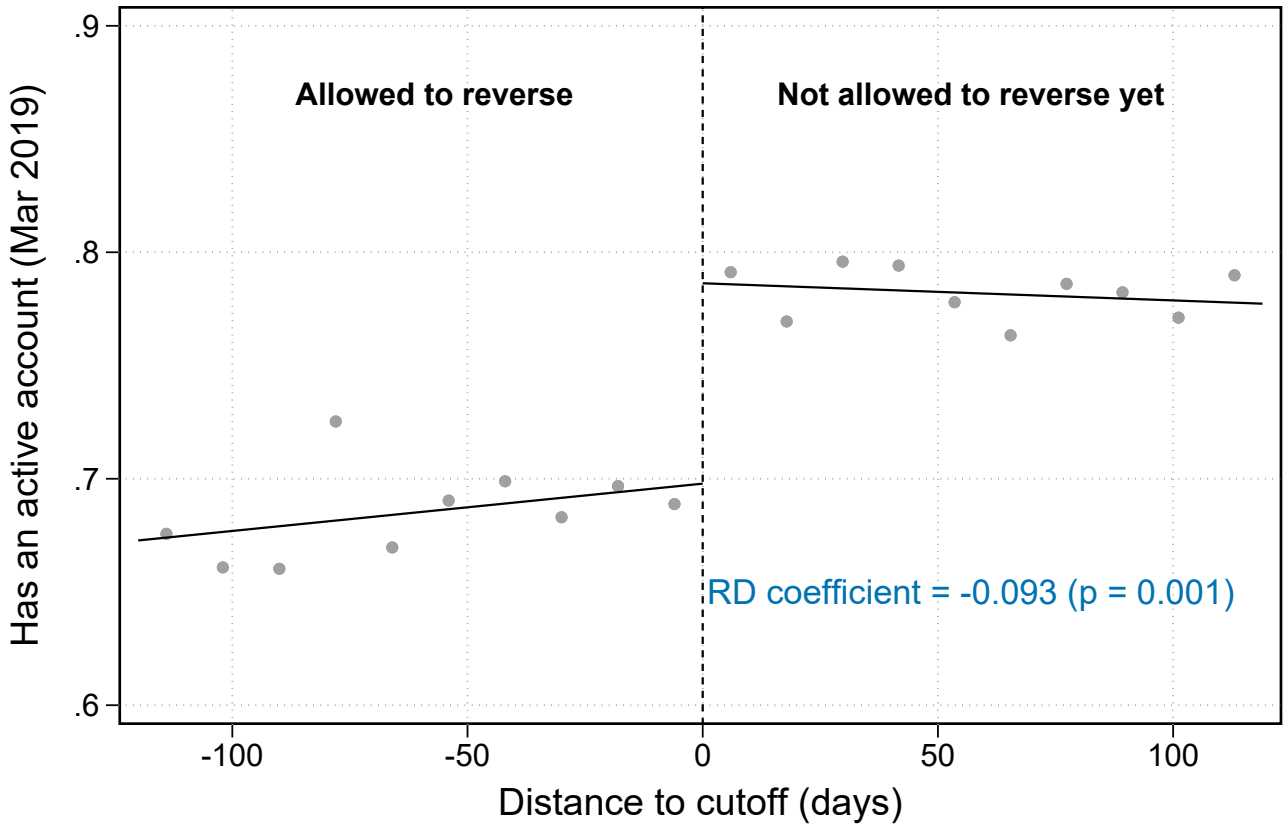


Gradual roll-out

- Gradually rolled out:
  - **Aged 56 or more by April 1st 2016 would go first (born in 1960)**
    - » Have between March 2018 to March 2019 to schedule consultation and choose whether to reverse or not
  - Then those aged 53 to 55, then 50 to 52
- Have data for 1960 cohort (not merged to labor market data)
  - RDD to look at whether they stayed in mixed system or not
    - » Do they have an active account by Mar 2019? (account is closed after deaffiliation)
    - » Careful with default effects (e.g. Madrian and Shea, 2001; Carroll et al., 2009)

Active by Mar 2019

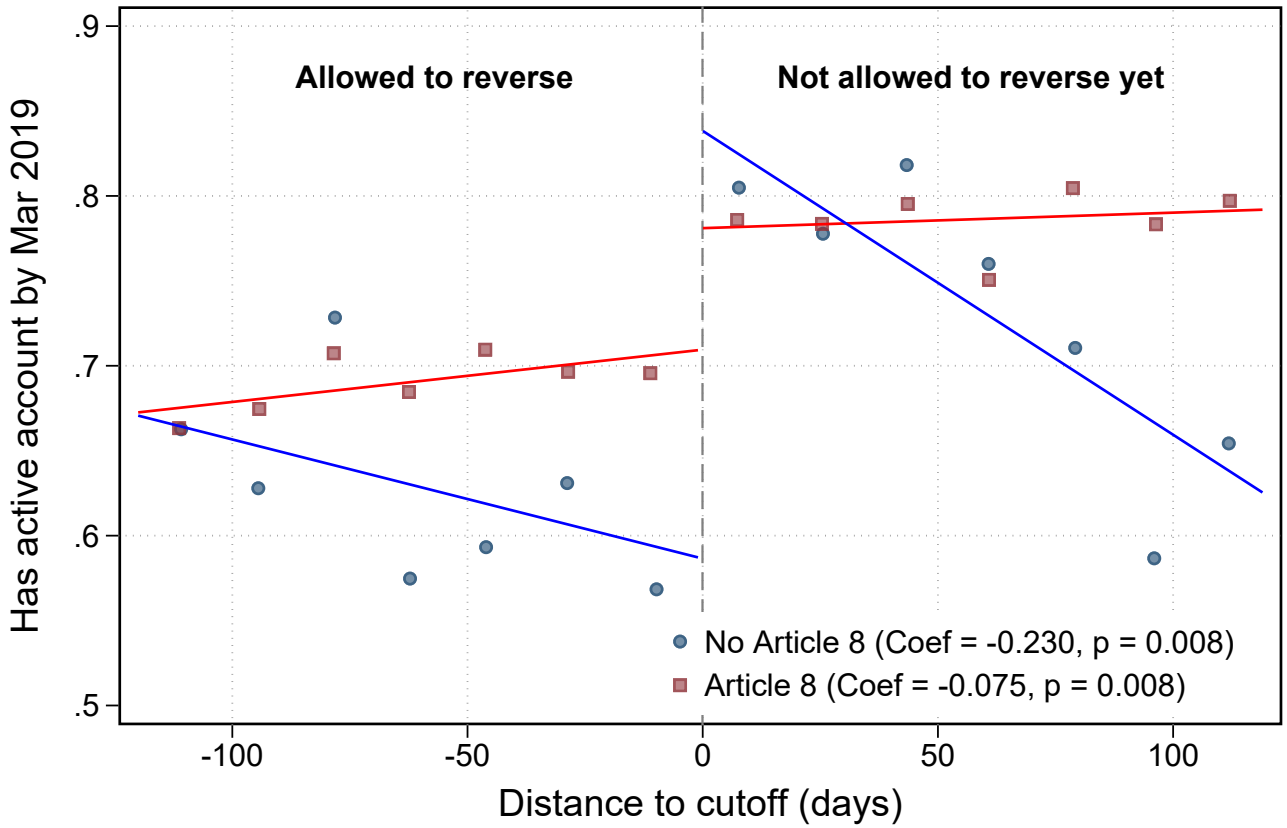
Figure: RD plot - Active by Mar 2019



- Significantly less likely to have an active account (10pp) if allowed to reverse, although the majority stay Jump to takeaways

Active by Mar 2019 (het Art 8)

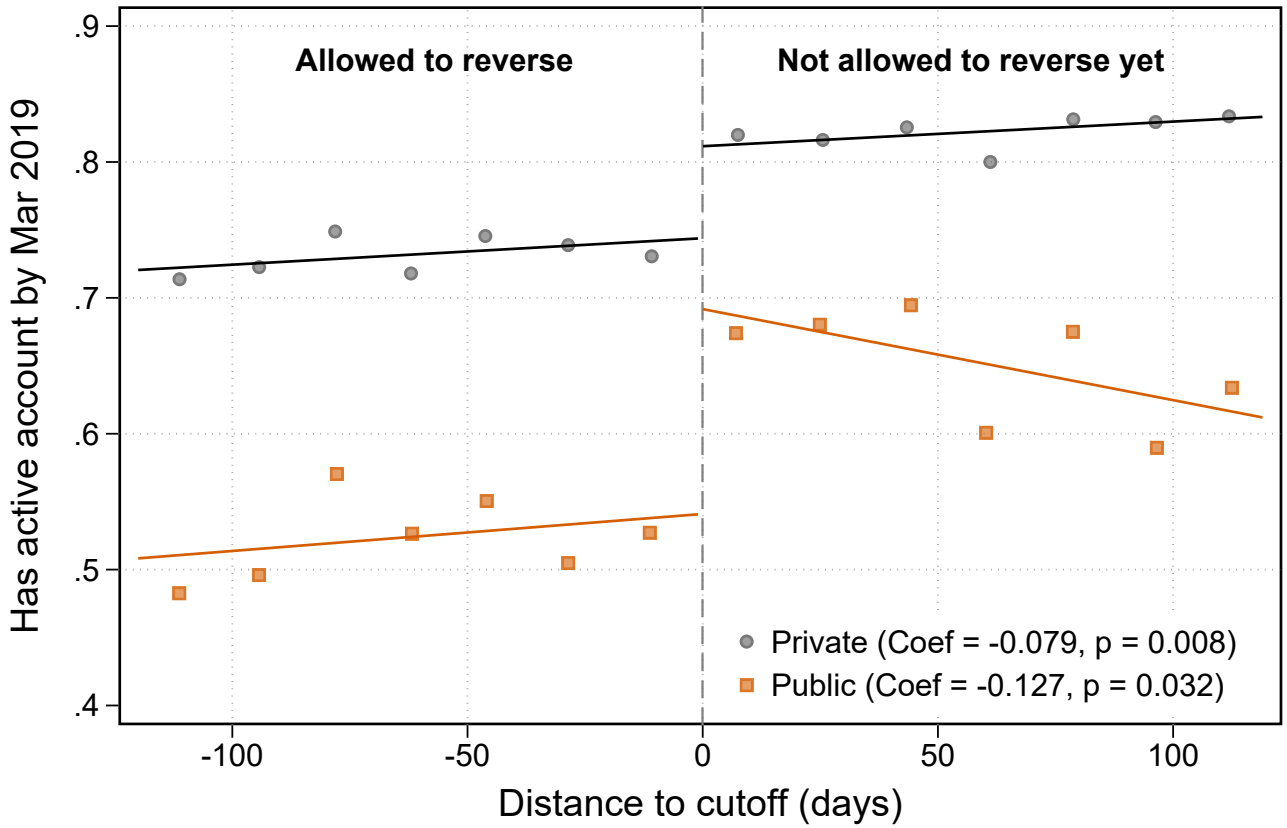
Figure: RD plot - Active by Mar 2019 (heterogeneity by Art 8)



- Much more reversal among those that did not choose profitable Article 8 (reasonable) Reminder on Article 8 Year of adoption

Active by Mar 2019 (het public)

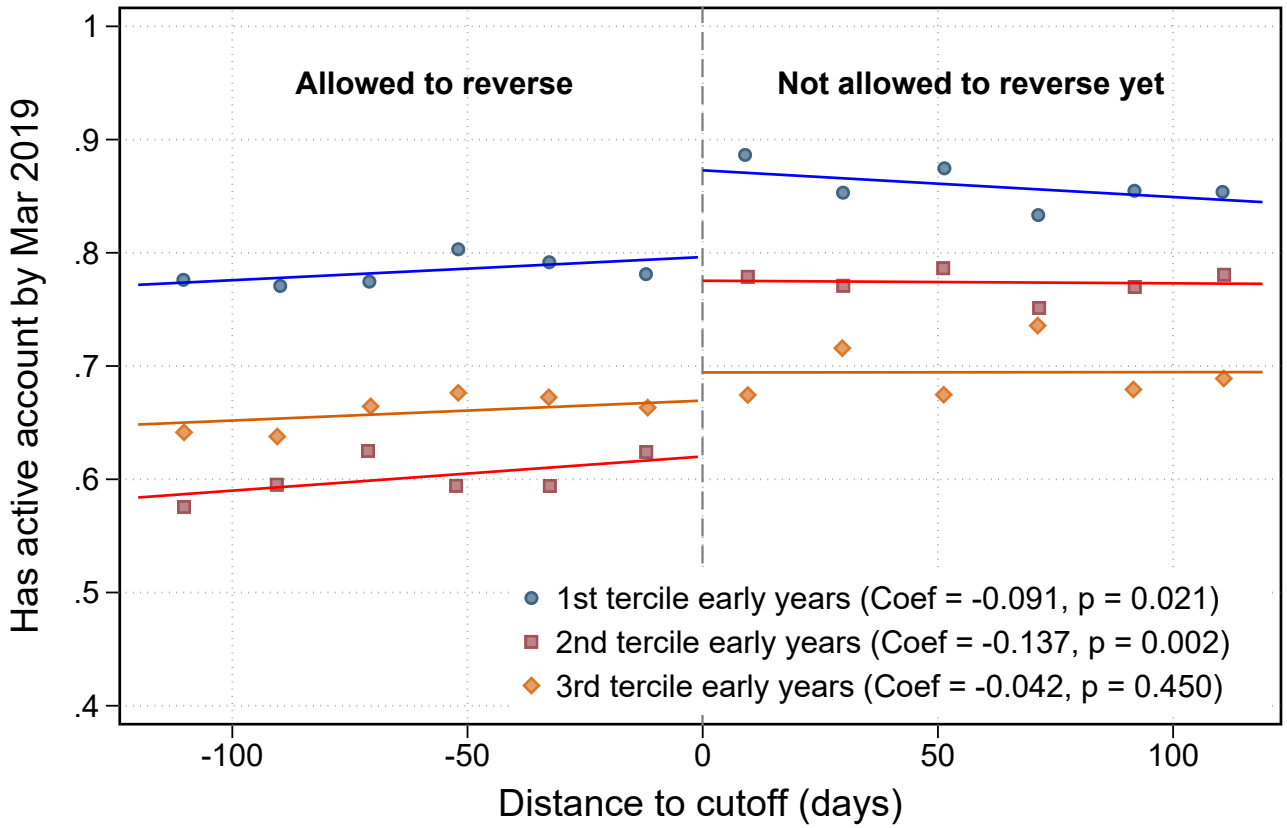
Figure: RD plot - Active by Mar 2019 (heterogeneity by public vs private)



- More reversal for those in the public sector (steeper earnings profile $\rightarrow$ DB better than DC) Earnings profiles

Active by Mar 2019 (het good years)

Figure: RD plot - Active by Mar 2019 (heterogeneity by good years)



- More reversal for workers who contributed less during the early years with good interest rates Returns of system over time

Reversal

- Although majority stay, significant reversal (something like 13%)
  - Anecdotally, in policy discussions the reversal law induced little reversal relative to gov expectation
- Driven by:
  - Those who did not chose profitable Article 8 option

    Reminder on Article 8 | Year of adoption
  - Those who contributed less in the early good interest rate years
  - Those employed in public sector (steeper earnings profile and less margin for response $\rightarrow$ DB formula way better than funded DC)

Takeaways from income in old age

- Similar income and poverty rates in old age
  - But differences in labor supply (despite convergence in retirement rates)
- Significant opt-in for reversal option
  - Those who do not choose profitable options within private system
  - Those who contributed less during the early good-interest years
  - Those for whom DB formulas are better than savings (steep earnings profiles and less margin for response)

Robustness checks

- Manipulation of running variable? (those born after cutoff changing to born before)
  - No, DOB non-manipulable Manipulation test
- Cutoff set at special date? (very different people left on each side?) (e.g. Buckles and Hungerman, 2013)
  - No, discontinuity introduced for first time ever in the 1996 SS reform (Forteza and Rossi, 2018) and no overlap with other cutoffs
  - No pre-reform data, but placebos with those born in year before/after show no such patterns Placebos
  - Census observables balanced around cutoff Census balance
- Specific window? No, robust to other windows Other windows

Outline

Conclusion

- We study effects of partial privatization of the pension system
  - Leverage cohort-based discontinuity in Uruguay

1. Document significant responses in workers' trajectories
   - $\uparrow$ employment in old age ($\approx$ 4pp, concentrated among low wealth and disabilities)
   - $\uparrow$ earnings early on ($\approx$ 20%, seems $\downarrow$ tax evasion)

   $\rightarrow$ Probably positive things, but with caveats
   - » Alleviate distortions of DB and improve sustainability
2. Similar incomes and poverty rates in old age, but labor supply differences and opt-in for reversal
   - Did not choose profitable alternative option, earnings profile favors DB, or contributed less in good early years

   $\rightarrow$ Losers depending on choices and career profiles
   - » Can explain some of the recent push for de-privatizations

Thank you!

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Countries that have privatized

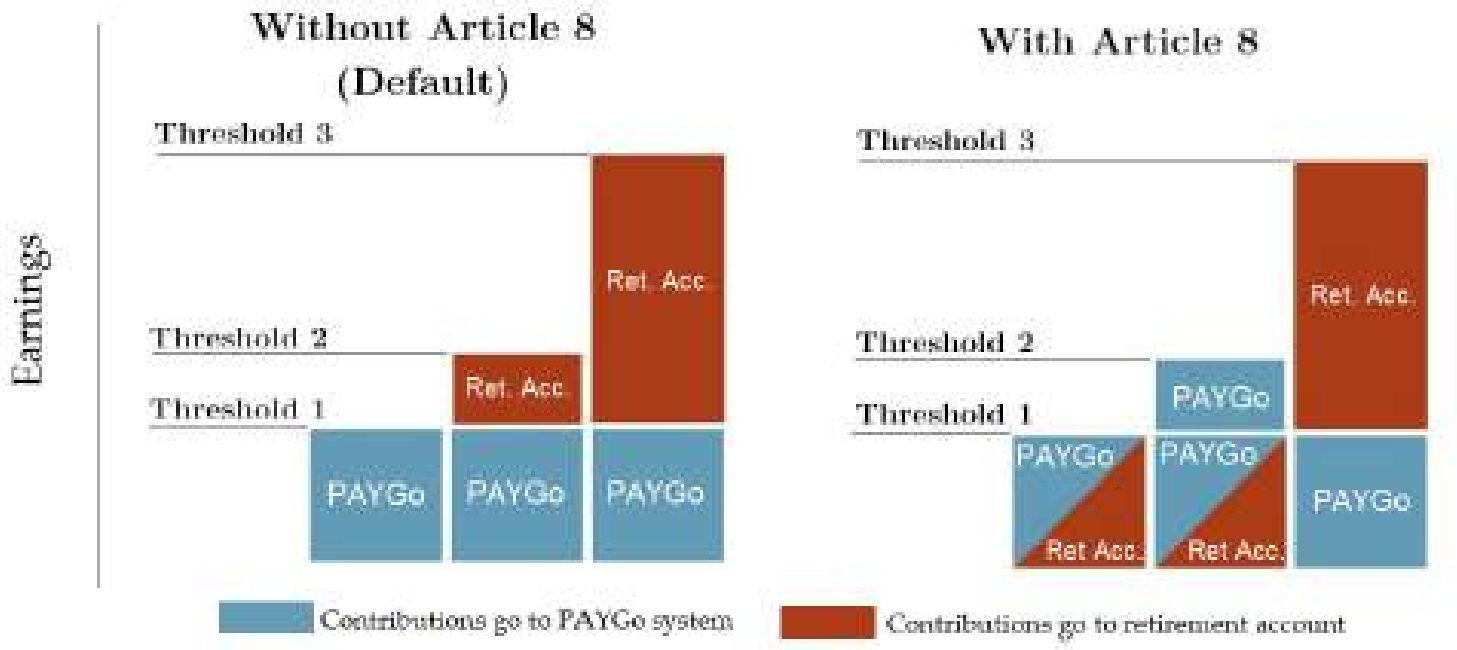
Country	Year of privatization	GDP per capita rank 2022
Chile	1981	63
United Kingdom	1986	25
Malaysia	1991	67
Peru	1993	94
Argentina	1994	72
Colombia	1994	97
Sweden	1994	12
Uruguay	1996	56
Bolivia	1997	136
Mexico	1997	78
Hungary	1998	50
Kazakhstan	1998	80
El Salvador	1998	117
Denmark	1999	10
Poland	1999	54
Costa Rica	2001	70
Germany	2001	19
Dominican Republic	2001	77
Estonia	2001	42
Kosovo	2001	107
Latvia	2001	48
Nicaragua	2001	144
Bulgaria	2002	68
Croatia	2002	59
Lithuania	2002	44
Macedonia	2002	96
Russia	2002	69
Slovakia	2003	47
Nigeria	2004	146
India	2004	142
Romania	2004	55
Taiwan	2004	31
Uzbekistan	2004	154
Czech Republic	2011	43
Malawi	2011	190

Source: (Orenstein, 2013), own data, and IMF.

Back

Detail of new system

Figure: Options in mixed system



- With Article 8, divide contributions evenly between PAYG and retirement account below Threshold 1 (rate is still 15%)
- The salary for pension calculation drops by 25% (not 50%!)

Back to reform Back to reversals

Account summary example

Figure: Account summary example

Back

More on reform and pension wealth

- Pension reforms are complex and can affect behavior in many ways: incentives (of course), but also what happens to pension wealth?
- Capitalization makes pensions “riskier” to a degree: calculations are tricky and depend on variables unknown at the time (e.g. interest rates)

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  - Have to differentiate: (i) what people expected at the time and (ii) what ended up happening after uncertainty is resolved

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  - Have to differentiate: (i) what people expected at the time and (ii) what ended up happening after uncertainty is resolved
  - Initially, pensions were expected to be somewhat similar, maybe a bit better (new system not seen as "cut" in pensions)
  - At the end of the day, as retirement approached, there was heterogeneity:
    - Given similar labor trajectories: lower income people weakly better, higher income people worse off (Forteza and Rossi, 2018)

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  - At the end of the day, as retirement approached, there was heterogeneity:
    - Given similar labor trajectories: lower income people weakly better, higher income people worse off (Forteza and Rossi, 2018)
    - But labor trajectories were not the same, people responded to reform...
- So... what happened to pension wealth? It's complicated Back

Detail of parameters

DB part calculated over “salary for pension calculation”

- Average of last 10 years of earnings
  - For those in the PAYG-DB only system, covers the whole salary
  - For those in the mixed system, capped at threshold 1
    - If they choose Article 8, then the “salary for pension calculation” drops by 25% (not by 50%, it’s subsidized), phased out until threshold 2

Statutory replacement rate of DB part typically between 50% and 70%, applied to the “salary for pension calculation”

- Same for both systems, increases with retirement age and years of contributions

DC part calculated as annuity based on the amount accumulated and actuarial calculations of time to live in retirement

- Funds transferred to government-run insurance company that does the calculations and disbursement

Back

Simulations (employment)

- Building upon existing simulations (Forteza and Rossi, 2018), can calculate strength of incentive to postpone retirement in each system (with some assumptions)
  - (assume standard values of interest rates, labor histories, etc)
- In the DB system, adjustments to replacement rate typically in the order of 0.5 to 1pp

  $\rightarrow$ Limited incentive to remain employed
- In mixed system, substantial increases in annuity from postponing retirement
  - Depends on parameters, but increases of about 4 to 10 percent or more from an additional year of employment

  $\rightarrow$ Huge incentive to remain employed (more similar to US) Back

Simulations (earnings reporting)

- Building upon existing simulations (Forteza and Rossi, 2018), can calculate costs of concealing earnings in each system (with some assumptions)
  - (assume standard values of interest rates, labor histories, etc)
- In the DB system, only last 10 years of earnings matter
  - → Huge incentive to conceal earnings when young
- In mixed system, substantial permanent drop in pension income from tax evasion when young
  - Depends on parameters, but reductions of 3 to 6 percent from hiding 20% of earnings prior to 10-year window for DB calculation
  - → Strong incentive to evade less Back

Set up

- Workers choose a concealing trajectory $\theta(t)$ and retirement age R to maximize

$$U = \int_0^T c(t)dt - \int_0^R \sigma(\theta(t))dt - V(R)$$

- Subject to lifetime budget constraint:

$$\int_0^T c(t)dt = \int_0^R (1-\tau)w(1-\theta(t))dt + \int_0^R w\theta(t)dt + \int_R^T Bdt$$

- Retirement pension B depends on the system
- (Set-up assumes full consumption smoothing, linear utility of consumption, no dynamic uncertainty, zero interest rate, no time discounting)

Pension benefits

- The pension B depends on the system the worker is in
- In PAYG-DB:

$$B = \rho^{DB} \frac{1}{L} \int_{R-L}^{R} w(1 - \theta(t))dt$$

  - (benefits = some replacement rate ρ over reported earnings in window L of years pre-retirement, in Uruguay $L = 10$)

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- In mixed system:

$$B = \rho^{M} \frac{1}{L} \int_{R-L}^{R} w(1 - \theta(t))dt + \frac{1}{T-R} \int_{0}^{R} \gamma\tau w(1 - \theta(t))dt$$

  - (benefits = a DB part $+$ accumulated funds based on proportion γ of contributions τ that goes to account)

Assume constant ρ because real formula adjustment is low

Versions of the model

- For simplicity in exposition and to build intuition, solve 2 special cases of the model
  1. Choice of retirement age given no concealing of earnings
     - » To understand the incentives for retirement postponing in each system
  2. Choice of concealing trajectories given a retirement age
     - » To understand incentives for concealing earnings under each system
  3. **(Not today)** Choice of both retirement age and concealing of earnings
     - » A bit more complicated, prob not worth discussing in length here (derivations in the paper)
     - » At the end of the day, with reasonable assumptions intuitions are similar to the combination of two previous simple cases

With no concealing of earnings

- Choose retirement age R given $\theta(t) = 0$ for all t
- Optimality conditions for each system ($V(R)$ convex):

$$V'(R^{DB}) = w(1 - \tau - \rho^{DB})$$
$$V'(R^{M}) = w(1 - (1 - \gamma)\tau - \rho^{M})$$

With no concealing of earnings

- Choose retirement age R given $\theta(t) = 0$ for all t
- Optimality conditions for each system ($V(R)$ convex):

$$V'(R^{DB}) = w(1 - \tau - \rho^{DB})$$
$$V'(R^{M}) = w(1 - (1 - \gamma)\tau - \rho^{M})$$

- **Prediction 1. Employment response:** workers in mixed system will remain employed longer
  - Postponing retirement increases pension fund by $\tau\gamma w$ (contributions are not "pure tax")
  - The loss of one period of government pension is smaller ($\rho^{M} < \rho^{DB}$)

With given evasion trajectory

Concealing of earnings given a retirement age

Choose trajectory $\theta(t)$ given retirement age R ($\sigma(\theta)$ convex):

$$\sigma'(\theta^{DB}(t)) = \begin{cases} \tau w & \text{if } t \leq R - L \\ \tau w - \rho^{DB} w \frac{T-R}{L} & \text{if } t > R - L \end{cases}$$

- High evasion early on, less evasion when in L-year window (could be zero) $\rightarrow$ consistent with (Dean et al., 2022)

Concealing of earnings given a retirement age

Choose trajectory $\theta(t)$ given retirement age R ($\sigma(\theta)$ convex):

$$\sigma'(\theta^{DB}(t)) = \begin{cases} \tau w & \text{if } t \leq R - L \\ \tau w - \rho^{DB} w \frac{T-R}{L} & \text{if } t > R - L \end{cases}$$

- High evasion early on, less evasion when in L-year window (could be zero) $\rightarrow$ consistent with (Dean et al., 2022)

$$\sigma'(\theta^{M}(t)) = \begin{cases} \tau w(1-\gamma) & \text{if } t \leq R - L \\ \tau w(1-\gamma) - \rho^{M} w \frac{T-R}{L} & \text{if } t > R - L \end{cases}$$

- In mixed system, evasion early on attenuated by γ, later on undetermined but shrinks towards zero as well

Concealing of earnings given a retirement age

Choose trajectory $\theta(t)$ given retirement age R ($\sigma(\theta)$ convex):

$$\sigma'(\theta^{DB}(t)) = \begin{cases} \tau w & \text{if } t \leq R - L \\ \tau w - \rho^{DB} w \frac{T-R}{L} & \text{if } t > R - L \end{cases}$$

- High evasion early on, less evasion when in L-year window (could be zero) $\rightarrow$ consistent with (Dean et al., 2022)

$$\sigma'(\theta^{M}(t)) = \begin{cases} \tau w(1-\gamma) & \text{if } t \leq R - L \\ \tau w(1-\gamma) - \rho^{M} w \frac{T-R}{L} & \text{if } t > R - L \end{cases}$$

- In mixed system, evasion early on attenuated by γ, later on undetermined but shrinks towards zero as well
- **Prediction 2. Reported earnings response:** workers in mixed system will report higher earnings early on, difference likely to shrink closer to retirement

Back to stylized framework

Summary stats (SSA data)

Table: Summary statistics - Administrative data

	Observations	Mean	Standard Deviation	Median
Employed	1552882	0.579	0.494	1.000
Total labor earnings	929,373	14858.658	19262.985	8728.500
Monthly hours worked	902,771	163.922	54.419	171.429
Days worked in the month	929,153	24.642	8.985	30.000
Public sector	893,059	0.288	0.453	0.000
Owner	922,403	0.121	0.327	0.000
High inf. sector	840,859	0.387	0.487	0.000

Back

Summary stats (Census data)

Table: Summary statistics - Census data

	Observations	Mean	Standard Deviation	Median
Employed	109,583	0.676	0.468	1.000
Retired	109,583	0.162	0.368	0.000
Disability	109,575	0.057	0.231	0.000
SES Index	109,354	0.007	1.001	0.108
Married	109,584	0.674	0.469	1.000
College complete	109,828	0.224	0.417	0.000
Female	109,828	0.524	0.499	1.000
Has children	109,828	0.468	0.499	0.000

Back

Summary stats (Income tax data)

Table: Summary statistics - Income tax data

	Observations	Mean	Standard Deviation	Median
Employed	408,544	.691	.462	1
Retired	408,544	.211	.408	0
Total labor earnings	408,544	302116	588324	136928
Pension income	408,544	31537	99020	0
Income under poverty line	408,544	.387	.487	0

Back

Summary stats (ret. accounts)

Table: Summary statistics - Retirement accounts data

	Observations	Mean	Standard Deviation	Median
Active March 2019	20,013	.756	.429	1
Female	20,013	.536	.499	1
Foreign born	20,013	.0616	.24	0
Article 8	20,013	.913	.283	1
Year of adoption of Article 8	18,262	1998	4.46	1996
Public sector	19,461	.262	.44	0

Back

Earnings in the data

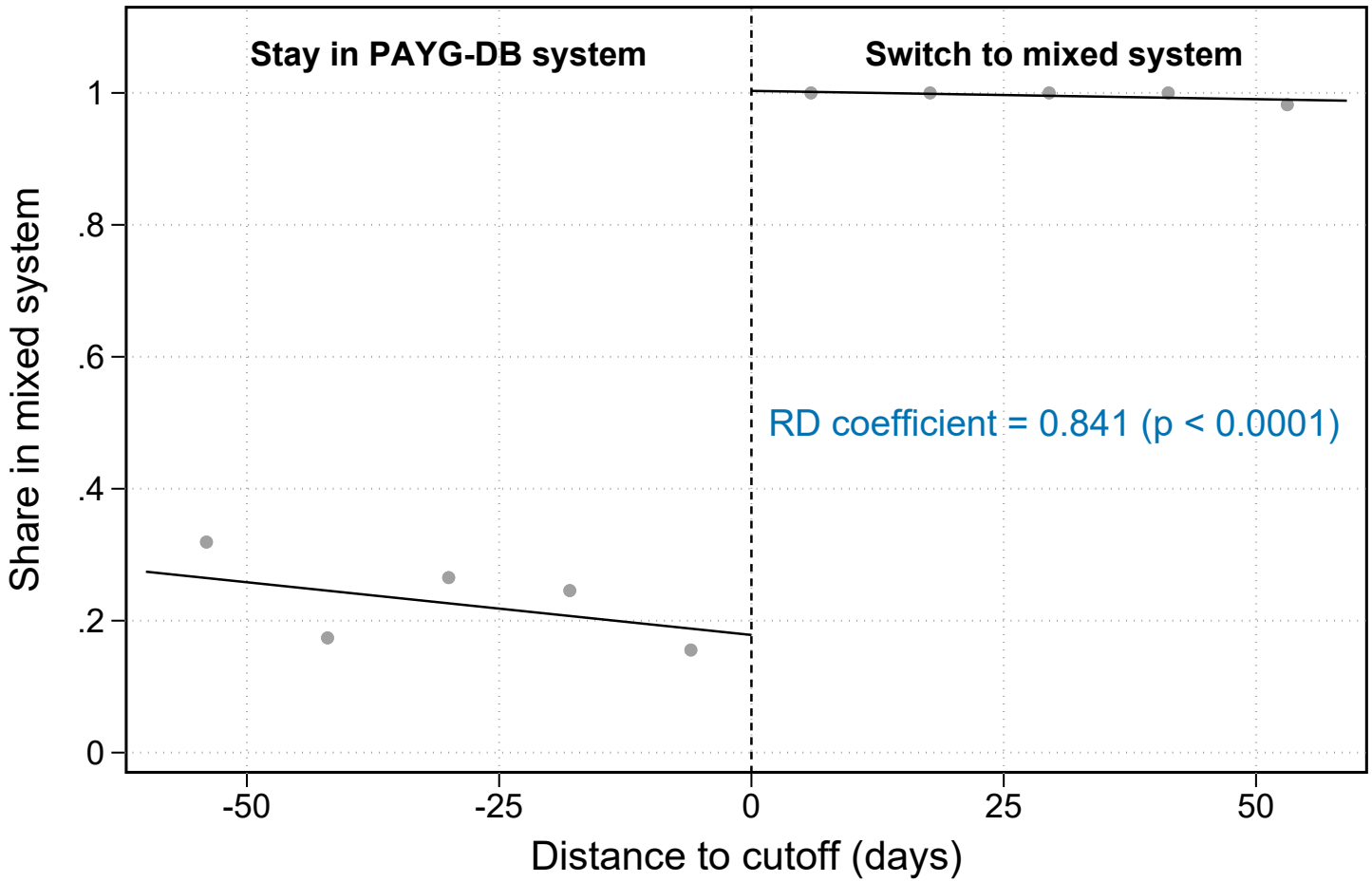
- We observe monthly pre-tax total labor earnings (they refer to these as “nominal wages”)
- Includes all mandatory employee contributions (pension, healthcare, unemployment insurance) and no employer payroll taxes
- Includes 13th salary (paid half in July and half in December)
- Data on days worked and hours worked
- We average the last 6 months of the year to reduce occasional noise and analyze far from birthdays
- Winsorize at 1% to reduce influence of potential outliers Back

IRS data

- All income tax returns, but only some with date of birth
  - Has to have generated the right for others to get SS benefits (often healthcare for children)
  - So it will have to be people with children, spouse, or something like that
  - Of key cohorts, get 53% of the sample
- Winsorize monetary values at 1% to reduce influence of potential outliers
- Deflate everything to 2009 Uruguayan pesos Back

First stage

Figure: First stage



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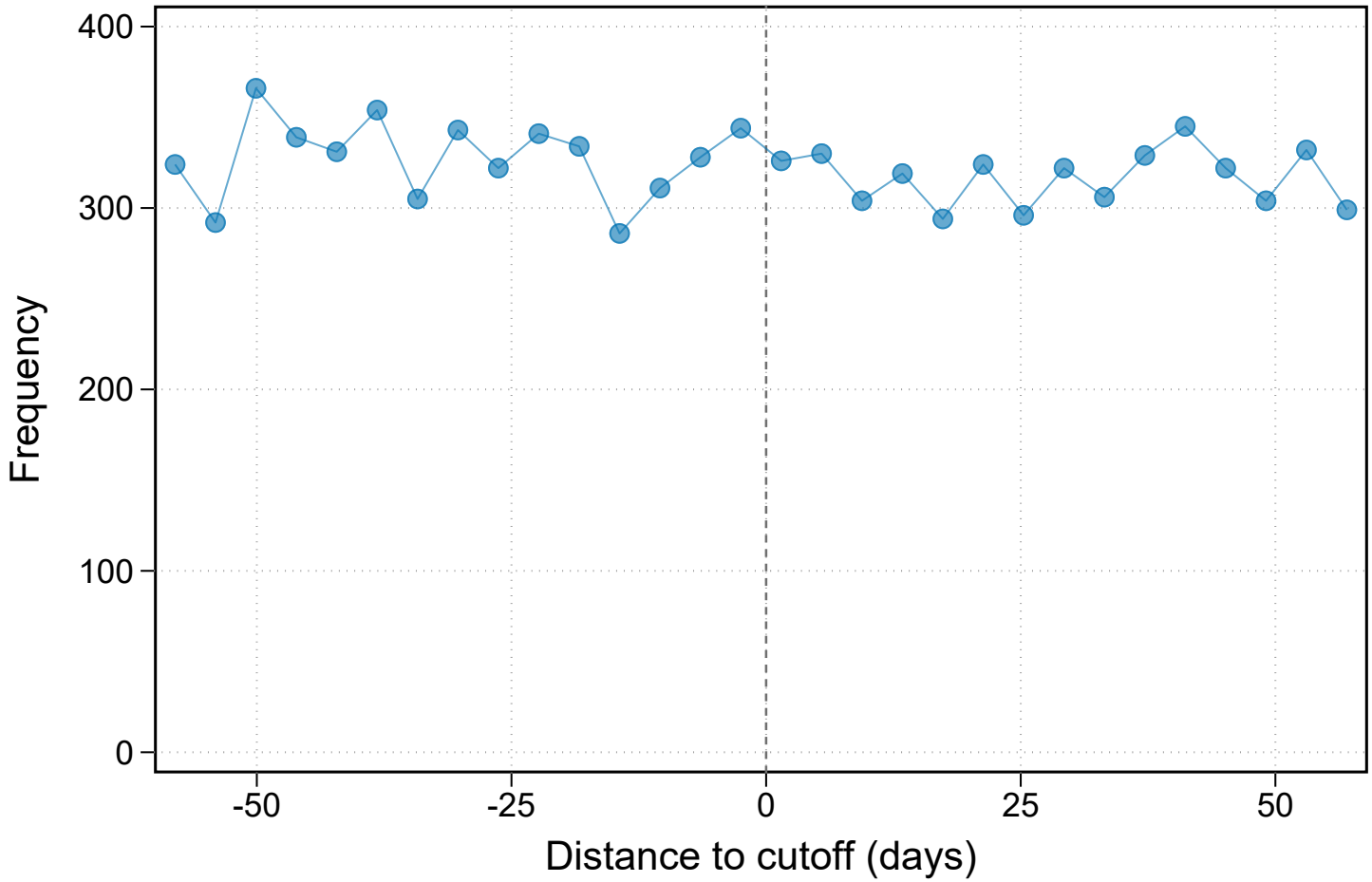
Density around cutoff

Figure: Density around cutoff



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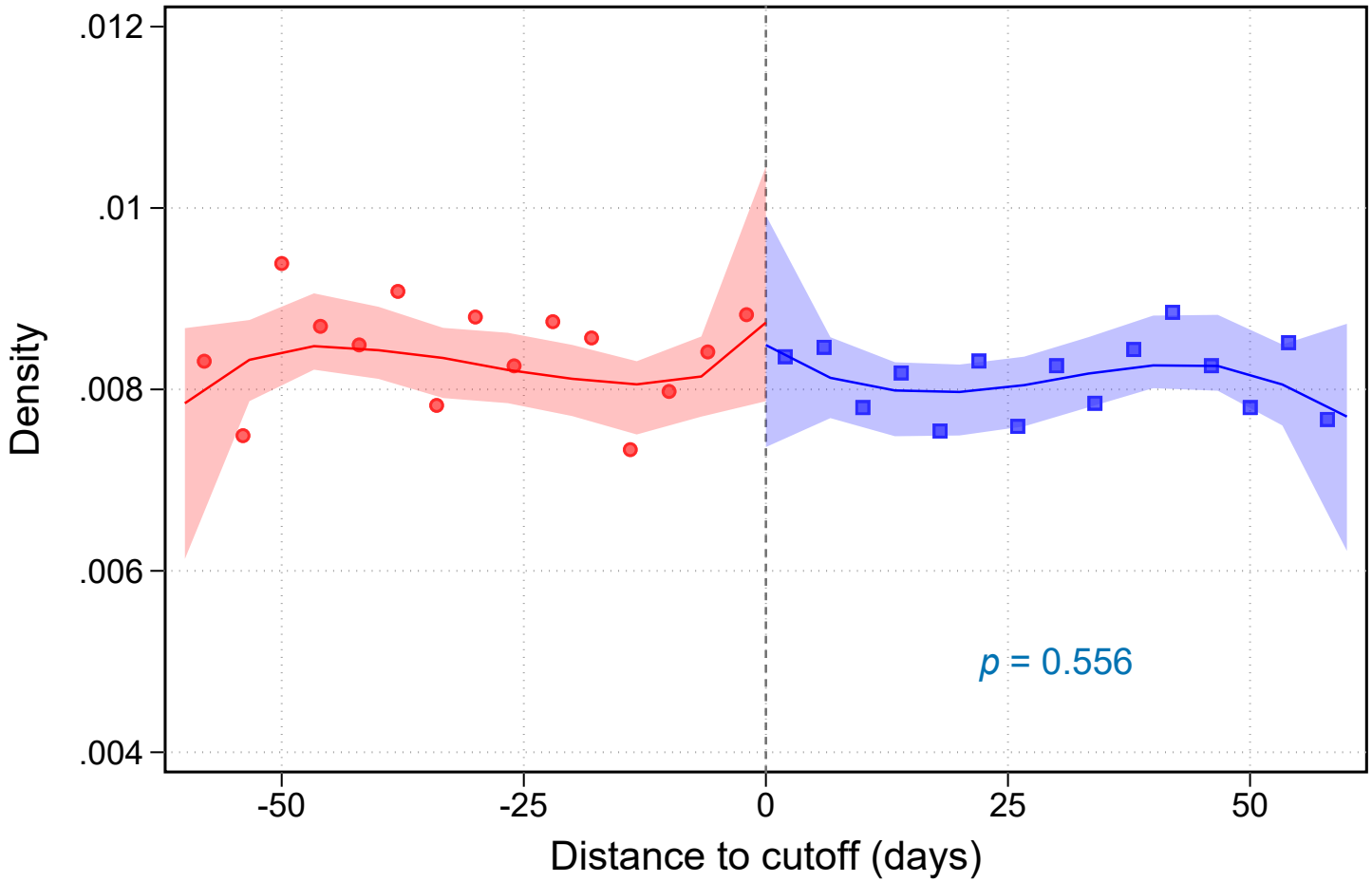
Manipulation test

Figure: Manipulation test



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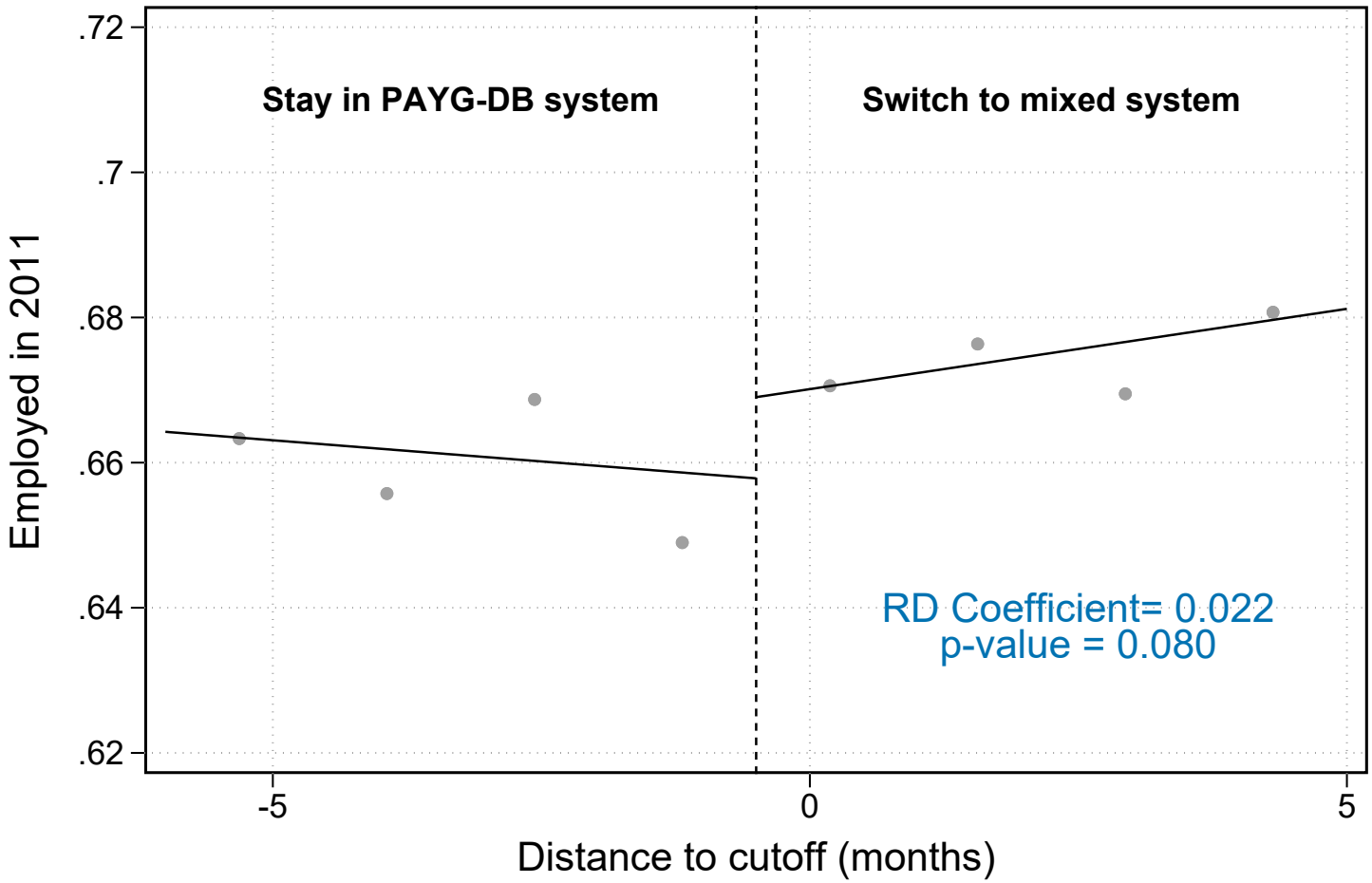
RD - Employed (census)

Figure: RD - Employed (census)

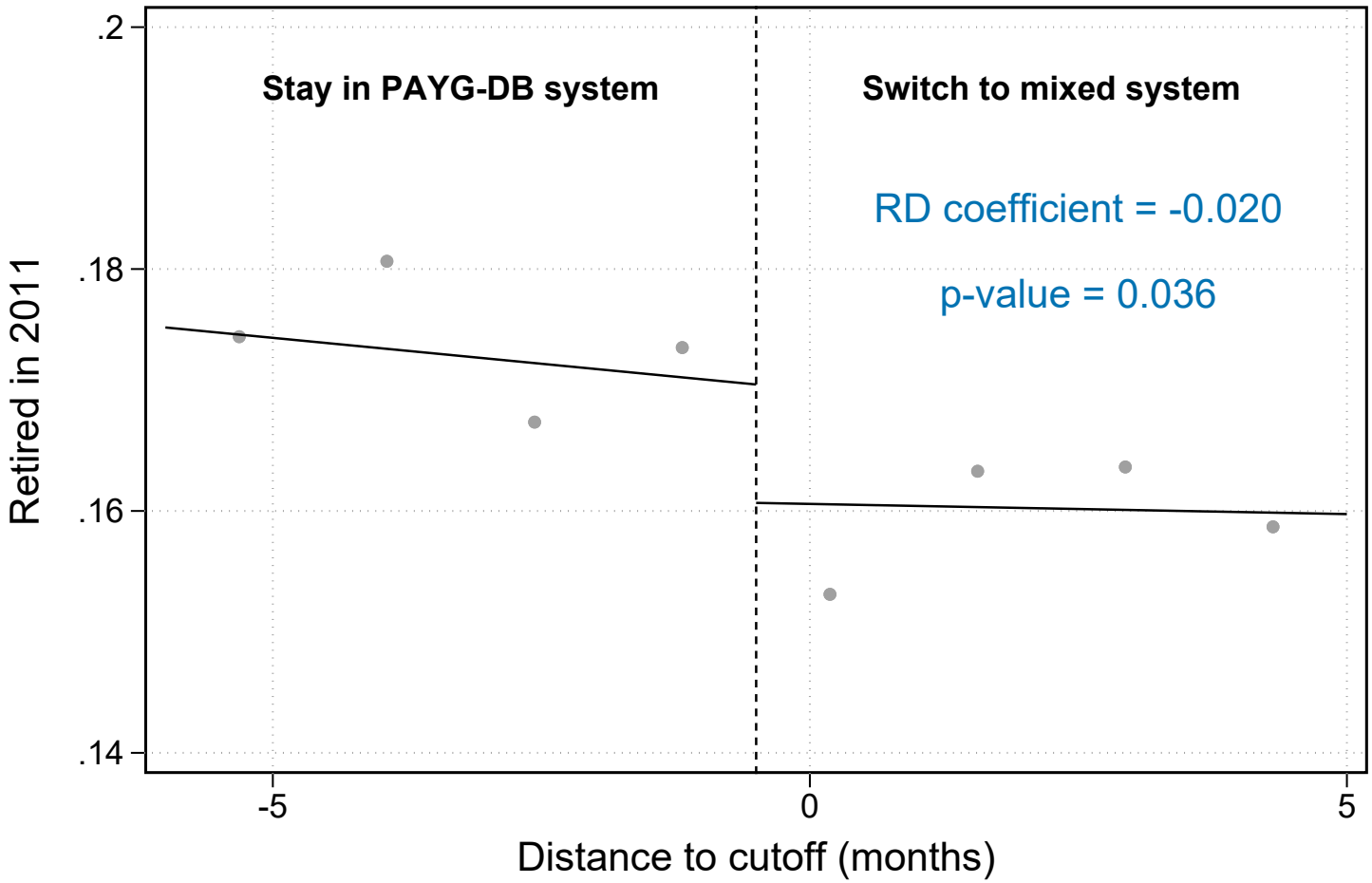


Also find slightly higher prob of being employed in 2011 census data

Compared with placebos Back

RD - Retired (census)

Figure: RD - Retired (census)



Comes mostly from not having retired Compared with placebos Back

Construction of SES index

PCA on several indicators of SES

Table: Principal component analysis for SES index

	Component 1	Component 2	Component 3
Panel A. Variable loadings			
College complete	.2957395	.0577124	-.3226414
Home owner	.1573287	.6922537	.5696147
Has clothes dryer	.2262674	.3437633	-.6546112
Number of TVs	.3858493	.060771	.0300353
Has mobile phone	.2058759	-.3836007	.3673276
Has computer	.5070501	-.2670452	.0579324
Number of cars	.3636602	.3293137	.0448591
Has internet	.5059405	-.2620643	.0415409
Panel B. Component statistics			
Eigenvalue	2.784	1.055	0.934
Proportion explained	0.348	0.132	0.117

Keep component 1 as SES index Back

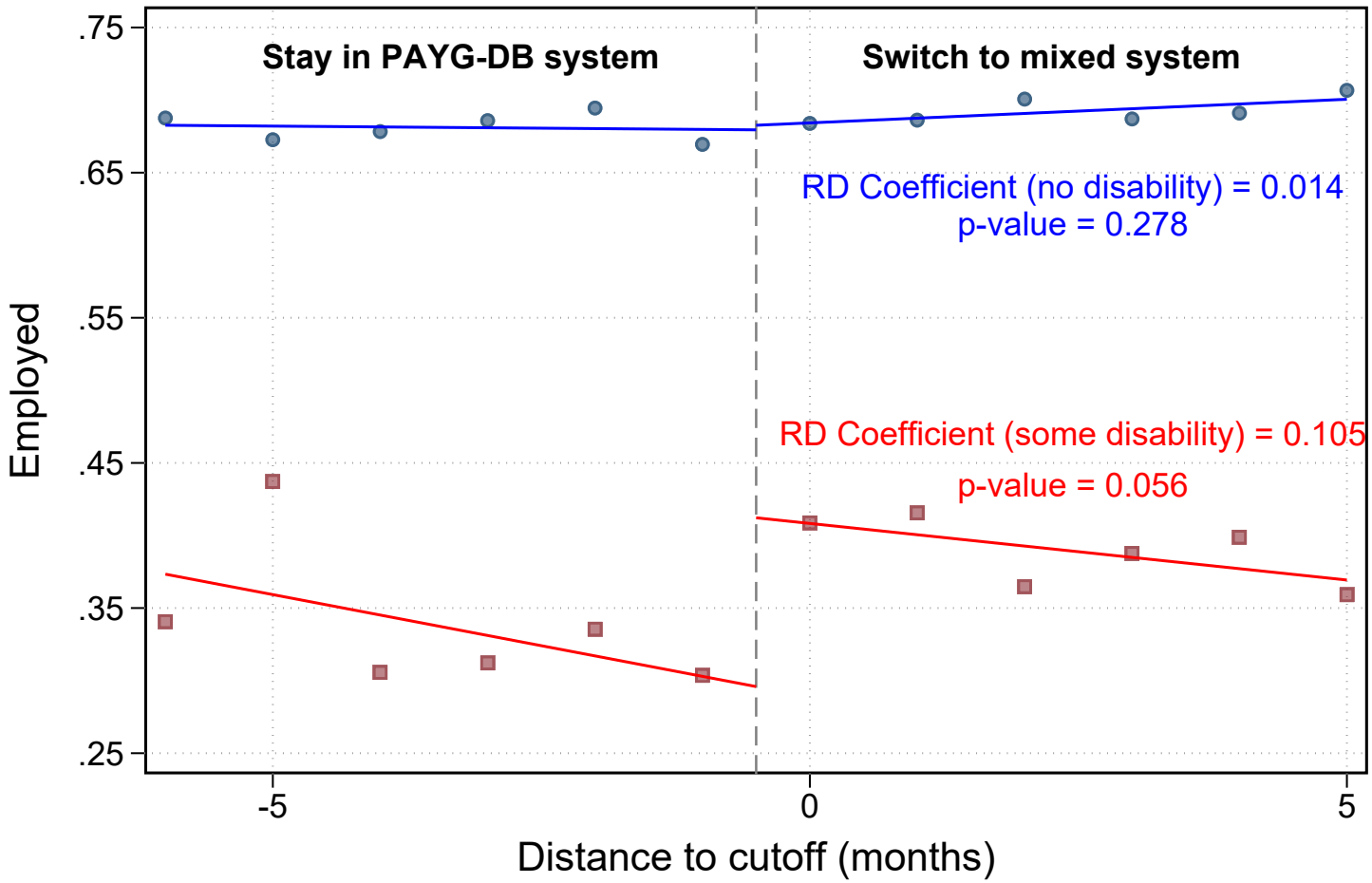
Caveats about ITT heterogeneity

- ITT heterogeneity could be biased if non-random selection into new system below cutoff
  - e.g. if all high SES people chose new system... mechanically the effect would be zero for them (they would be in the same system as those after cutoff)
- However, this is bounded:
  - First stage indicates about 15% of those below cutoff are in new system
  - Worst-case scenario: *every* person who chose new system is high SES, it can only be 30% of all high SES people

  $\rightarrow$ downward bias of *at most* 30%, not 100% Back

RD - Employed (census, heterogeneity)

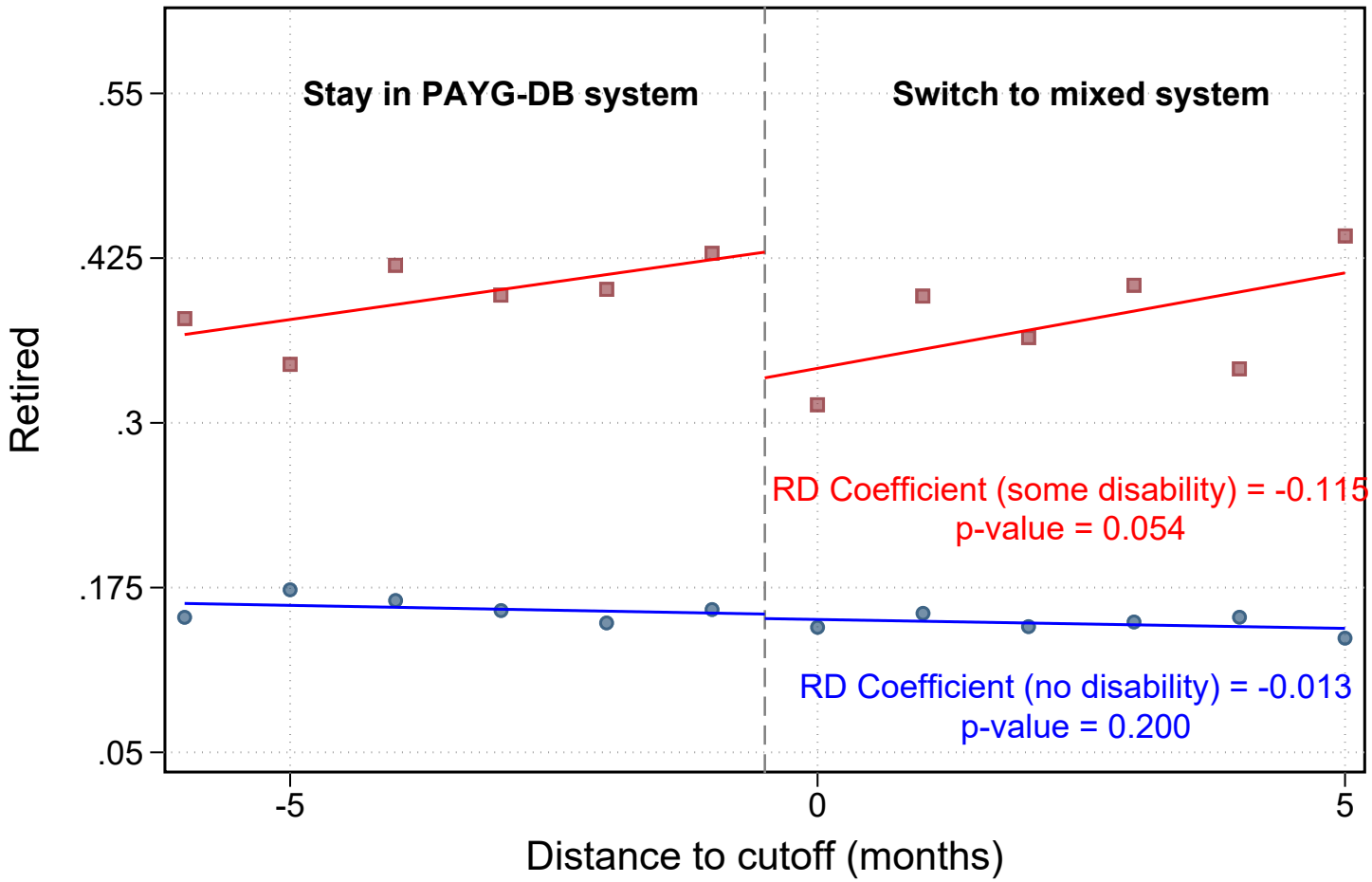
Figure: RD - Employed (census, heterogeneity by disability)



Driven in large part by people that experience some disability Back

RD - Retired (census, heterogeneity)

Figure: RD - Retired (census, heterogeneity by disability)

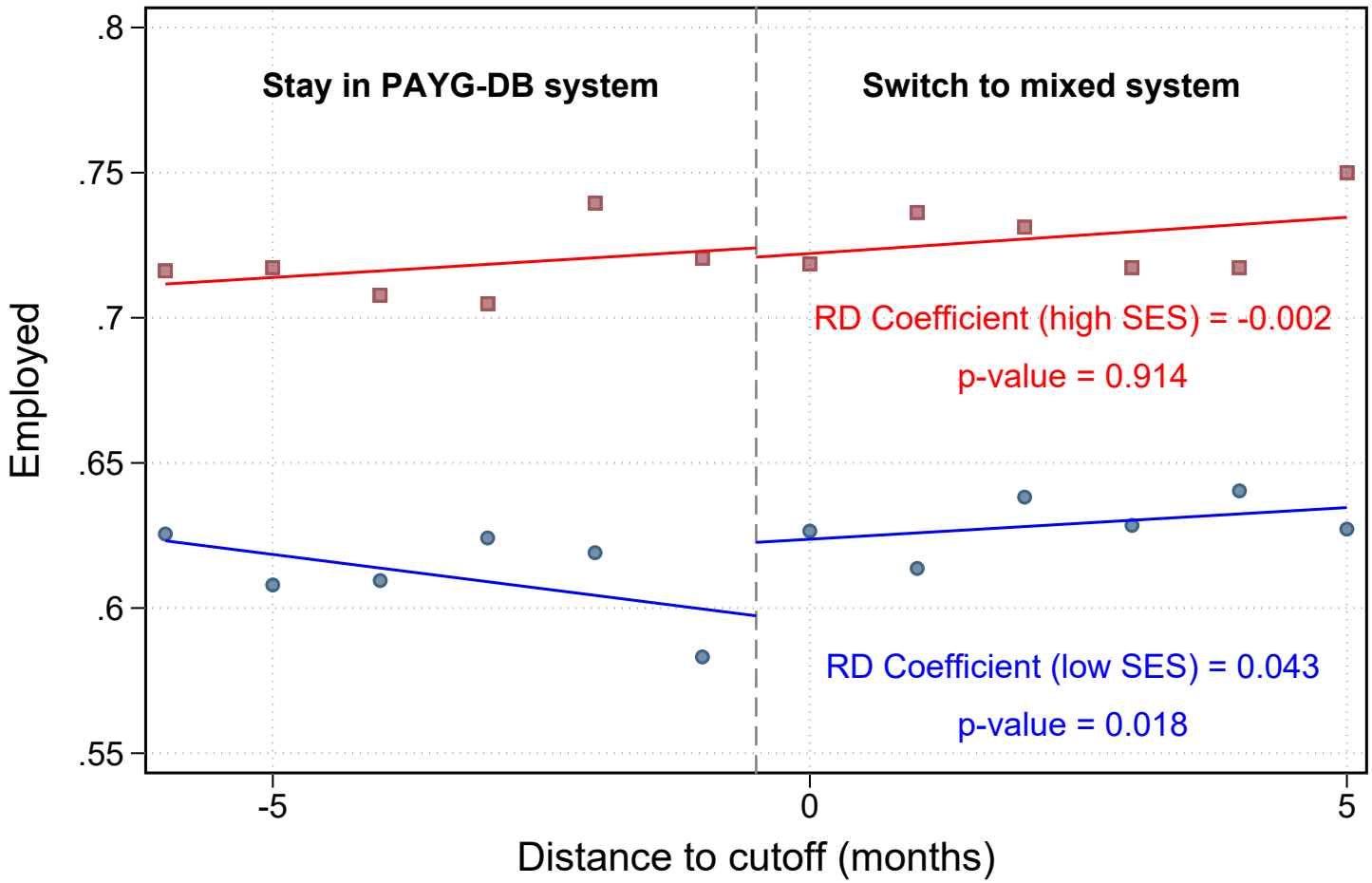


Driven in large part by people that experience some disability

Back

RD - Employed (census, heterogeneity)

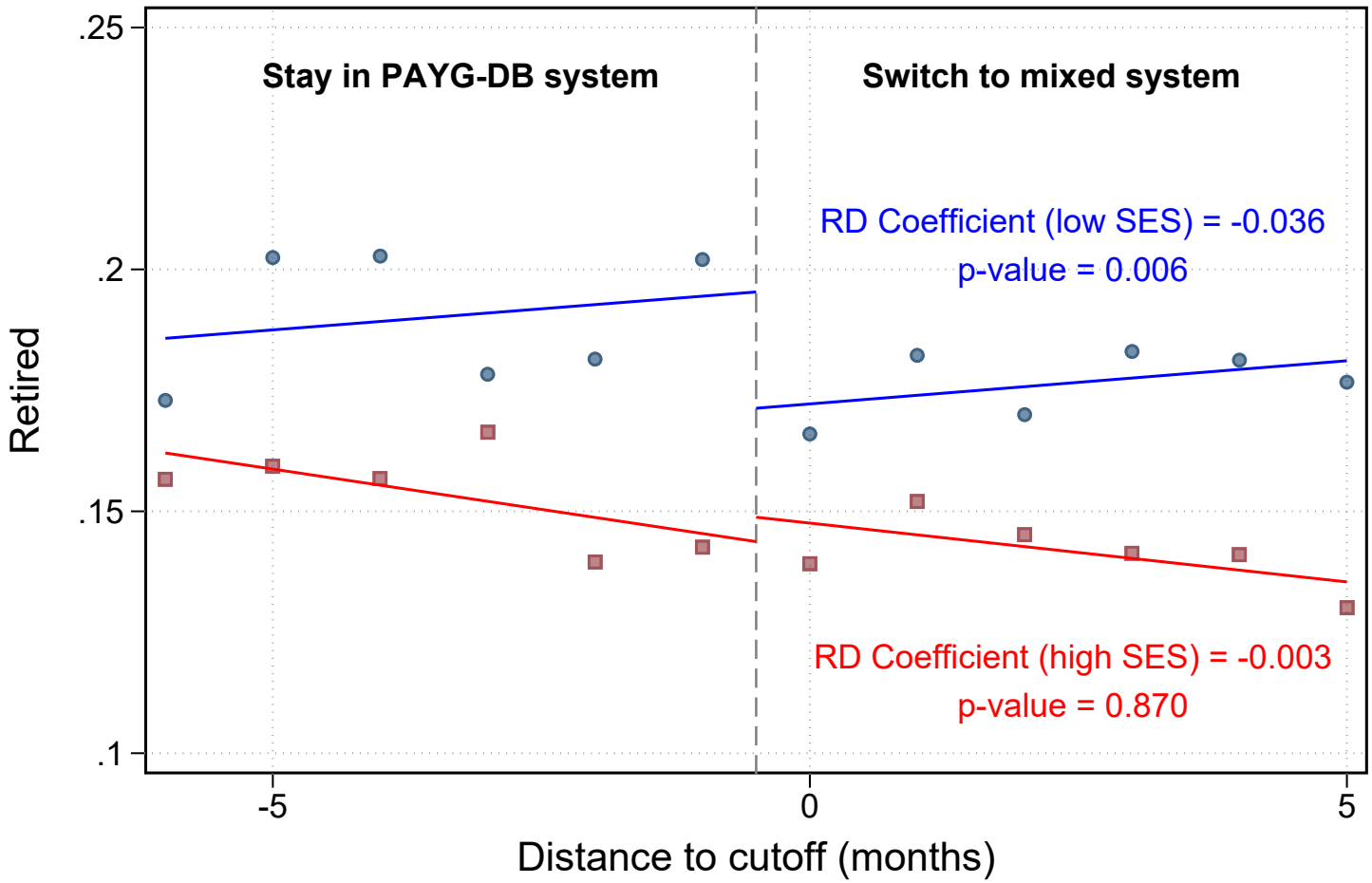
Figure: RD - Employed (census, heterogeneity by SES)



Driven in large part by people with low SES Back

RD - Retired (census, heterogeneity)

Figure: RD - Retired (census, heterogeneity by SES)



Driven in large part by people with low SES

Back

Earnings and days/hours worked

Table: Regressions of earnings on hours and days worked

	Total labor earnings (log)			
	(1)	(2)	(3)	(4)
Panel A. Days worked				
Days worked in the month	0.0366***	0.0392***	0.0228***	0.0258***
	(0.000406)	(0.000400)	(0.000287)	(0.000235)
Year fixed effects		✓		✓
Worker fixed effects			✓	✓
Number of workers	121356	121356	108831	108831
Panel B. Hours worked				
Monthly hours worked (log)	0.315***	0.343***	0.266***	0.272***
	(0.00626)	(0.00602)	(0.00446)	(0.00335)
Year fixed effects		✓		✓
Worker fixed effects			✓	✓
Number of workers	120728	120728	107957	107957
Panel C. Days and hours worked				
Days worked in the month	0.0447***	0.0463***	0.0236***	0.0260***
	(0.000445)	(0.000434)	(0.000328)	(0.000271)
Monthly hours worked (log)	-0.00512	0.0120*	0.123***	0.114***
	(0.00645)	(0.00615)	(0.00470)	(0.00345)
Year fixed effects		✓		✓
Worker fixed effects			✓	✓
Number of workers	120728	120728	107957	107957

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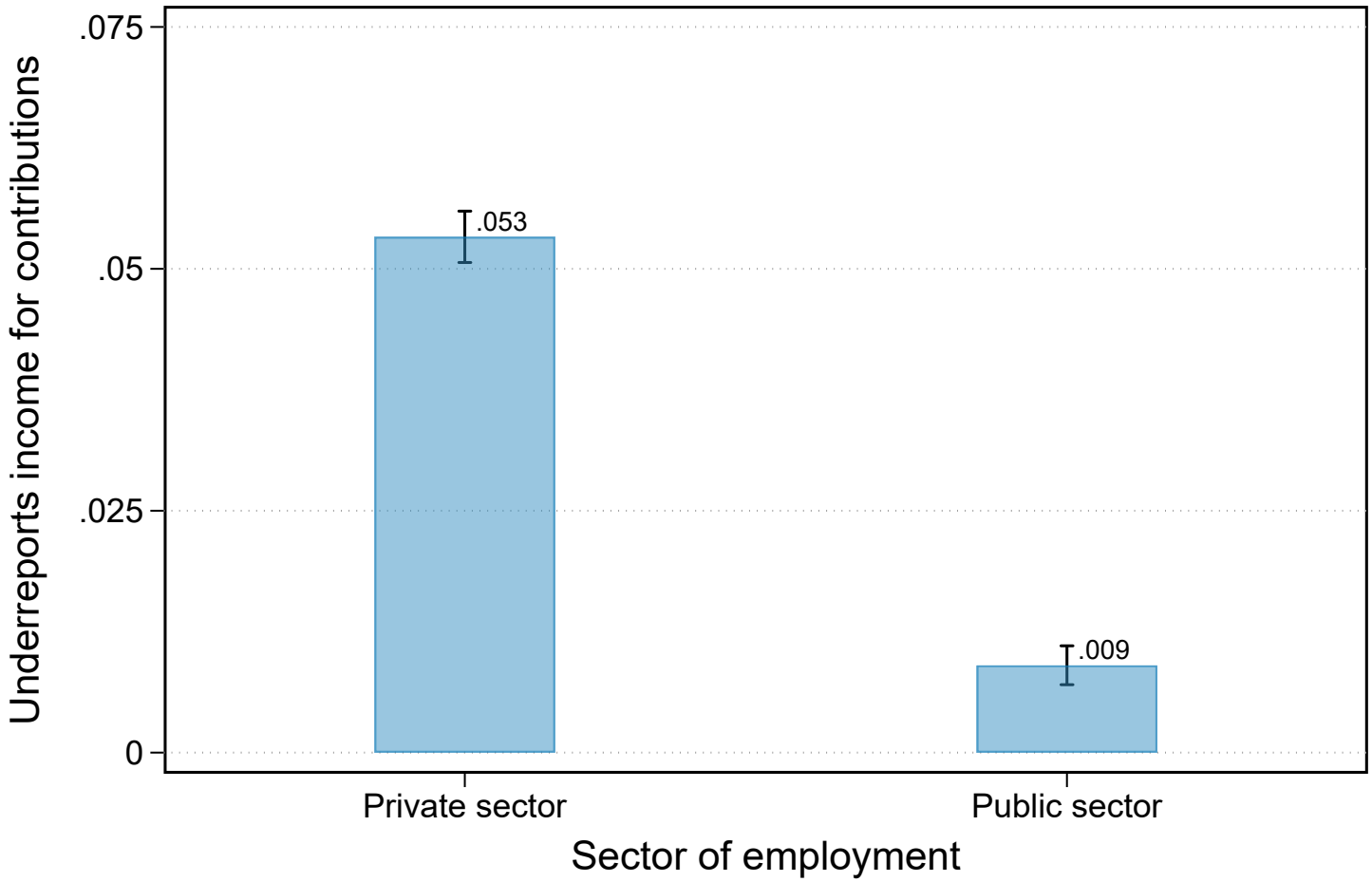
Income underreporting by sector

Figure: Income underreporting by sector



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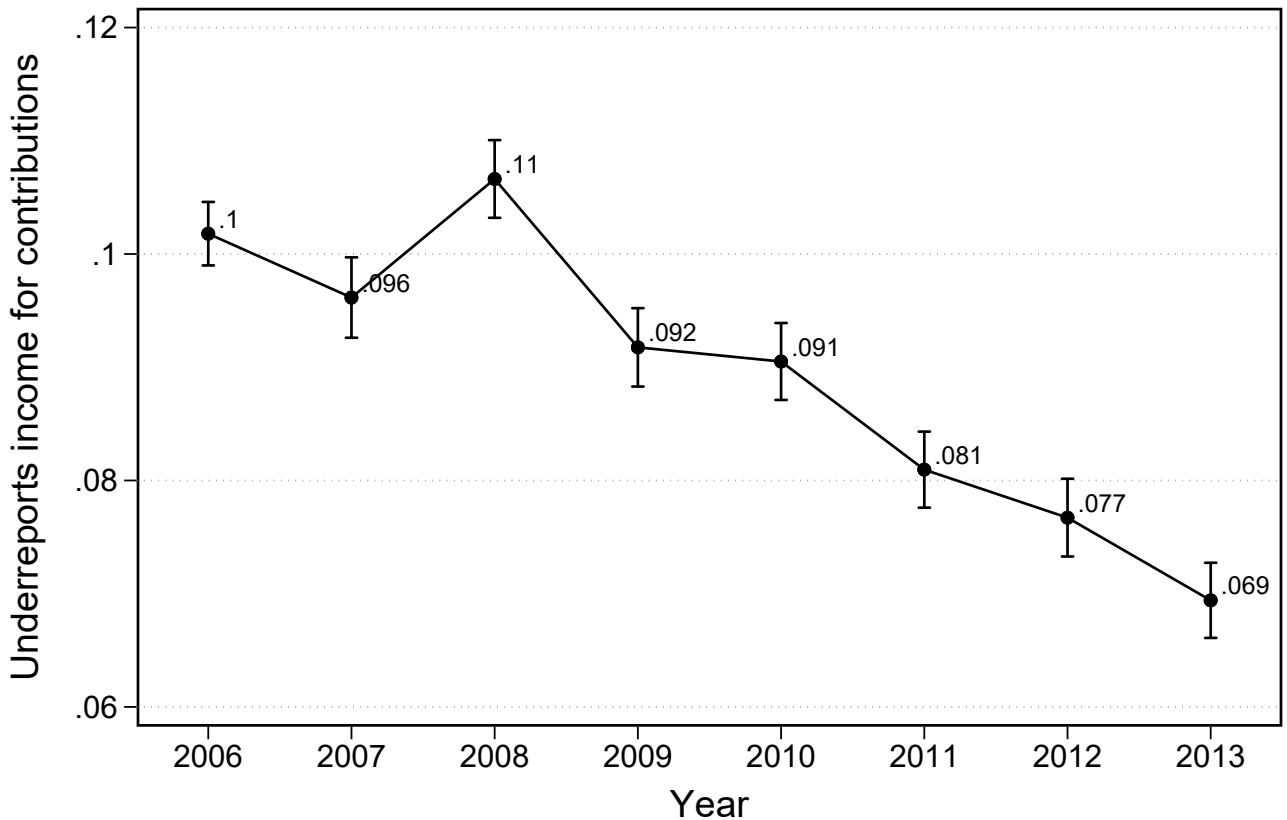
Income underreporting over time

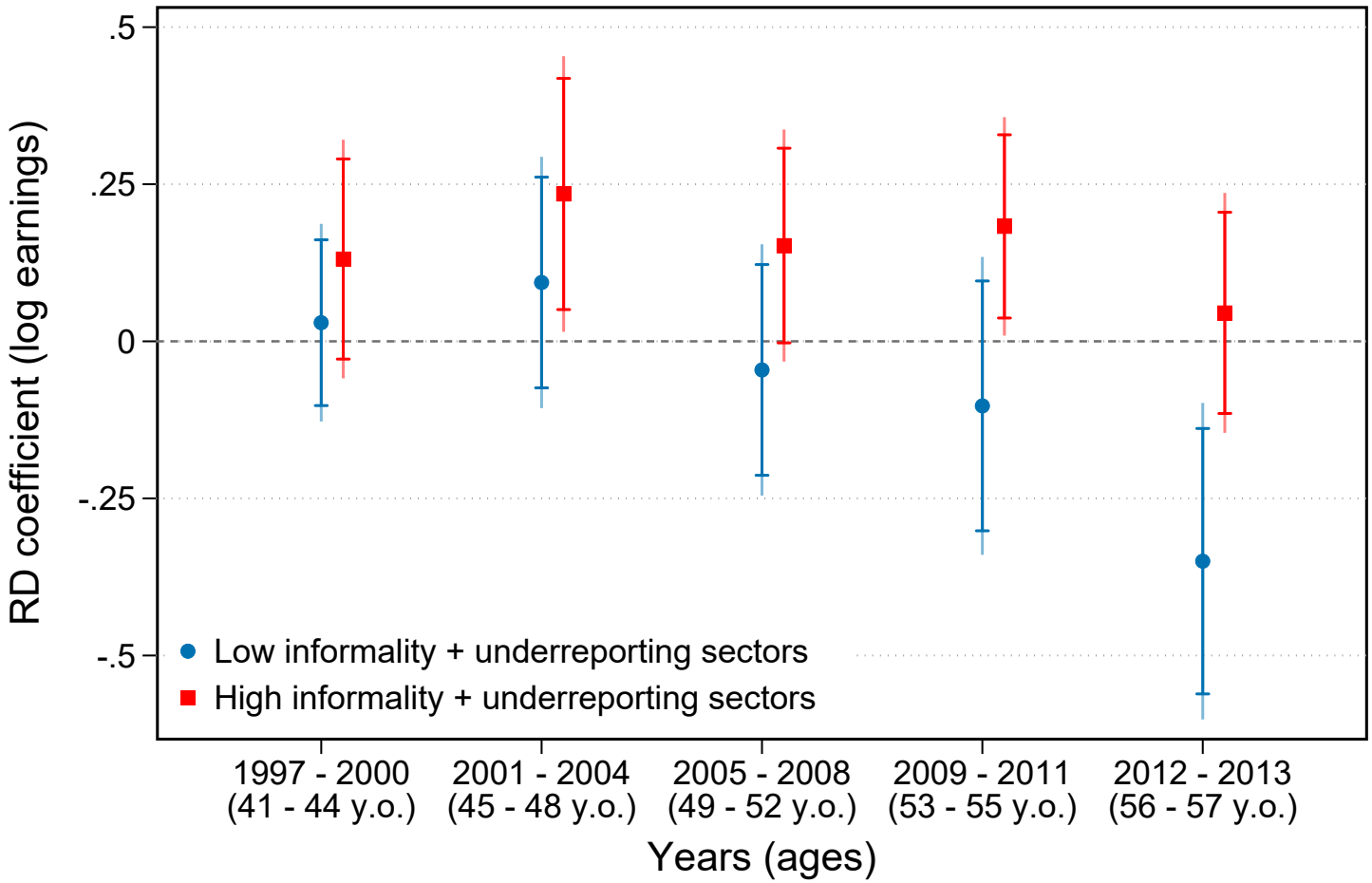
Share of formal workers who admit to underreporting earnings in HH survey: Back

Figure: Income underreporting over time



Time series plot (salary - by informality)

Figure: RD time series (salary - by informality (employees only))



Also when looking at employees only Back

Informality by sector

Table: Informality by sector

	(1) Proportion informal	(2) Proportion underreports	(3) Informality index
Panel A. Low informality sectors			
Education	0.0975	0.0430	-1.629
Financial services	0.0605	0.0591	-1.453
Social and Health services	0.137	0.0492	-1.369
Professional services	0.224	0.0557	-0.935
Water and sewage	0.0296	0.105	-0.678
Information and communication	0.189	0.0790	-0.613
Real Estate	0.233	0.0807	-0.426
Arts and entertainment	0.372	0.0571	-0.385
Mining	0.343	0.0672	-0.293
Electricity and gas	0.0303	0.126	-0.270
Panel B. High informality sectors			
Agriculture	0.312	0.124	0.686
Commerce	0.504	0.0961	0.831
Administrative support services	0.417	0.113	0.845
Hotels and Restaurants	0.416	0.135	1.259
Construction	0.607	0.106	1.395
Other services	0.678	0.120	1.909
Home services	0.635	0.199	3.265

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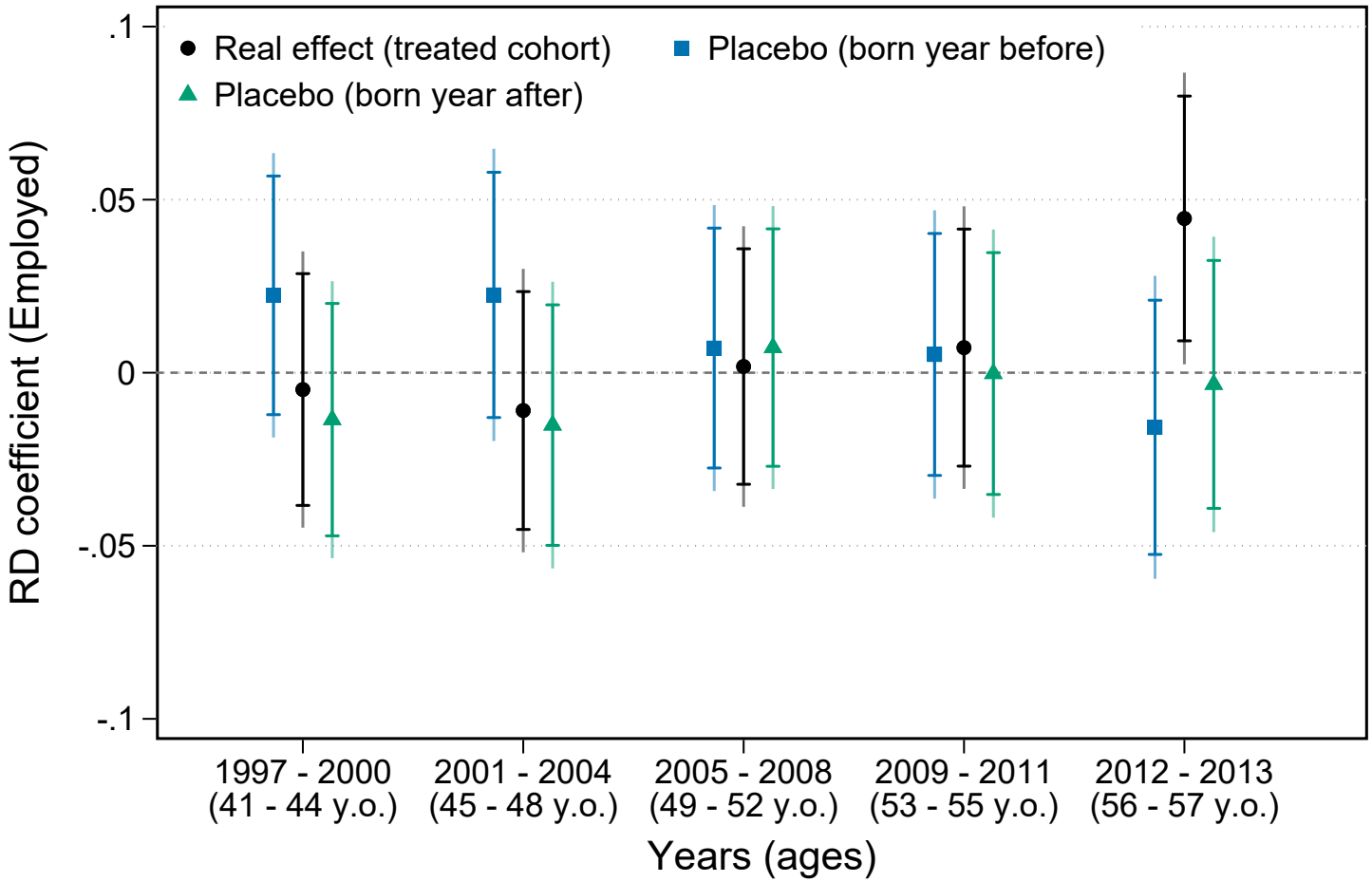
Real RD with placebos - Employed

Figure: Real RDs with placebos - Employed



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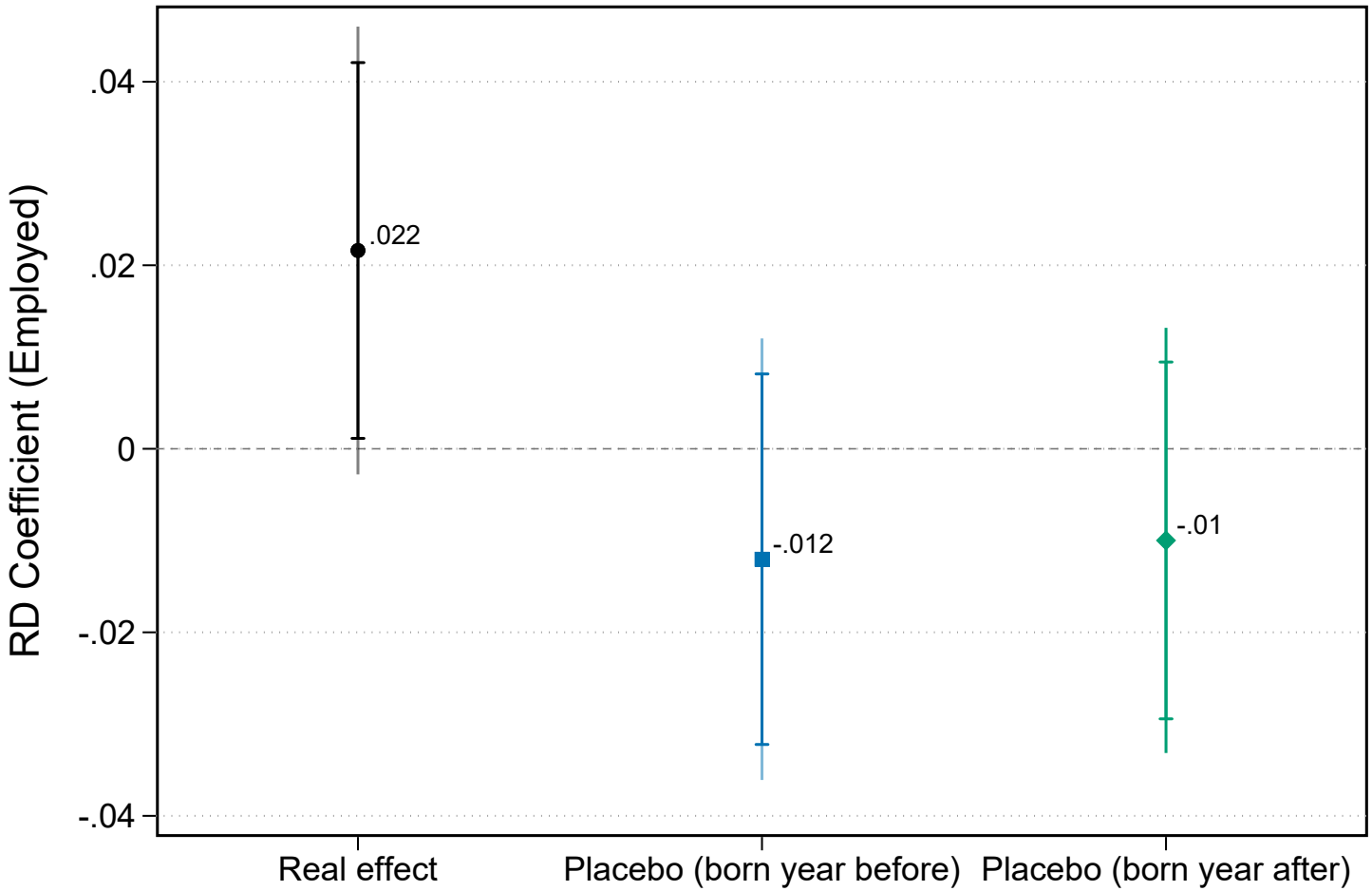
Placebos - Employed (Census)

Figure: Placebos - Employed (Census)



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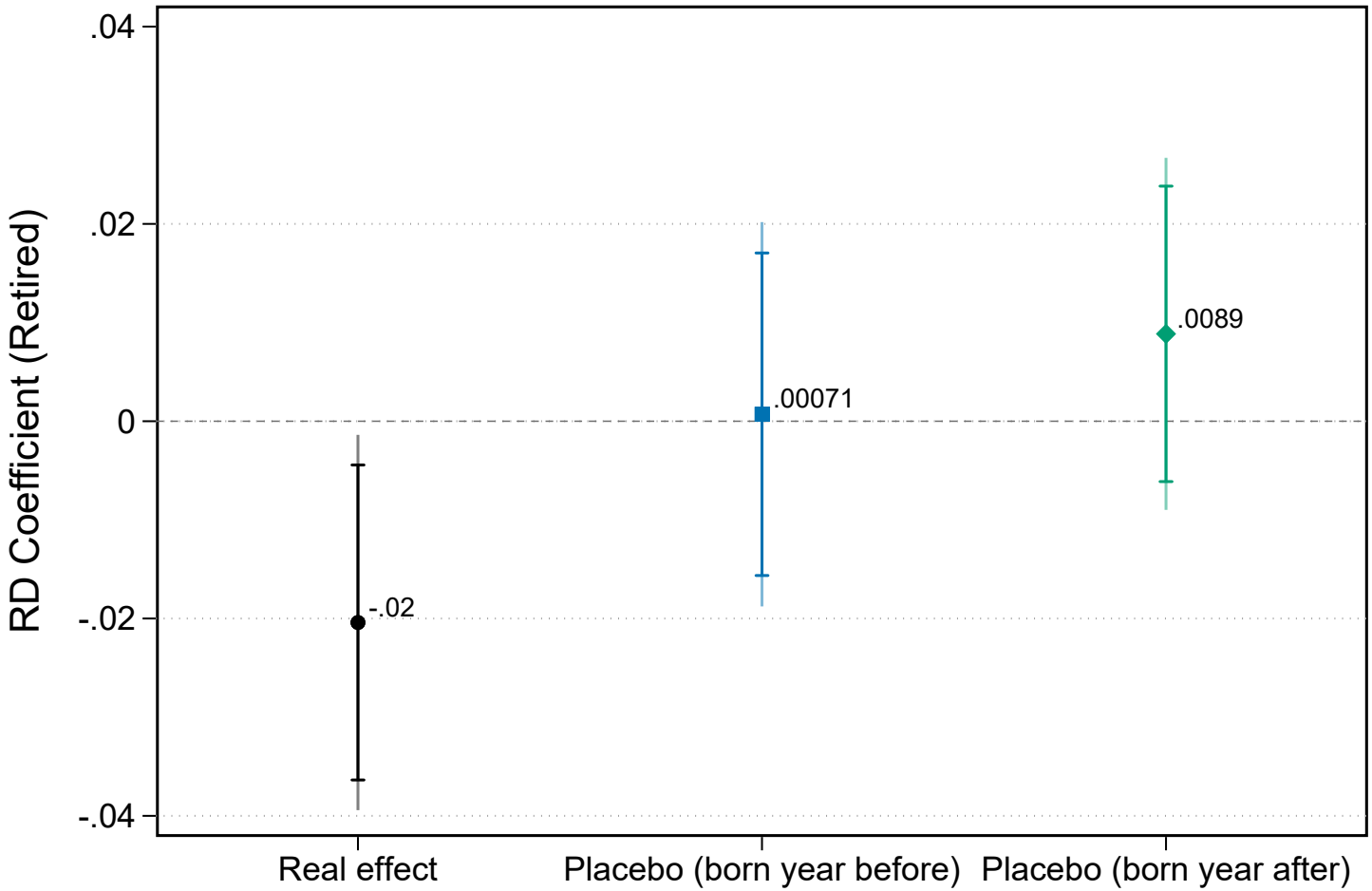
Placebos - Retired (Census)

Figure: Placebos - Retired (Census)



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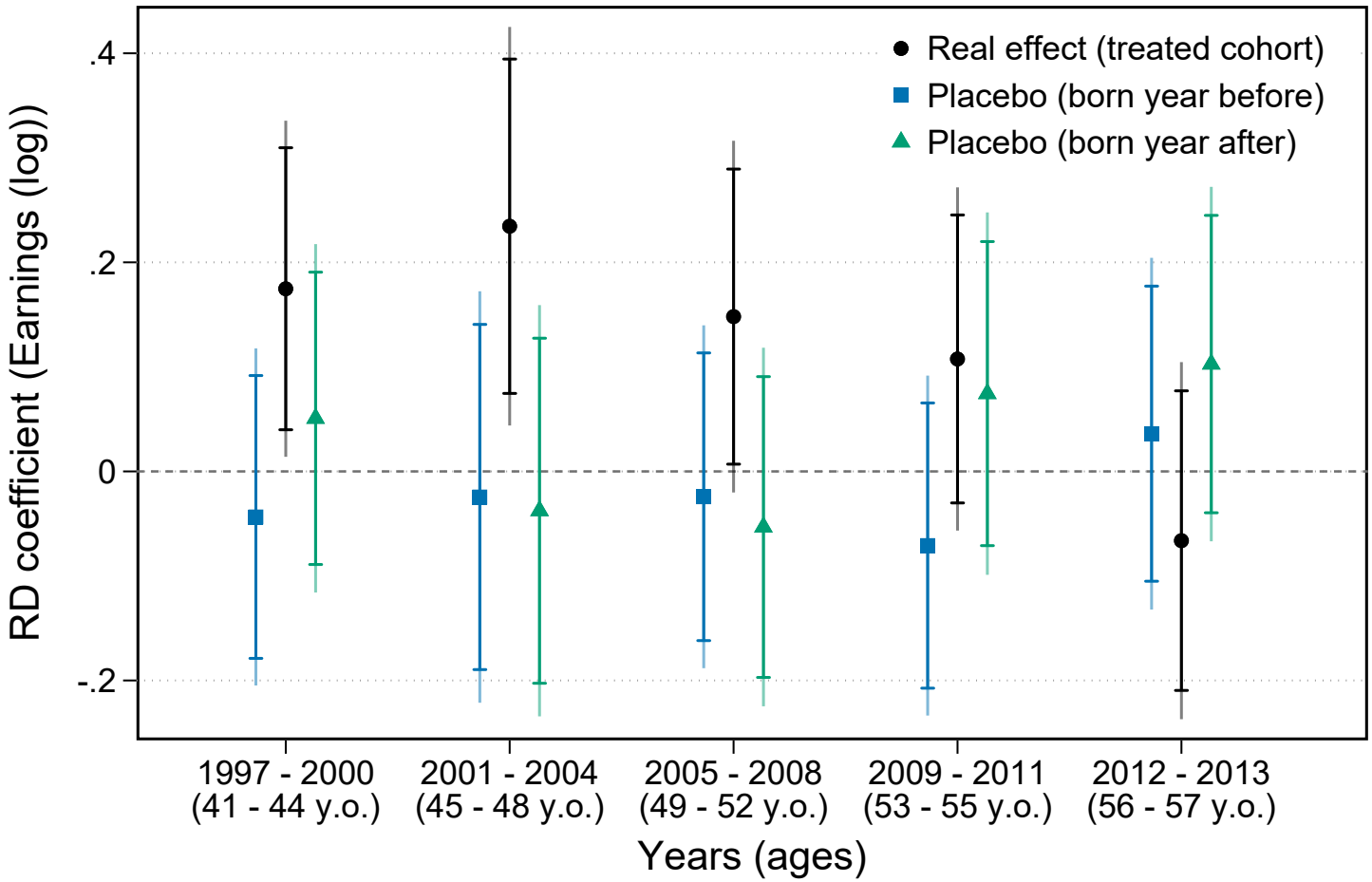
Real RD with placebos - Earnings

Figure: Real RDs with placebos - Earnings



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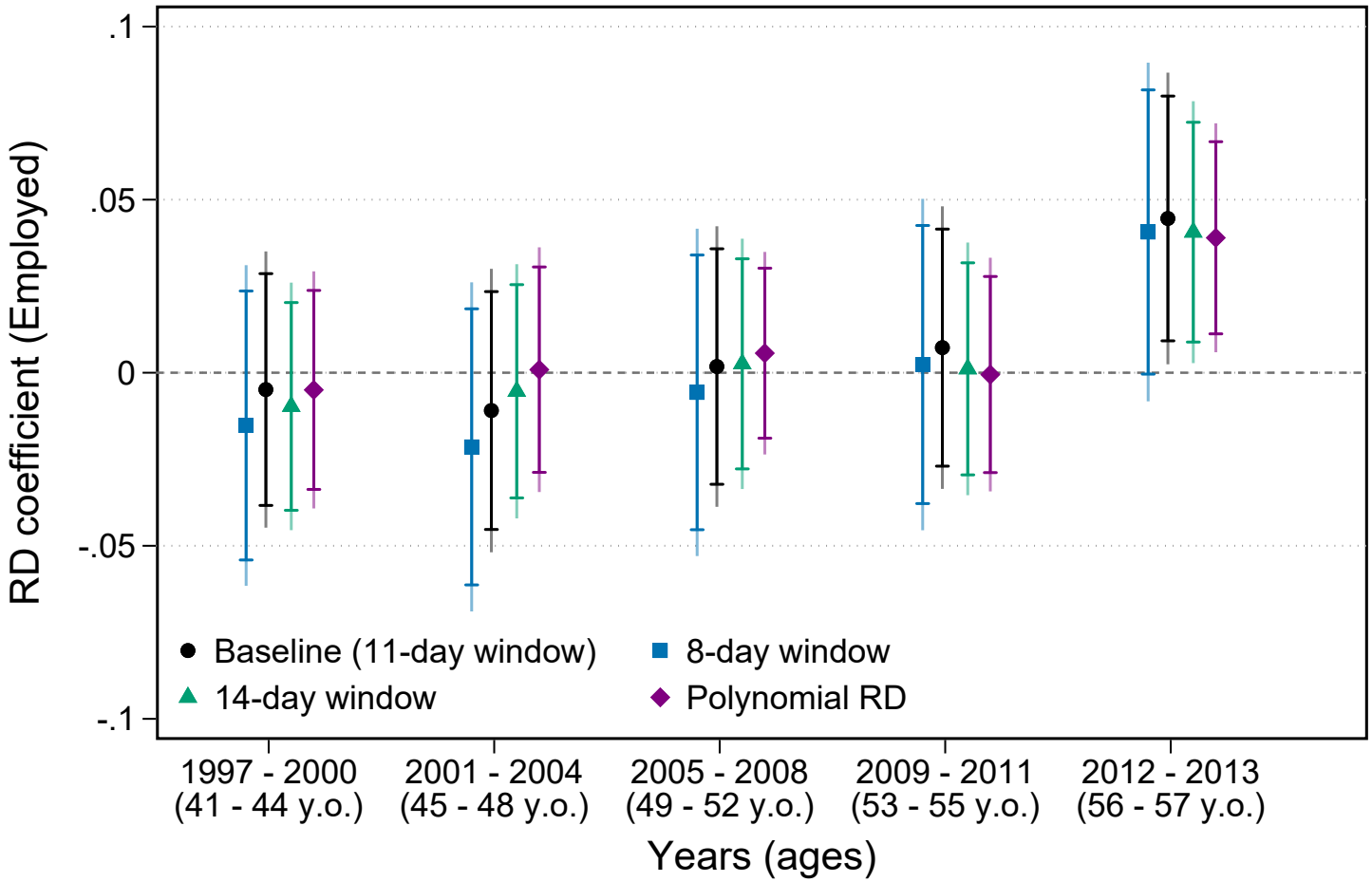
Different specifications - Employed

Figure: Time series plot different specifications - Employed



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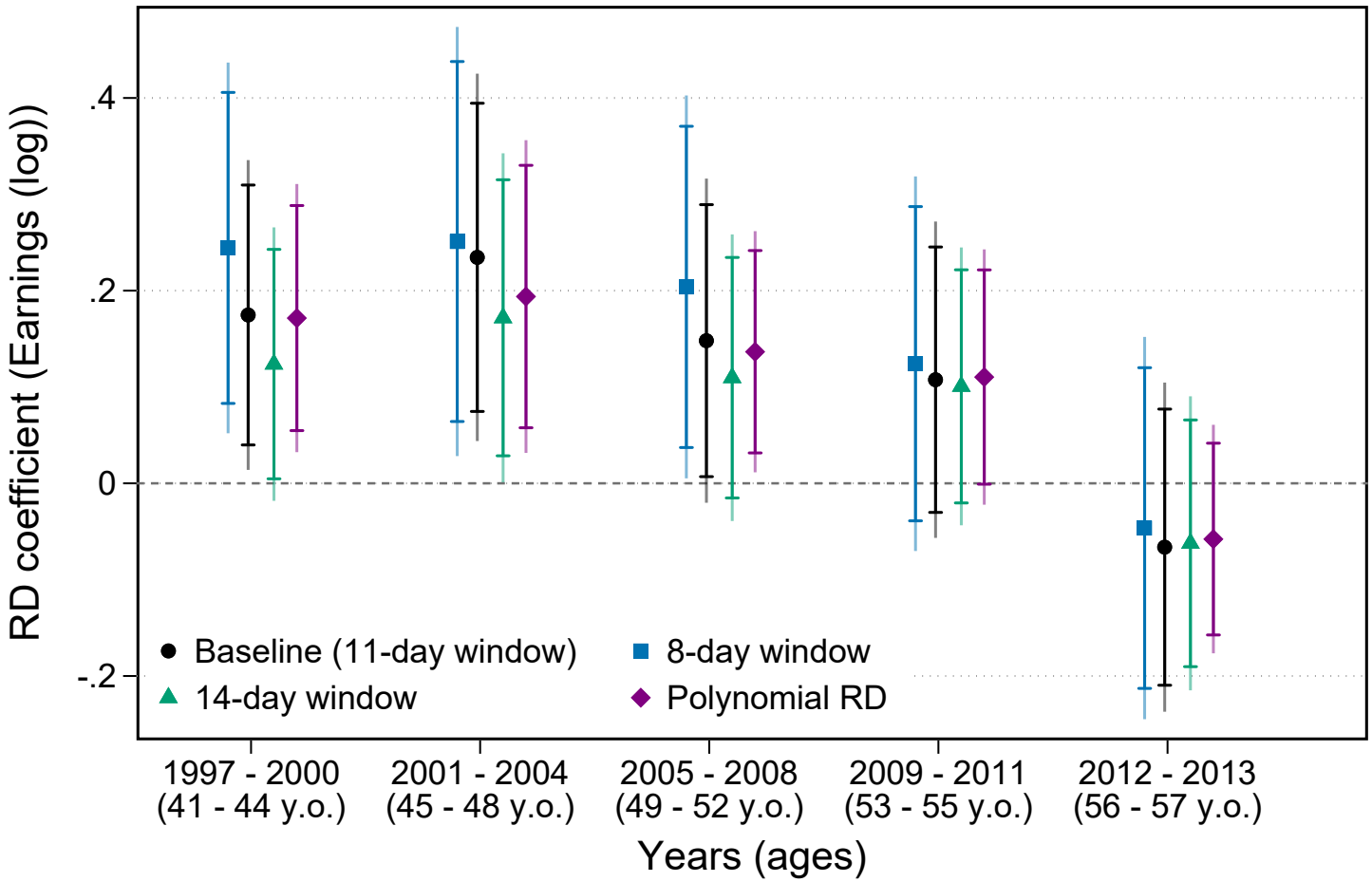
Different specifications - Earnings

Figure: Time series plot different specifications - Earnings



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Balance on observables (Census)

Table: Balance - Census data

Variable	(1) Unfunded DB system	(2) Mixed system	(3) Difference
Married	0.692	0.706	0.014
	(0.462)	(0.456)	(0.012)
College complete	0.238	0.238	-0.000
	(0.426)	(0.426)	(0.011)
Has children	0.481	0.474	-0.007
	(0.500)	(0.499)	(0.013)
Disability	0.056	0.049	-0.007
	(0.230)	(0.216)	(0.006)
SES Index	0.012	0.025	0.012
	(1.014)	(1.014)	(0.027)
Female	0.540	0.528	-0.012
	(0.499)	(0.499)	(0.013)
Observations	3,004	2,810	5,814

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Additional placebo cutoffs (census)

Table: Additional placebo cutoffs - census data

	=1 if employed				
	(1) Cutoff = -6	(2) Cutoff = -3	(3) Cutoff = 0	(4) Cutoff = 3	(5) Cutoff = 6
Panel A. Effect on employment					
Treated	-0.00604	0.00726	0.0216*	-0.0113	-0.00314
	(0.0120)	(0.0120)	(0.0124)	(0.0122)	(0.0117)
Observations	6141	6261	5799	5946	6322
	=1 if retired				
	(1) Cutoff = -6	(2) Cutoff = -3	(3) Cutoff = 0	(4) Cutoff = 3	(5) Cutoff = 6
Panel B. Effect on retirement					
Treated	-0.00278	-0.00842	-0.0204**	0.00523	-0.000320
	(0.00952)	(0.00964)	(0.00970)	(0.00954)	(0.00909)
Observations	6141	6261	5799	5946	6322

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Additional placebo cutoffs (admin data)

Table: Additional placebo cutoffs - administrative data (employed)

	= 1 if employed				
	(1) 1997 to 2000	(2) 2001 to 2004	(3) 2005 to 2008	(4) 2009 to 2011	(5) 2012 and 2013
Panel A. Placebo cutoff at -120					
Treated	-0.0197	-0.0185	0.00132	-0.000455	0.00629
	(0.0196)	(0.0203)	(0.0200)	(0.0200)	(0.0210)
Number of workers	1933	1933	1933	1933	1933
Panel B. Placebo cutoff at -60					
Treated	0.00185	0.00863	-0.0163	-0.0309	0.0122
	(0.0205)	(0.0213)	(0.0206)	(0.0206)	(0.0217)
Number of workers	1787	1787	1787	1787	1787
Panel C. Real cutoff at 0					
Treated	-0.00486	-0.0109	0.00179	0.00726	0.0446**
	(0.0203)	(0.0209)	(0.0207)	(0.0208)	(0.0215)
Number of workers	1804	1804	1804	1804	1804
Panel D. Placebo cutoff at +60					
Treated	-0.00899	-0.00140	0.00264	-0.00419	0.00585
	(0.0207)	(0.0216)	(0.0211)	(0.0212)	(0.0220)
Number of workers	1728	1728	1728	1728	1728
Panel E. Placebo cutoff at +120					
Treated	0.0202	0.0220	0.0102	0.0165	0.0142
	(0.0198)	(0.0200)	(0.0197)	(0.0200)	(0.0209)
Number of workers	1960	1960	1960	1960	1960

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Additional placebo cutoffs (admin data)

Table: Additional placebo cutoffs - administrative data (earnings)

	Total labor earnings (log)				
	(1)	(2)	(3)	(4)	(5)
	1997 to 2000	2001 to 2004	2005 to 2008	2009 to 2011	2012 and 2013
Panel A. Placebo cutoff at -120					
Treated	0.00465	-0.0121	-0.0644	0.0324	-0.0988
	(0.0785)	(0.0898)	(0.0759)	(0.0753)	(0.0810)
Number of workers	1141	987	1066	1050	921
Panel B. Placebo cutoff at -60					
Treated	-0.0200	-0.0151	-0.00849	-0.0112	-0.0842
	(0.0758)	(0.0866)	(0.0731)	(0.0743)	(0.0777)
Number of workers	1029	862	988	970	833
Panel C. Real cutoff at 0					
Treated	0.175**	0.235**	0.148*	0.108	-0.0662
	(0.0819)	(0.0971)	(0.0857)	(0.0837)	(0.0870)
Number of workers	1056	902	985	952	867
Panel D. Placebo cutoff at +60					
Treated	0.0136	0.0603	0.0546	0.119	0.158*
	(0.0833)	(0.101)	(0.0832)	(0.0828)	(0.0875)
Number of workers	1007	810	943	924	863
Panel E. Placebo cutoff at +120					
Treated	0.0842	0.109	0.0960	0.0123	0.0547
	(0.0771)	(0.0887)	(0.0791)	(0.0766)	(0.0788)
Number of workers	1114	974	1028	1036	964

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Retirement age with fixed evasion

With given evasion trajectory the FOCs are:

$$V'(R^{DB}) + \sigma(R) = w\left(1 - (1-\theta(R))\tau - \frac{1}{L}\rho^{DB}\int_{R-L}^{R}(1-\theta(t))dt\right)$$

$$V'(R^{M}) + \sigma(R) = w\left(1 - (1-\theta(R))(1-\gamma)\tau - \frac{1}{L}\rho^{M}\int_{R-L}^{R}(1-\theta(t))dt\right)$$

Very similar to case without evasion ($R^M > R^{DB}$), a bit more cumbersome Back

Choosing both concealing trajectory and retirement age

- Can solve in two-step process:
  1. Solve for optimal earnings trajectory given a retirement age (previous section)
     - » Two levels of evasion for each system, high θ_h^S early on and low θ_l^S within the L-year window
  2. Use those conditions to derive the optimal retirement age (envelope theorem)

Optimality conditions for R:

$$V'(R^{DB}) = w\left[1-(1-\theta_h^{DB})\tau\right] - \sigma(\theta_h^{DB}) - \rho^{DB} w(1-\theta_l^{DB})$$
$$V'(R^{M}) = w\left[1-(1-\theta_h^{M})(1-\gamma)\tau\right] - \sigma(\theta_h^{M}) - \rho^{M} w(1-\theta_l^{M})$$

(assuming $V''(R) > \rho^{DB} w/\sigma''(\theta_l^{DB})$ and $V''(R) > \rho^{M} w/\sigma''(\theta_l^{M})$)

Retirement age conditions

- Balance increase in lifetime consumption from one additional period of high evasion with disutility of postponing retirement
  - Relevant margin is one more period of high evasion bc workers adjust to only evade little within the L-year window
- Which R is higher depends on parameters
- Forces that push the retirement age upwards and downwards relative to the DB system
  - Retire later bc increase pension fund (and prob DB part lower)
  - Retire earlier bc evade less when young (so pay more taxes)

  But reasonable conditions predict higher R for mixed system
  - We'd expect $\rho^{DB} w(1-\theta_l^{DB}) > \rho^{M} w(1-\theta_l^{M})$ for any R (DB part of mixed system lower than pension of DB-only system)
  - Then a sufficient condition: $\sigma(\theta_h^{DB}) - \sigma(\theta_h^{M}) + w\gamma\tau(1-\theta^{M}) > w\tau(\theta^{DB}-\theta^{M})$ (gain in pension fund and cost saving from evading less more than compensate higher taxes paid due to lower evasion)

Evasion within window

- With the optimal retirement age, can get the optimal level of evasion within the L-year window
- Which system this will be higher for depends on parameters
  - Higher retirement age and lower DB replacement rate in mixed system pushes evasion up
  - But fraction going to pension fund pushes evasion down
- But it will be for sure lower than the high level of evasion (it is likely to be 0 as well)

Back

Conditions for retirement age

$R^M > R^{DB}$ under two very reasonable sufficient conditions

1. $\rho^{DB}(1-\theta_L^{DB}) > \rho^M(1-\theta_L^M)$
   - (DB pension is greater than DB part of mixed pension)
     - Reasonable, given lower ρ, the idea is that workers in M do not evade so much less such that they end up getting a better DB part than the full pension of DB workers
2. $w\tau\gamma(1-\theta_h^M) + \sigma(\theta_h^{DB}) - \sigma(\theta_h^M) > w\tau(\theta_h^{DB} - \theta_h^M)$
   - (Gain in pension fund compensates the higher taxes paid net of the cost saving from evading less when young)
     - Also reasonable, taxes are not too high and the cost of evading is not too low

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Elasticities

- Getting an elasticity is complicated (interest rates, time discounting, uncertainty, lack of information)
- Basic approach: interpret as "tax cut" (contributions to ret acc = "take-home pay")
- Assume that half of contributions go to retirement account (in reality it varies)
- Net-of-tax rate increases by $\approx 9.3\%$:
  - With $\approx 22.5\%$ increase in earnings $\rightarrow$ Intensive-margin elasticity ≈ 2.4
  - With $\approx$ 5pp increase in employment $\rightarrow$ Extensive-margin elasticity ≈ 0.5

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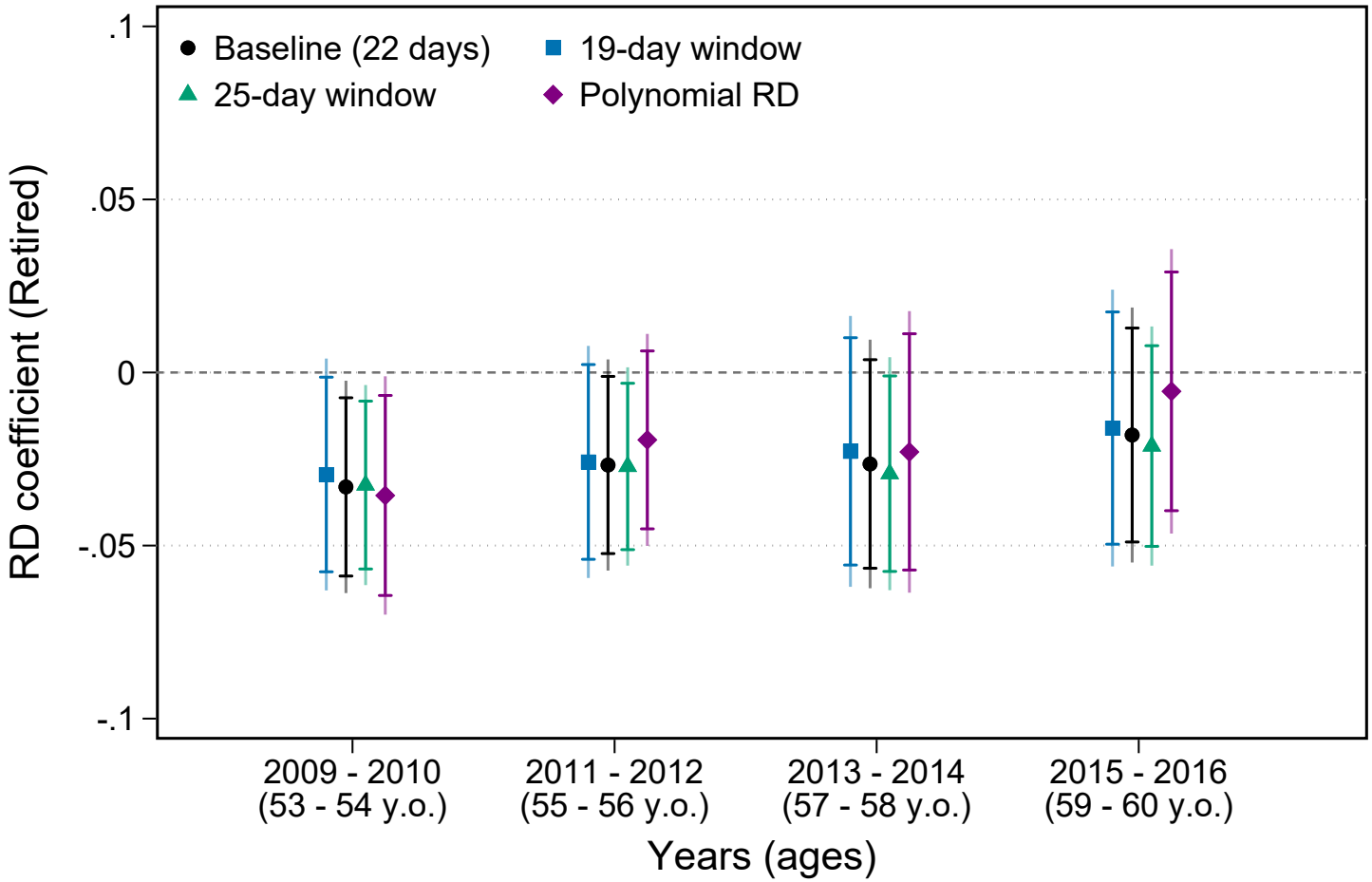
RD time series

Figure: Time series of RD coefficients (Retired IRS)



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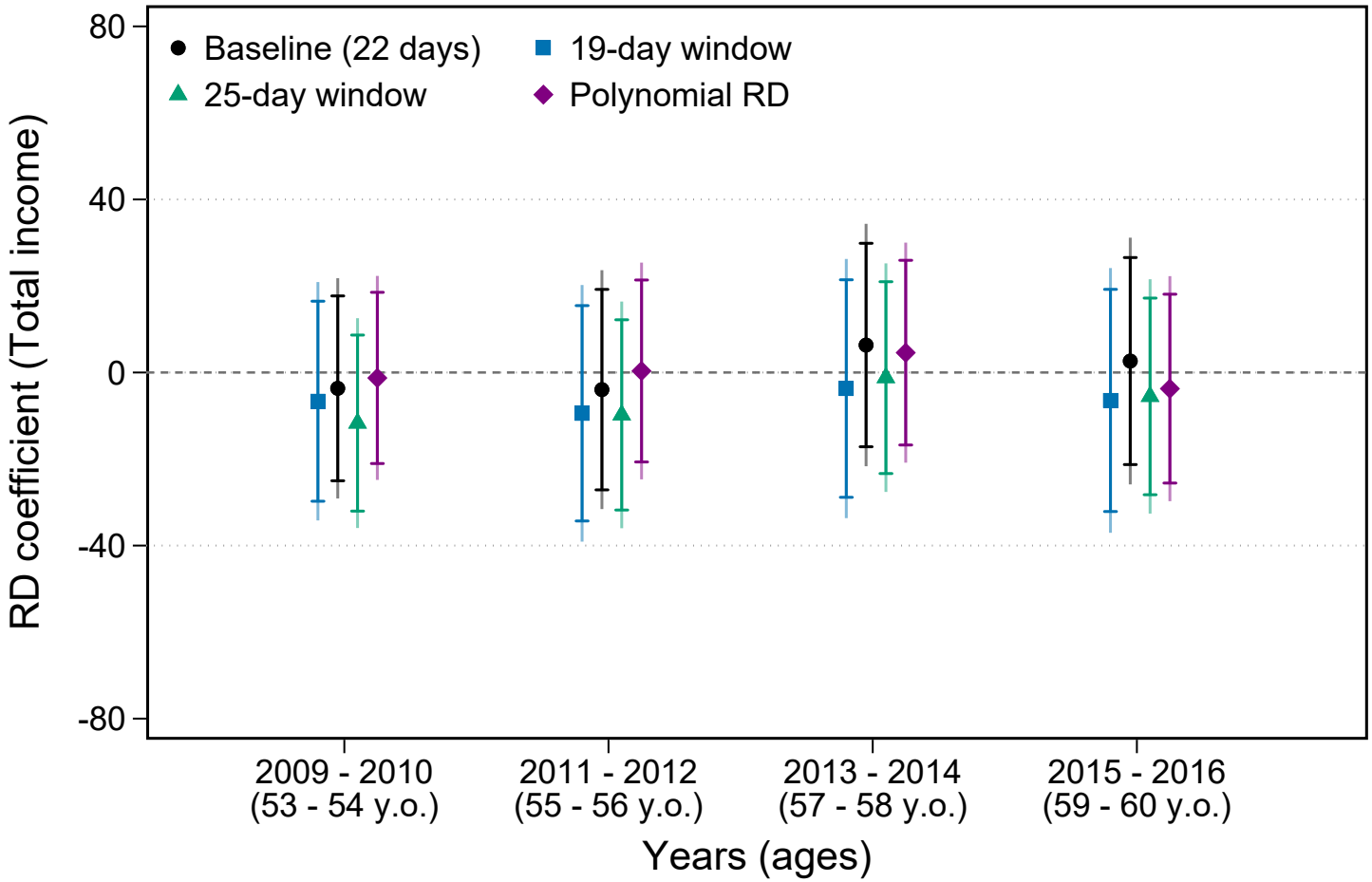
RD time series

Figure: Time series of RD coefficients (Retired IRS)



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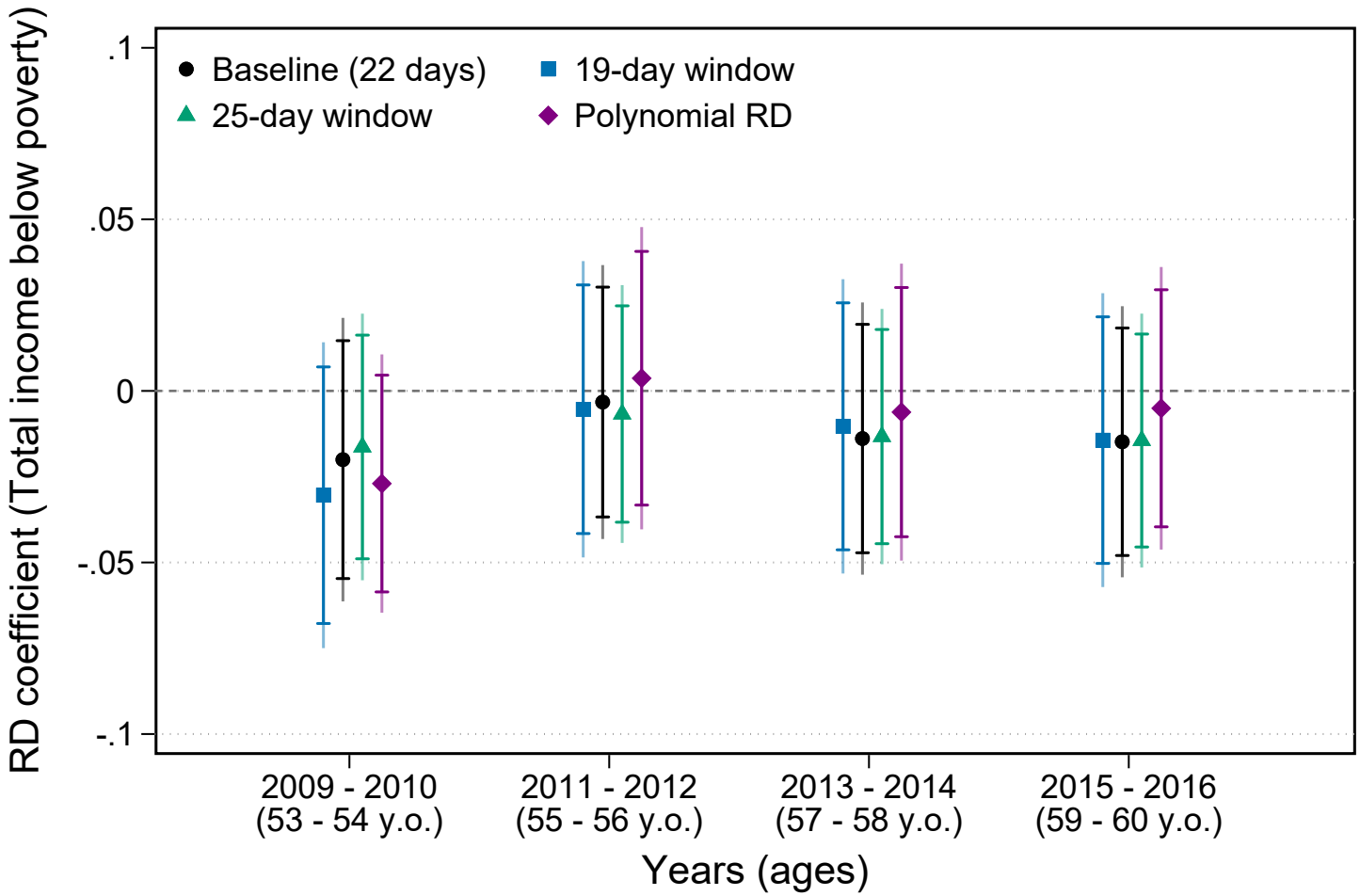
RD time series

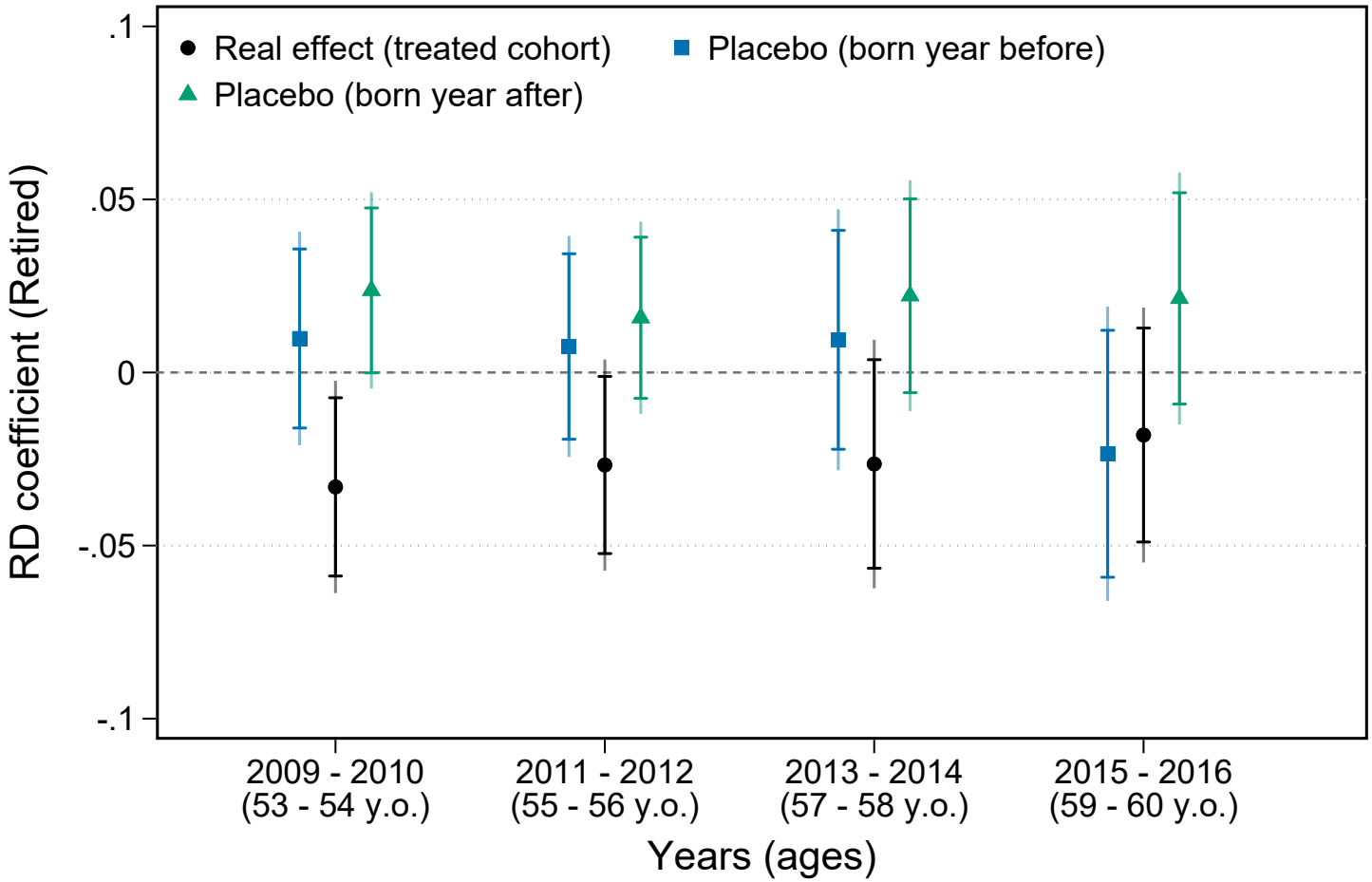
Figure: Time series of RD coefficients (Retired IRS)



Back to TS plot Back to robustness

RD time series

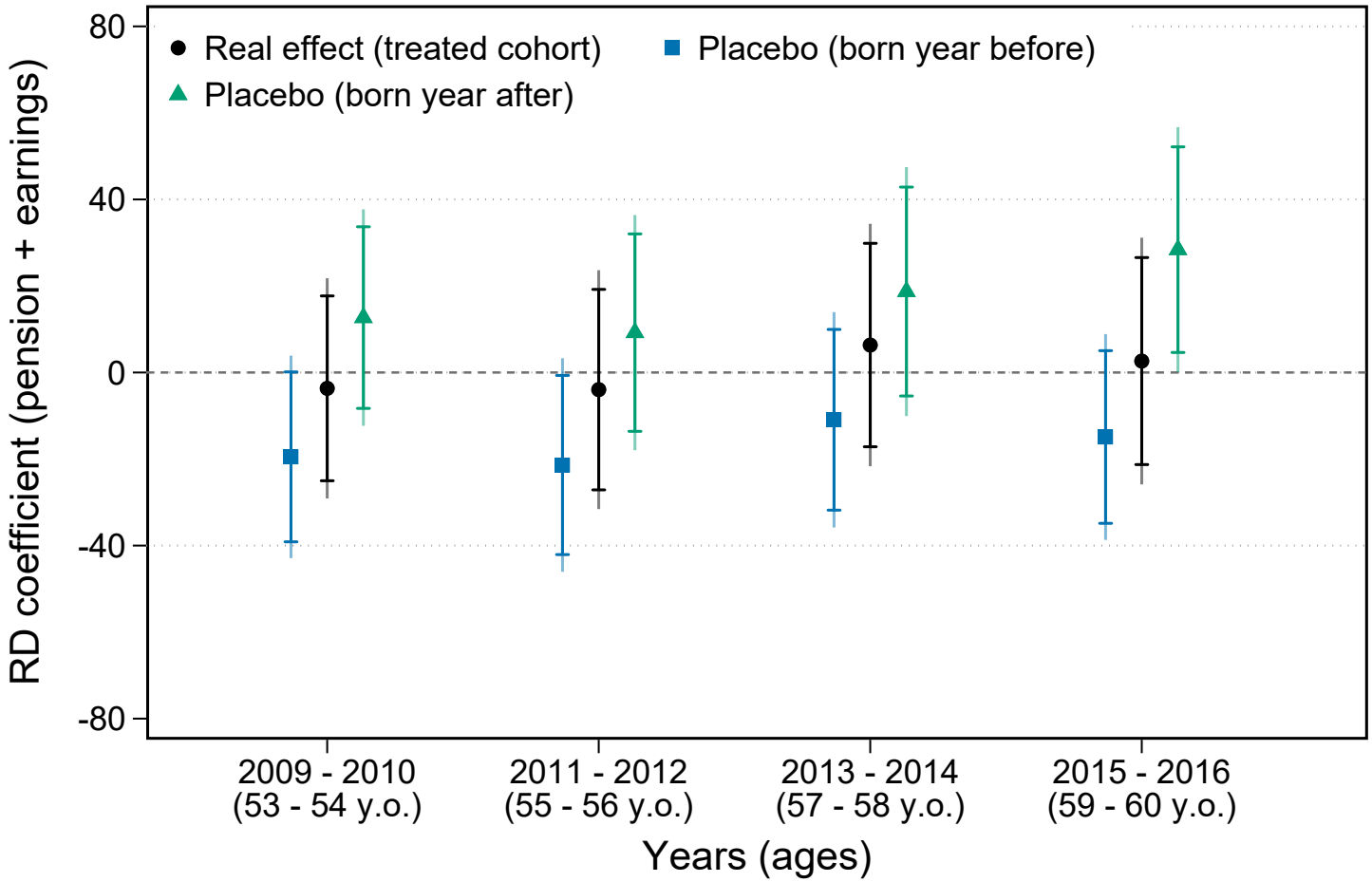
Figure: Time series of RD coefficients (Retired IRS)



Back to TS plot Back to robustness

RD time series

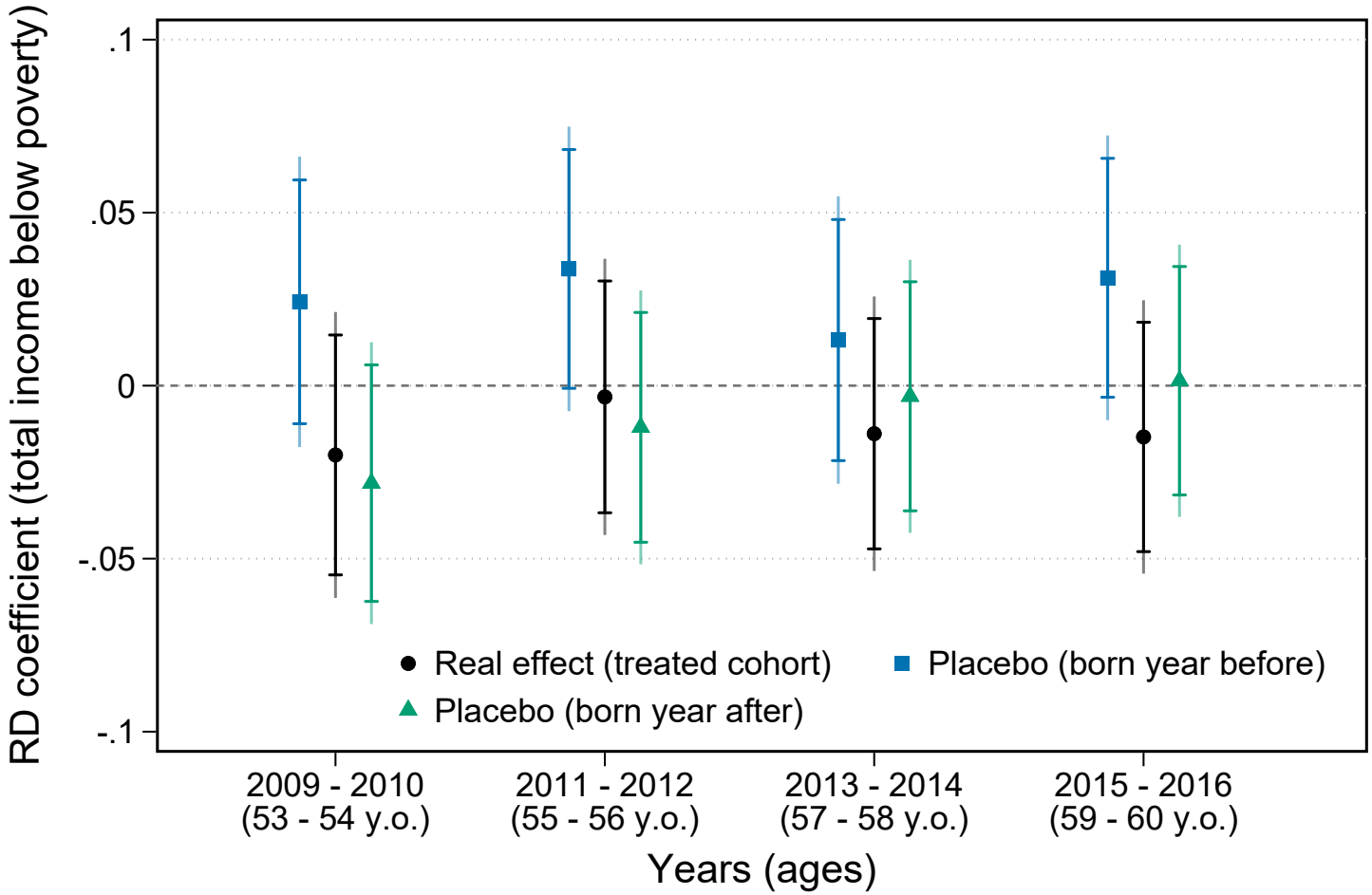
Figure: Time series of RD coefficients (Retired IRS)



Back to TS plot Back to robustness

RD time series

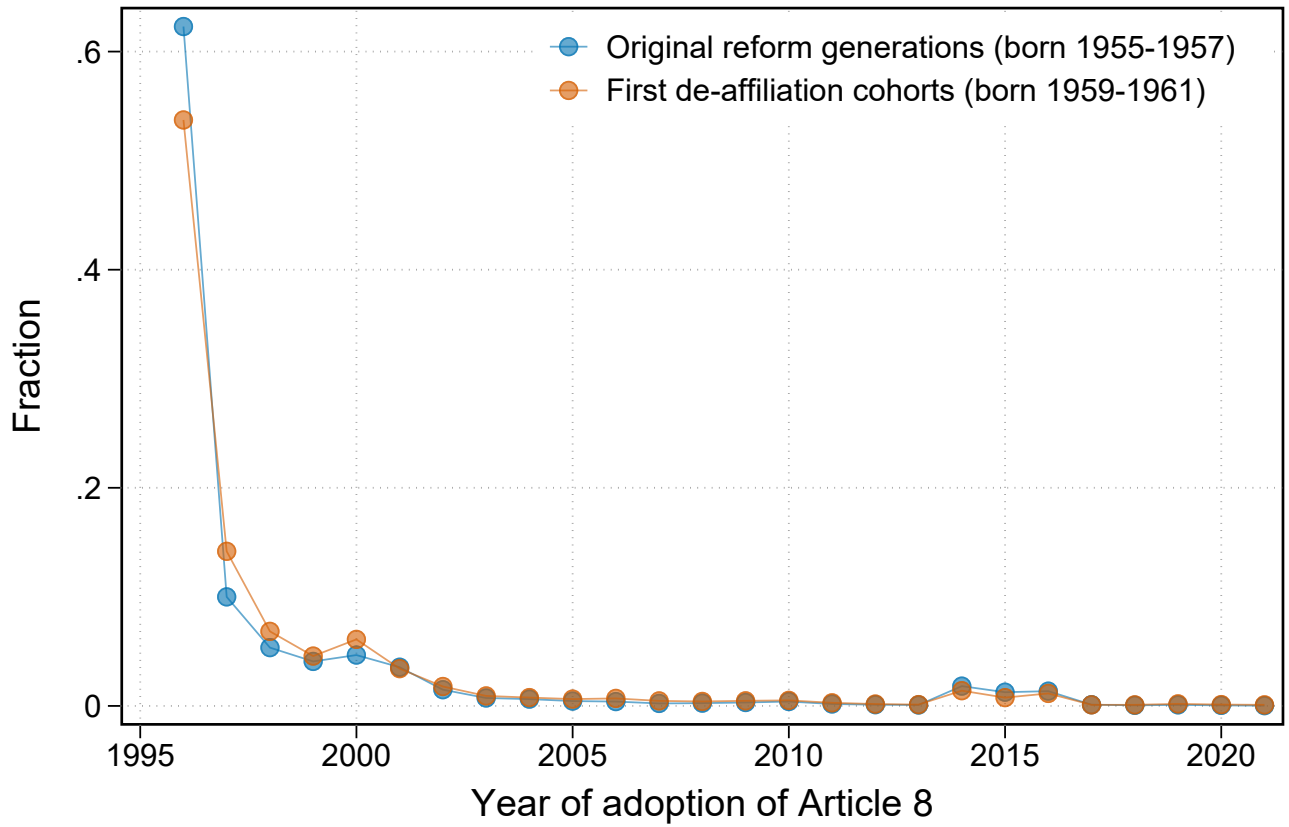
Figure: Time series of RD coefficients (Retired IRS)



Back to TS plot Back to robustness

Year of Article 8 choice

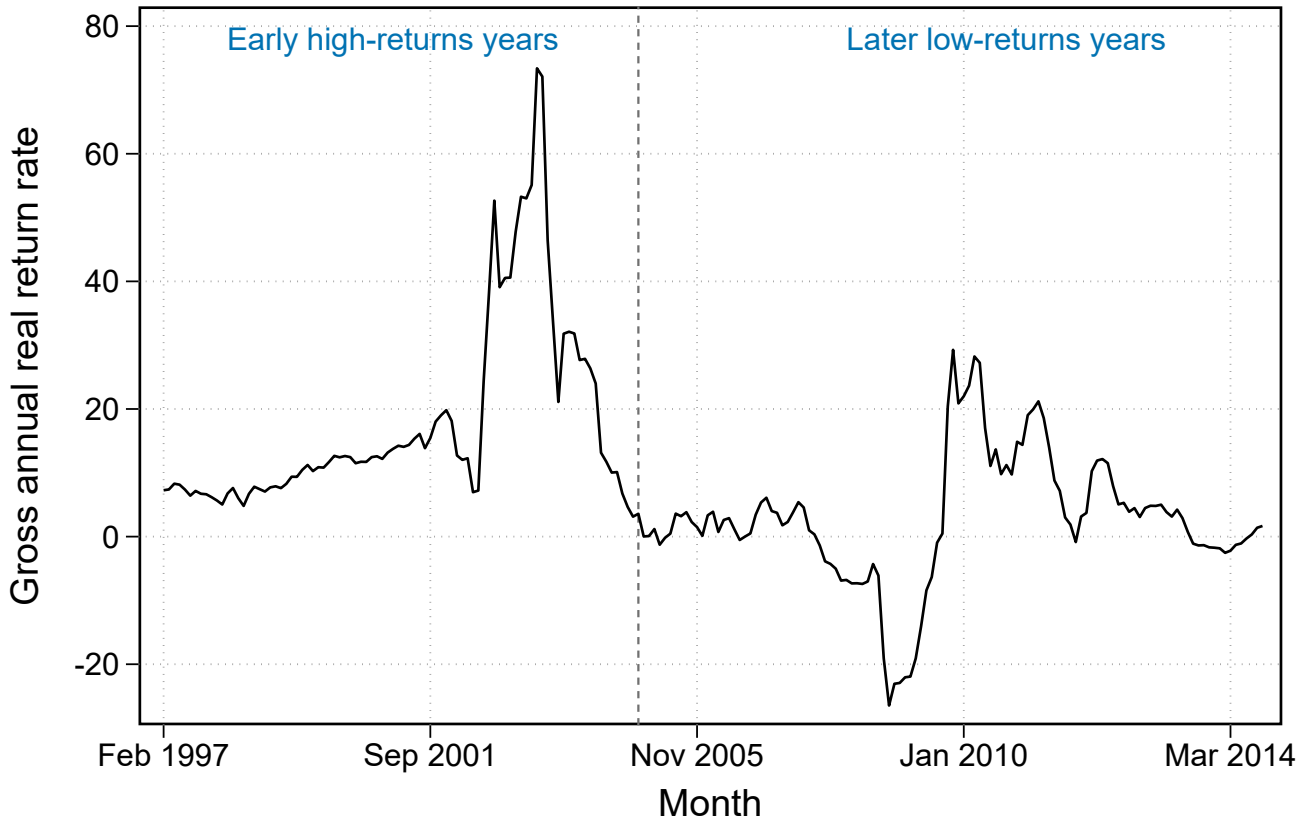
Figure: Year of Article 8 choice



- Among choosers, adopt early on Back

Returns over time

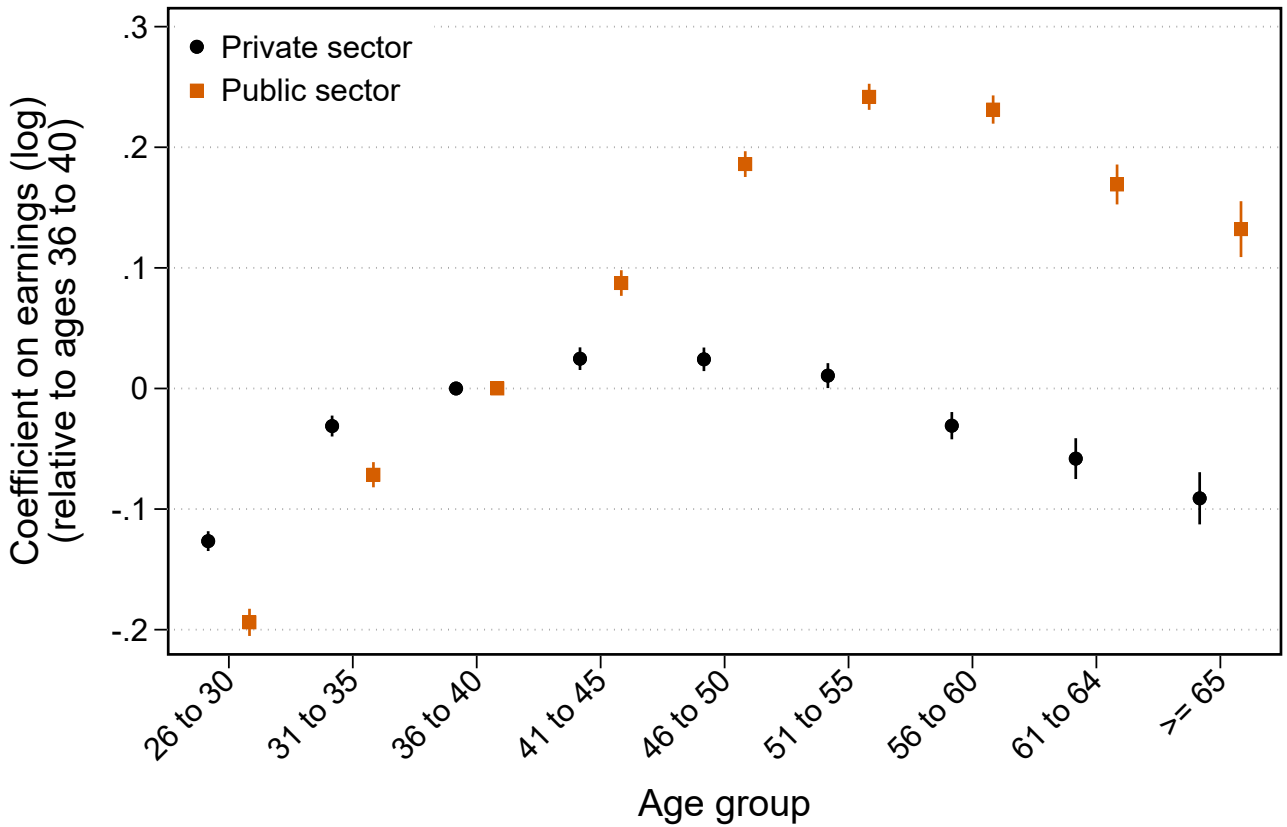
Figure: Gross real annual interest rate on pension funds



- Very high returns in early years, later not so much Back

Earnings profiles

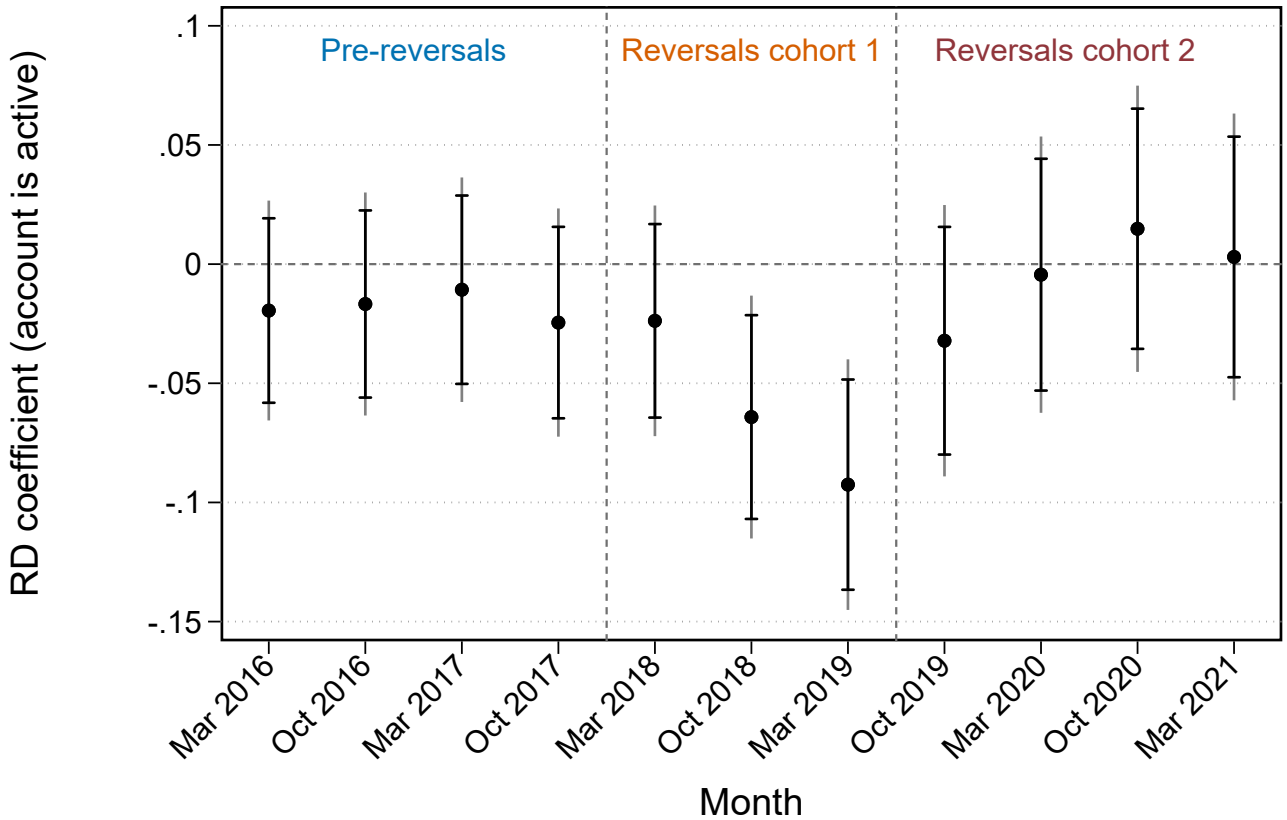
Figure: Age-earnings profile by public or private sector



- Steep earnings profile for public sector Back

Time series plot

Figure: Time series plot of RD coefficients



- People were similarly likely to be active prior to reform, converge when following cohort allowed to reverse