

COMING IN AT A TRICKLE:
THE OPTIMAL FREQUENCY OF PUBLIC BENEFIT PAYMENTS

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MOTIVATION: OPTIMAL DESIGN OF PUBLIC PAYMENT SCHEDULES

- Governments offer public transfer payments to qualifying citizens which pay out at **regular intervals** (UBI, UI, Social Security/SSI, SNAP/WIC)
- **Example:** pay cycle lengths for 36 OECD countries w/universal public pensions
 - | 31 operate on (semi-)monthly systems
 - | 2 every two weeks (Australia/New Zealand)
 - | 2 annually (Iceland/Ireland)
 - | 1 every two months (Japan)
- Also calendar variation within countries ("5th Friday" or "birthday" rules)
 - | Pro: fixing a calendar date for payments good if otherwise non-salient
 - | Con: can magnify welfare losses from self-control problems, liquidity constraints, etc.
- Extant research examines design of these programs in terms of limiting moral hazard, financing, redistributive consequences

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ONE BIG (NEST) EGG, OR MANY SMALL ONES?



Policy question

How should governments set the frequency of benefit payments?

- Introduce **su cient statistics** approach to determining optimal pay frequency
 - | Regulator faces tradeo : " frequency \Rightarrow " **admin costs** and # **welfare loss from consumption non-smoothing**
 - | Model can exibly accommodate various **behavioral frictions**
 - | Complements work on pay timing from employer's POV (Parsons & Van Wesep 2013)
- Empirical application to national Japanese Pension System (JPS)
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BASIC MODELING FRAMEWORK

- Govt. picks T to minimize welfare loss subject to balanced budget

Full model

$$\min_T \quad p \cdot \ell(T) + p \cdot b(T) + \ell(T)$$

- Govt. sets length of pay cycle T to equate the marginal reduction in the welfare loss to marginal cost of reducing T

$$\underbrace{p \cdot \ell'(T)}_{\text{marginal benefit}} = \underbrace{\ell'(T) + p \bar{B}}_{\text{marginal cost}}$$

- Depends on fraction of recipients p , the average daily benefit amount \bar{B} , **slope** of welfare loss $\ell'(T)$ and cost function $\ell'(T)$
- Key challenge: admin costs and welfare losses not directly observed
 - Exploit local exposure to 1980s pension system reform which moved $T = 90 / 60$
 - Admin costs increase by 4% \Rightarrow fairly flat cost function

Jump

WHAT UNDERLYING BEHAVIORS COULD GENERATE NON-SMOOTHING?

- 1 Liquidity constraints: Zeldes (1989); Broda & Parker (2014); Baker (2018) [By age](#) [By quality](#)
 - 1 No retirement consumption drop + similar responses by income based on store quality
- 2 Near-rationality (Kueng 2018): welfare loss is small relative to permanent income
 - 1 Payday spending similar across distribution of avg. total spending [Jump](#)
- 3 Consumption commitments: timing of bills matches timing of income
 - 1 Chetty & Szeidl (2007); Vellekoop (2018) focus on mortgage payments
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INTUITION: OPTIMAL FREQUENCY UNDER TWO “NAIVE” INTERNALITIES

- 1 **Quasi-hyperbolic discounting:** with $\beta < 1$ discounting, as β^t consumption declines almost linearly over pay cycle at rate $f(t) = \beta^t$ [Details](#) [Figure](#)

- 2 **Mental accounting (“payday liquidity”):** extra spike in consumption on payday $x(T)$

- For log utility, inc. frequency of payments ($T \neq$) can improve welfare if... [Details](#)

$$\left| \frac{1 + x(T)}{Z} - \log \frac{1 + x(T)}{Z} \right| > \frac{T}{Z} x'(T) \quad (1)$$

loss from spike magnitude as $T \uparrow$
gain from subdivision as $T \uparrow$

- $\theta(T)$ quantitatively very similar regardless of underlying behavioral mechanism

- True for a wide range of parameter values (i.e. not just in our setting)

- Calibrated model offers support for monthly payment schedules [Jump](#)

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EMPIRICAL SETTING: JAPANESE PUBLIC PENSION SYSTEM

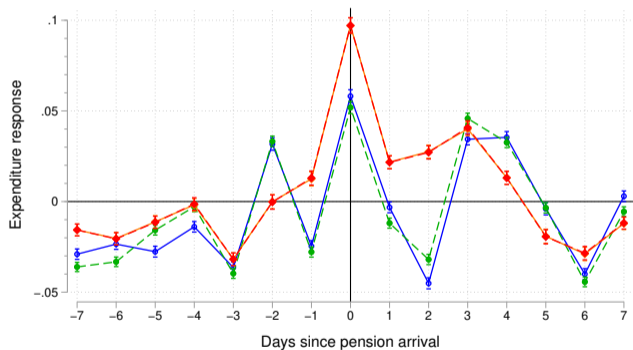
- Largest public pension fund in the world (\$474 bil. paid out annually)
- Structure similar to U.S. Social Security [Background](#) [Sample profile](#)
 - Early retirement age 60, normal retirement age 65, late retirement until age 70
- Paydays scheduled for the 15th of each even month
 - If scheduled date falls on Saturday, Sunday, or public holiday, moved to first previous non-holiday weekday ⇒ **random variation in pay cycle length**
- Pension payments account for > 80% of income for recipients (survey evidence)

TIMESTAMPED RETAIL DATA ON SHOPPER SPENDING HISTORIES

- **Hourly** retail scanner data from Japanese marketing research firm
 - | Covers regional grocery store chains for 2011-14
 - | Prices and quantities at barcode level Classification
- **Shoppers' purchase history connected to loyalty point card**
 - | Basic demographic info: store/chain ID, Census region, gender, and age (MM/YYYY)
 - | Use age to determine pension eligibility (intent to treat)
 - | Scale up by claiming probability from retirement surveys (95% claim by age 65)
- Apply restrictions to obtain set of **regular (weekly) shoppers** and stores visited
 - | Final sample: 511 stores spread across 21 chains, 416,726 unique shopper IDs Selection
 - | 28% above normal retirement age, 41% reach early retirement age Summary stats

BASELINE: HIGH-FREQUENCY EVENT STUDY AROUND PAYDAYS

$$\frac{X_{i;c;t}}{\bar{X}_{i;c}} = \sum_{j=-7}^7 \beta_j \text{Payment}_{i;t+j} + \text{dow} + \text{wom} + \text{my} + \text{h} + \text{i} + \text{i;c;t} \quad (2)$$



—●— Baseline
—■— Chain x month-year FEs
- -▲- - Day-of-week x shopper FEs
—◆— Chain FEs

- Hetero. treatment effects due to preferences over store brands
- Use 10% " to calibrate behavioral frictions underlying (T)
 - Same as spike in spending on perishables Robustness
 - \Rightarrow = 0.2% daily consumption decline in between paydays
- Spending concentrated in **spurge goods** like prepared foods (22% " Evidence) and alcohol (28% " Evidence)

CALENDAR VARIATION IN INTERVALS TO TEST FOR PENT-UP DEMAND

$$\frac{X_{i;c;t}}{\bar{X}_{i;c}} = \text{Payday}_t \text{ Length}_{t2p} + \text{dow} + \text{wom} + \text{my} + \text{h} + \text{i} + \text{i}_{c;t} \quad \text{Attention} \quad (3)$$

	(1)	(2)	(3)	(4)	(5)	(6)
<i>Payday</i> <i>Length</i>	0.0013 (0.0000)	0.0015 (0.0000)	0.0052 (0.0007)	0.0055 (0.0007)	0.7360 (0.0330)	0.7390 (0.0330)
<i>Payday</i> <i>Length</i> ²			0.00001 (0.0000)	0.00001 (0.0000)	0.0247 (0.0011)	0.0248 (0.0011)
<i>Payday</i> <i>Length</i> ³					0.0002 (0.0000)	0.0002 (0.0000)
<i>Length</i>		0.0002 (0.0000)		0.0002 (0.0000)		0.0002 (0.0000)
Joint F-test (p-value)	{	{	0.000	0.000	0.000	0.000
N	660,895,995	660,895,995	660,895,995	660,895,995	660,895,995	660,895,995
Adj. <i>R</i> ²	0.017	0.017	0.017	0.017	0.017	0.017

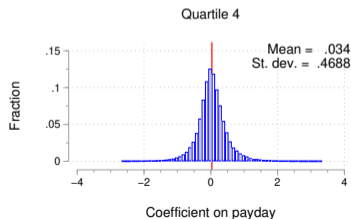
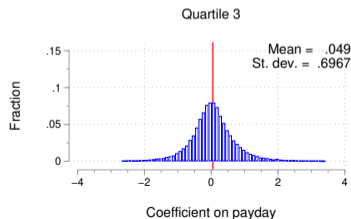
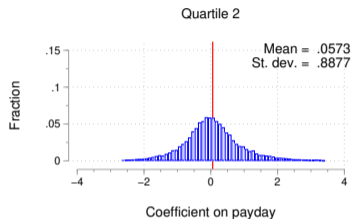
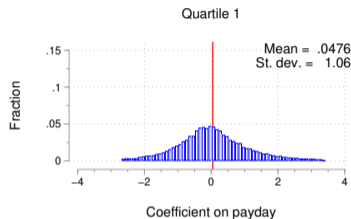
- ⇒) 0.13 p.p. inc. in payday spending for each extra day in pay cycle *p*

[Details](#)
[Theory](#)

LIMITED EVIDENCE IN FAVOR OF LIQUIDITY/NEAR-RATIONALITY STORY

Other channels

$$X_{c;t}^i = \bar{X}_{i;c} = \beta^i \text{Payday}_t + \text{dow} + \text{wom} + \text{my} + \text{h} + \frac{i}{t}$$



- Run separate time series regression for each shopper age 65
- Sort b_i by i 's quantile of avg. total pay cycle expenditures
- Total spending reasonable proxy for permanent income (Kueng 2015,18)
- **Stable avg. payday response across PI dist.**

Continuous

By decile

SEPARATING RETAILER RESPONSES FROM “SPLURGE” SPENDING

- Formally decompose observed store-level daily inflation $\Delta\Phi_{s;t}$ into... Decomposition
 - **Consumer variety effects:** buying more barcodes in set of commonly purchased goods Ω^*
 - **Consumer substitution effects:** quality upgrading Ω^{new} vs. Ω^{old} Evidence
 - **Retailer response:** sales or change in discount rate or regular price within Ω^*
- **Punchline:** quantitatively small retail pricing response, driven by targeted temporary sales strategy on payday Filters
 - For above (below-) median priced goods, payday sales 1.5 p.p. less (more) likely, with 1 p.p. less (more) generous discounts Distributions
 - Effect on $\Delta\Phi_{s;t}$ quantitatively important only for prepared foods
 - Uniform pricing across stores (DellaVigna & Gentzkow 2019) / use chain time FEs
 - Robust to choice of temporary sales filter (Kehoe-Midrigan or Nakamura-Steinsson)

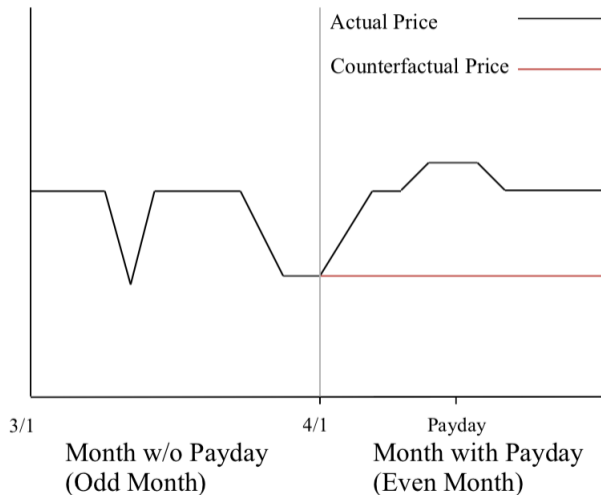
Menu cost model

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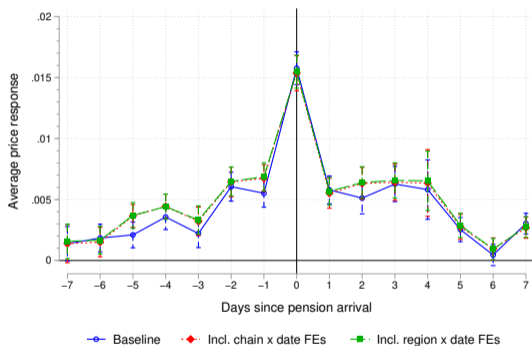
ILLUSTRATION: COUNTERFACTUAL "LAST PRICE" INDEX



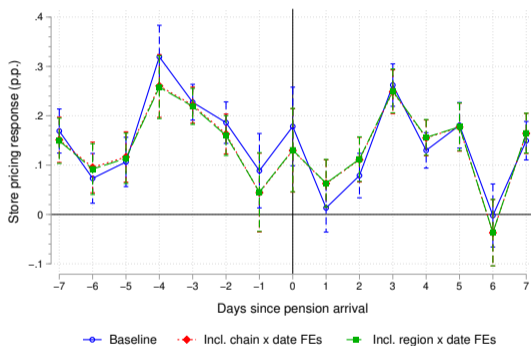
- **Idea:** hold fixed barcode-level p to isolate demand changes
- Two-step procedure:
 - 1 Event study w/outcome $\Delta\Phi_{s;t}$
 - 2 Same event study w/outcome $\Delta\Phi_{s;t}^{last}$ and take difference in coefficients
- Check robustness to measures of "last" prices Check
 - | Last month index (diagram)
 - | Last week index using prices in week before payday

NO CLEAR RETAILER PRICING RESPONSE AROUND PAYDAY

Store level average price index $\Phi_{s;t}$



Retailer response = $\Delta\Phi_{s;t}$ $\Delta\Phi_{s;t}^{last}$



- $< 10\%$ of store-level inflation around payday due to retail price changes By category
- \Rightarrow "menu costs" sufficiently large that $P(T) \approx P$ is a reasonable simplification

NATURAL EXPERIMENT TO ESTIMATE SLOPE OF ADMIN COST FUNCTION

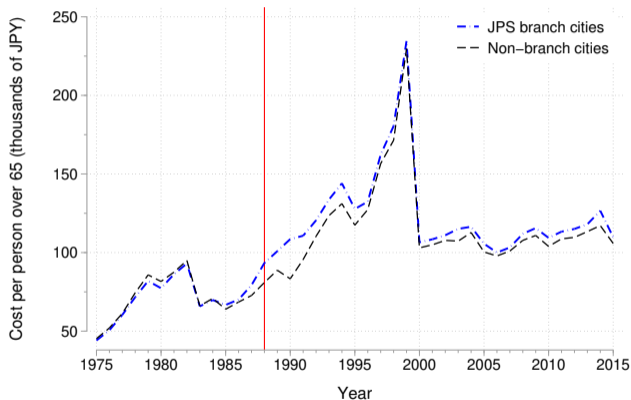
$$p \frac{\partial \{Z(T)\}}{\partial T} = \frac{\partial \{Z(T)\} + p \bar{B}}{\text{marginal cost}}$$

- Use 1988 reform to the JPS which **only altered pay frequency** without changing eligibility criteria or generosity of benefits
 - Transitioned from payments every 3 months to every 2 months ($T = 90 / 60$)
- **Identification:** exploit fact that municipal budgets differentially exposed to admin costs of the reform depending on whether they have one of 312 local JPS branch offices
 - Local offices run day-to-day operations of JPS w/o managing pension funds
 - Admin costs: applications, reconciling benefits, confirming eligibility, investigating fraud
- Data: local public spending on elderly welfare benefits from PM's Cabinet Office
 - National welfare programs, so per capita non-JPS spending differenced out

DiD ANALYSIS => 4% " IN ADMIN COSTS FROM MOVING $T = 90 ! 60$

Intro

$$\log j_{;t} = \text{Branch}_j \text{ Post}_t + j + t + j;t \quad (4)$$



- Small uptick in costs among JPS branch cities starting in FY 1987
- Branch office cities more populated, but similar per capita spending on elderly
- At most, covariate-adjusted uptick in costs of 7%

Map + balance

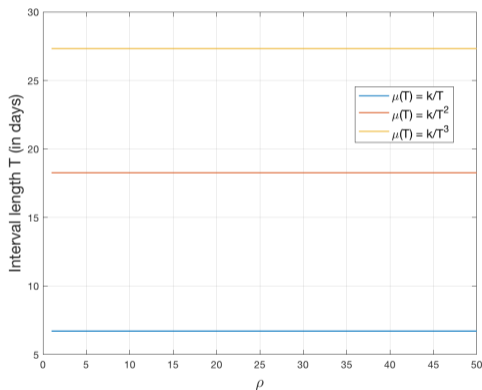
Table

Notes: Municipal spending in thousands of real 2012 JPY on administering the pension system and elderly welfare benefits divided by the number of persons over age 65 residing in the municipality.

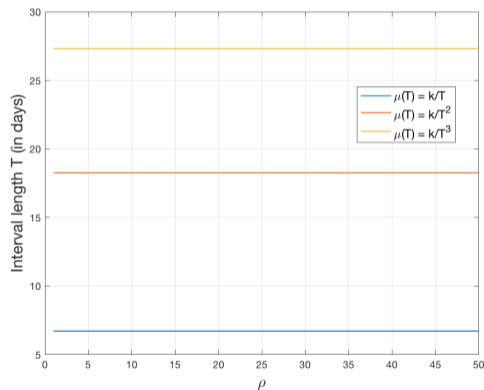
OPTIMAL FREQUENCY FLAT W.R.T. INVERSE IES

Main Deck Admin Cost

Quasi-hyperbolic Discounting



Payday Liquidity



- T very weakly decreasing in ρ (out to 6 decimals), **regardless of type of internality**
- Logic: welfare loss $\Delta W(T)$ varies a lot with ρ , but marginal loss $\partial W(T)/\partial \rho$ does not

IMPLICATIONS FOR PENSION ELIGIBILITY AGE REFORMS

- Many countries with pay-as-you-go systems raising retirement age to cut costs as birth rate declines
 - Japan: phased increase in NRA from 60 to 65
 - France: April 2023 increase from 62 to 64 / **protests!**
 - UK: phased increase from 65 to 67 between 2020 to 2028
- **Alternative:** cut admin costs by sending same pension amount but in fewer payments

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COST COMPARISONS: ELIGIBILITY AGE VS. PAYMENT FREQUENCY REFORMS

- Consider raising NRA for at-rate pensions from 65 to 70
- **Counterfactual:** what would be the increase in pay cycle length $\Delta T > 0$ required to reduce (nominal) costs by an equivalent amount to raising the NRA?
- **Answer:** equivalent to moving along the cost function from $T = 30$ (our upper bound optimum) to $T = 45$, or payments every 6.5 weeks
 - | 36.12 billion JPY in initial annual savings at stake [Details](#)
 - | Assume distribution of claiming ages from Japanese Pension Survey in 2021 / valid if moral hazard is minimal
 - | Caveat: ignores the revenue side, so opportunity cost of keeping NRA fixed might be greater
- In practice, gains to increasing T and NRA simultaneously ("double dividend") [Result](#)
 - | Intuition: govt. FOC easier to satisfy when fraction eligible declines $\Rightarrow T^* "$

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CONCLUSION: SUPPORT FOR PREVALENCE OF MONTHLY PAY CYCLES

- First paper to consider payment frequency as a policy parameter
- Framework is simple, but can be applied to any country and public benefit program with data on costs and high-frequency recipient behavior
- In the empirical application, we show:
 - ┆ Large spike in expenditures on payday which appears to be unrelated to liquidity proxies
 - ┆ Mental accounting, or consumer type switching within pay cycle
 - ┆ Limited evidence of retailer price discrimination \Rightarrow menu costs are large
 - ┆ Calibrated model yields optimal frequency = 1 month
- Variety/substitution effects are important drivers of prices during peak demand periods.
- Lowering pension frequency might be more attractive than raising retirement age

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Appendix

Consumer responses to the timing of (regular) payments:

- | Stephens (2003,06); Shapiro (2005); Dobkin & Puller (2007); Mastrobuoni & Weinberg (2009); Foley (2011); Stephens & Unayama (2011); Evans & Moore (2012); Gelman et al. (2014); Olafsson & Pagel (2018); Vellekoop (2018); Baker (2018); Baugh & Wang (2021); Baugh & Correia (2022); Zhang (2022); Gross, Layton, Prinz (2022)

Motivations for consumption non-smoothing behavior:

- | Zeldes (1989); Thaler (1999); Human & Barenstein (2005); Chetty & Szeidl (2007); Broda & Parker (2014); Farhi & Gabaix (2020); Kueng (2015,18); Parker (2017); Hastings & Shapiro (2018); Chevalier & Kashyap (2019); Baugh, Ben-David, & Parker 2021

Retailer pricing during peak demand periods:

- | Warner & Barsky (1995); MacDonald (2000); Chevalier, Kashyap, Rossi (2003); Nevo & Hatzitaskos (2006); Hastings & Washington (2010); Goldin, Homono, & Meckel (2022)

Retirement consumption puzzle:

- | Bernheim, Skinner, & Weinberg (2001); Aguiar & Hurst (2005); Battistin et al. (2009); Stephens & Unayama (2012); Agarwal, Pan, Qian (2015); Olafsson & Pagel (2020)

Japan's mandatory public pension system (JPS) has two tiers

- | National pension (NP): at-rate pension w/compulsory coverage for residents age 20-59
- | Employee pension insurance (EPI): earnings-related pension with compulsory coverage for those employed full-time by private company with 5 workers
- | NP and EPI implemented jointly as one system (i.e. same payment timing)

Other features related to payment amounts

- | Earnings test: if working beyond age 65, EPI benefit reduced or suspended if monthly EPI payment + wages > 460,000 JPY
- | Normal retirement at age 65, with early (60-64) or deferred (66-70) collection possible
- | Not very generous compared to other OECD countries: 2012 full NP amount was 780,100 JPY (\$7,800) per year for 40 years of contributions

Both NP and EPI payments are distributed regularly on the 15th of even months

If scheduled benefit delivery date falls on a Saturday, Sunday, or public holiday, it is moved to the first previous non-holiday weekday

22 delivery dates in our sample time period: 15 on the 15th, 4 dates moved to the 14th and 3 moved to the 13th

Payments usually arranged via bank transfer when pensioners submit a form to local office to begin claiming benefits

- | Local city offices not directly involved in remitting payments
- | But involved in processing applications and withholding taxes from pension payments

Source: "Japan Pension Service and its Operation", Japan Pension Service, April 2017 Report.

[Main deck](#)

Source: "Japan Pension Service and its Operation", Japan Pension Service, April 2017 Report.

[Main deck](#)

Estimation sample: identifying "regular" shoppers

Main deck

Regular shoppers with k store visits each month

Baseline: always restrict to weekly shoppers ($k = 4$)

Defining regular shopper panel helps pin down consumption

Non-regular shoppers either have access to storage or do their spending elsewhere

Check results similar for $k = 2$ (every other week)

Retail Expenditures Summary Statistics Main deck

	All Goods	Raw Foods
Avg. monthly expenditures	23,102 (15,752)	10,127 (7,260)
Avg. expenditures per trip	2,320 (1,180)	1,086 (579)
Avg. number of monthly trips	9.1 (6.2)	8.5 (5.7)
Avg. periodicity	2.7 (2.5)	2.9 (2.7)
% Early retirement age	40.6%	42.7%
% Normal retirement age	27.9%	29.3%
# Stores	511	511
# Shoppers	1,035,431	831,662

One-digit goods category classification system

Main deck

One-digit Category	Two-digit Category	Four-digit Categories
Fresh fruits & vegetables	Fresh fruits	seasonal fruits, imported fruits, assorted fruits, fruit-related products,
	Fresh vegetables	leafy veg., stalk veg., root crops, edible plants, edible seeds, mushrooms, germinated veg., assorted veg.
Processed fruits & vegetables	Processed fruits	frozen fruits, cut fruits,
	Processed vegetables	boiled veg., frozen veg., cut veg.
Fresh sh	Fresh sh	round items, let, shell sh, assorted sh
	Sashimi	brick form, sashimi, tataki, raw sh, assorted fresh sh
Preserved sh products	Salted & dried sh	boiled sh, frozen sh, seasoned sh, pickled sh, salted sh, dried sh, sh eggs, seaweed
Raw meat & poultry	Beef	wagyu, domestic beef, imported beef,
	Pork	domestic pork, imported pork
	Chicken	domestic chicken, imported chicken, brand name chicken, duck meat
	Meat varieties	lamb, horse meat, minced meat, o al, raw meat, eggs, dairy products
Grains	Cereals	powder, rice, mochi, raw noodles, dough, bread, cereal

One-digit Category	Two-digit Category	Four-digit Categories
Other processed foods	Seasonings	cooking oil, spices, condiments, spread/dips, toppings, rice seasoning
	Dry produce	dried sh, dried fruits
	Processed food	pickled items, processed sh, pastes, cooked beans, processed meats
	Instant foods	cup noodle, instant soup, frozen foods, sealed rice pouch
Prepared foods	Semi-prepared dishes	fried, simmered, grilled, Japanese, Western, Chinese
	Side dishes	fried, grilled, grilled eel, Japanese, Western, Chinese
	Bento	cooked rice, sushi, bread dishes, noodle dishes
Sweets and desserts	Confectionery	toppings, jelly/pudding, ice cream, frozen confections, candies/cookies, rice crackers
Non-alcoholic beverages	Beverages	co ee/tea, milk-based drinks, vegetable/fruit drinks, soft drinks
Alcohol	Alcohol	beer, liqueurs, wine liquor, sake
Tobacco	Tobacco	tobacco
Other discretionary	Other	owers, gifts/confections, kiosk goods, service counter goods

Payday Spending Responses by Margin and Goods Category

Main deck

Category	Overall	Incl. Chain FEs	Intensive	Extensive
All goods	0:059 (0.001)	0:099 (0.002)	0:096 (0.002)	0:001 (0.000)
Raw foods	0:053 (0.001)	0:093 (0.002)	0:093 (0.002)	0:001 (0.000)
Prepared foods	0:079 (0.003)	0:212 (0.007)	0:219 (0.006)	0:002 (0.000)
Sweets/desserts	0:069 (0.003)	0:166 (0.007)	0:167 (0.007)	0:006 (0.000)
Alcohol	0:137 (0.008)	0:275 (0.053)	0:281 (0.051)	0:004 (0.000)
Fresh produce	0:044 (0.002)	0:077 (0.003)	0:076 (0.003)	0:001 (0.000)
Fresh sh	0:060 (0.003)	0:226 (0.009)	0:225 (0.009)	0:001 (0.000)
Meat & poultry	0:049 (0.002)	0:141 (0.005)	0:132 (0.004)	0:002 (0.000)

Category	Overall	Incl. Chain FEs	Intensive	Extensive
Grains	0:024 (0.003)	0:092 (0.009)	0:073 (0.008)	0:001* (0.000)
Non-alcoholic beverages	0:048 (0.002)	0:110 (0.006)	0:101 (0.006)	0:005 (0.000)
Tobacco	0:137 (0.026)	0:135 (0.086)	0:140* (0.079)	0:001 (0.001)
Processed fruits/vegetables	0:051 (0.006)	0:180 (0.039)	0:120 (0.037)	0:002 (0.000)
Preserved sh	0:028 (0.003)	0:064 (0.011)	0:060 (0.010)	0:002 (0.000)
Other processed foods	0:056 (0.002)	0:107 (0.003)	0:102 (0.003)	0:003 (0.000)

Spending concentrated in discretionary goods categories

Notes: Each cell in the table is the coefficient on Payment from a separate regression within a particular expenditure subcategory. Overall refers to the spending response and including shopper-day observations of zero expenditures. The second column indicates how our point estimates of the overall spending response changes when we include store chain fixed effects. The dependent variable in the intensive margin regressions is expenditures on a store visit relative to average daily expenditures. The dependent variable in the extensive margin regressions is a dummy for whether the shopper makes a purchase on a given date. In each regression, we winsorize the top 1% of total daily expenditures. Robust standard errors clustered by shopper ID in parentheses. **p < 0:001; *p < 0:01; *p < 0:05; +p < 0:1

Response of Major Subcategory Expenditures to Payday [Main deck](#)

(a) Prepared Foods

(b) Sweets/Desserts

(c) Alcohol

(c) Fresh Produce

(d) Fresh Fish

(e) Meat & Poultry

(f) Grains

(g) Non-alcoholic beverages

(h) Tobacco

Restrict to age ≥ 65 y.o. and interact payday dummy with length of pay cycle

$$\frac{X_{i;c;t}}{\bar{X}_{i;c}} = \beta_1 \mathbb{1}_{\text{Payday}_t} \text{Length}_{t2p} + \beta_2 \mathbb{1}_i \text{Payday}_t \text{Length}_{t2p}^2$$

Control: $\mathbb{1}_{\text{Payday}_t} = 0 \Rightarrow C_0 = \bar{c}$

- | \bar{c} not pinned down for pensioner pay cycles if include non-recipients in the control
- | Hence, we use Payday_t rather than $\text{Payment}_{i;t}$ here

Treatment: $\mathbb{1}_{\text{Payday}_t} = 1 \Rightarrow C_0 = \bar{c} \left(1 + \frac{\beta_1 T + \beta_2 T^2}{x(T)} \right)$

Length_{t2p} varies between 57 and 62 days in our sample

Raw Daily Google Searches for \Public Pension Payments

Main deck

Notes: The figure displays the daily time series of the Japanese Google SVI for "public pension payments." Dashed red lines indicate scheduled pension payment dates during our sample period for the scanner data.

$$\Delta SVI_t = \sum_{j=7}^{X^7} \beta_j \text{Payday}_{t+j} + \gamma_1 t + \gamma_2 \text{dow} + \gamma_3 \text{wom} + \gamma_4 \text{my} + \gamma_5 \text{h} + \gamma_6 \text{p} + \epsilon_t$$

Run time series regressions using Google SVI for "public pension payments" relative to average daily SVI as outcome

- Include linear time trend and dummies for other pension system announcements

Search activity peaks 20% on the day prior to a scheduled payday

Placebo w/randomized paydays shows no search spike ⇒ inattention unlikely to play a role here

Flat relationship between permanent income and payday response

$$X_{c;t}^i = \bar{X}_{i;c} = \beta^i \text{Payday}_t + \beta_{\text{dow}} + \beta_{\text{wom}} + \beta_{\text{my}} + \beta_{\text{h}} + \beta_t^i$$

Main deck

Notes: We estimate the time series regression pictured above for each individual shopper ID using all goods expenditures. The figure fits a local linear function to the relationship between payday responses β^i and average expenditures over the two-month pay cycle. We winsorize the top 1% of daily expenditures. 99% confidence intervals represented by the gray shaded area.

Payday Expenditure Responses by Permanent Income Dec Main deck

	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Intensive margin	0:106 (0.011)	0:097 (0.009)	0:088 (0.008)	0:074 (0.007)	0:069 (0.006)	0:054 (0.006)	0:052 (0.005)	0:048 (0.004)	0:035 (0.003)	0:031 (0.003)
Intensive margin w/controls	0:0104 (0.011)	0:094 (0.009)	0:085 (0.008)	0:073 (0.007)	0:067 (0.006)	0:051 (0.006)	0:050 (0.005)	0:046 (0.004)	0:033 (0.003)	0:029 (0.003)
Total response	0:069 (0.005)	0:062 (0.005)	0:047 (0.005)	0:045 (0.005)	0:036 (0.004)	0:035 (0.004)	0:026 (0.004)	0:029 (0.004)	0:022 (0.003)	0:003 (0.003)
Extensive margin	0:008 (0.001)	0:007 (0.001)	0:003 (0.001)	0:003 (0.001)	0:002 (0.001)	0:001 (0.001)	0:002* (0.001)	0:002* (0.001)	0:002* (0.001)	0:012 (0.001)

Shoppers' Payday Responses (DiD) by Age Bir. [Main deck](#)

A. Weekly Shoppers

B. Very Frequent Shoppers

Notes: Point estimates relative to the 20-29 age group. Very frequent shoppers are those for whom we can match average total grocery spending with the FIES (i.e. those who visit a store, on average, at least 16 times per month). Capped bars indicate 99% confidence intervals with standard errors clustered by shopper ID.

Little difference in responses between younger vs. older pensioners

$$X_{i;t} = \bar{X}_i = \beta_i \text{ Payday}_t + \beta_{\text{dow}} + \beta_{\text{wom}} + \beta_{\text{my}} + \beta_{\text{h}} + \beta_t$$

Main deck

A. Weekly Shoppers

B. Very Frequent Shoppers

Payday spending response does not vary much with store quality

Using stores in all Census regions

Using only Tokyo metro stores

Within-Tokyo analysis takes out CoL differences across area [Main deck](#)

Nearly identical point estimates if define store quality using equal-weighted vs. sale share-weighted (figure above) price index

Store quality measure using prices

Main deck

$$e_s = \frac{1}{jT^{npj}} \sum_{t \in T^{np}} X_{k,s;t} \log p_{k,s;t}$$

- A. Sales Share-Weighted Retail Chain Index B. Equal-Weighted Average Retail Chain Index

Age cohort heterogeneity in retirement consumption responses

Main deck

A. Early retirement age

B. Normal retirement age

People cross retirement age threshold at different times \Rightarrow 1f $age_{i,t}$ young

OLS shows drop in consumption, while other DiD estimators show uptick

- | Sun & Abraham (2021): compare retirees to never treated (young)
- | de Chaisemartin & D'Haultf uille (2020): compare retirees to not-yet-retired (fuzzy RD)

Can write store-level inflation (geometric avg.) as the sum of three terms:

$$\begin{aligned}
 \pi_{s;t} = & \underbrace{\frac{1}{n_{s;t}} \sum_{k \in \text{common}} \log p_{k;s;t}}_{\text{retail price change of common goods}} + \underbrace{\frac{1}{n_{s;t}} \sum_{k \in \text{new}} \log p_{k;s;t}}_{\text{consumer substitution towards new goods}} \\
 & + \underbrace{\frac{1}{n_{s;t}} \sum_{k \in \text{old}} \log p_{k;s;t}}_{\text{consumer variety response}}
 \end{aligned} \tag{5}$$

Retail price change can be due to temporary sales or changes in regular prices

Variety effect / $\log n_{s;t}$! 6% jump in # of unique barcodes purchased on payday

Last price index partitions into a set of common, new, and old goods

Robustness to definition of last price index

Main deck

$$s;t = \sum_{j=7-1;j}^{+7} \text{Payday}_{t+j} + \text{dow} + \text{wom} + \text{h} + \text{s} + \text{'c;my} + s;t$$
$$\text{last } s;t = \sum_{j=7-2;j}^{+7} \text{Payday}_{t+j} + \text{dow} + \text{wom} + \text{h} + \text{s} + \text{'c;my} + s;t$$

A. Month Before Counterfactual Price

B. Week Before Counterfactual Price

Variety response: 6% " in # of unique barcodes purchased on payday

$$\log \theta_{s;t} = \sum_{j=0}^{+7} \beta_j \text{Payday}_{t+j} + \beta_{\text{dow}} + \beta_{\text{wom}} + \beta_{\text{h}} + \beta_{\text{s}} + \beta_{\text{c;my}} + \beta_{\text{s;t}}$$

Main deck

Response of Store-Level Major Subcategory Average Prices to Payd [Main deck](#)

(a) Prepared Foods

(b) Sweets/Desserts

(c) Alcohol

(d) Grains

(e) Non-alcoholic beverages

(f) Tobacco

(g) Processed Fruits/Vegetables

(h) Preserved Fish

(i) Other Processed Foods

Store-Level Variety Responses within Each Major Goods Subcategory [Main deck](#)

(a) Prepared Foods

(b) Sweets/Desserts

(c) Alcohol

(d) Grains

(e) Non-alcoholic beverages

(f) Tobacco

(g) Processed Fruits/Vegetables

(h) Preserved Fish

(i) Other Processed Foods

Store Pricing Responses around Payday by Major Goods Subcategory [Main deck](#)

(a) Prepared Foods

(b) Sweets/Desserts

(c) Alcohol

(d) Grains

(e) Non-alcoholic beverages

(f) Tobacco

(g) Processed Fruits/Vegetables

(h) Preserved Fish

(i) Other Processed Foods

Apply two sets of filters to separate regular prices $p_{s,t}$ from observed prices p_t :

Rolling mode (Kehoe & Midrigan 2008,15): regular price = most common price

V-shaped (Nakamura & Steinsson 2008): identify temporary sales by symmetric dips followed by rebounds
 good out-of-sample prediction of sales lag in CPI microdata

Compute store-level average temporary sales frequency \bar{f}_s and discount rates \bar{d}_s via:

$$\bar{f}_s = \frac{1}{jTj} \sum_{t=2}^T \frac{1}{jK_{sj}} \sum_{k=2}^{K_s} \mathbb{1}_{\{p_{s;t;k} < r_{s;t;k}\}}$$

$$\bar{d}_s = \frac{1}{jTj} \sum_{t=2}^T \frac{1}{jK_{sj}} \sum_{k=2}^{K_s} \mathbb{1}_{\{p_{s;t;k} = r_{s;t;k}\}}$$

Tuning parameters: search for V-shape and 3-month centered mode over 42 days (1.5 months), similar patterns if search over one week

Store-Level Temporary Sales Frequency and Discount

Main deck

Rolling Mode Sales Frequency

V-Shaped Filter Sales Frequency

Rolling Mode Discount Rate

V-shaped Filter Discount Rate

Notes: The left-hand side panels show the frequencies and discount rates under the rolling mode filter, while the right-hand side panels show the distributions when we use the V-shaped filter to identify sales. In both algorithms we search for temporary sales over a 42-day window on either side of a calendar date. Solid grey vertical lines indicate the mean daily frequency or discount rate across stores on non-paydays, while blue dashed lines show the mean across stores on paydays. The K-S p-value shows the two-sided exact p-value from a Kolmogorov-Smirnov test of equality for the payday vs. non-payday distributions.

Store-Level Temporary Sales Frequency and Discounts on Above-Median Price Goods [Main deck](#)

Rolling Mode Sales Frequency

V-Shaped Filter Sales Frequency

Rolling Mode Discount Rate

V-shaped Filter Discount Rate

Notes: Includes only products which have an above-median average price within their four-digit goods category. The left-hand side panels show the frequencies and discount rates under the rolling mode filter, while the right-hand side panels show the distributions when we use the V-shaped filter to identify sales. In both algorithms we search for temporary sales over a 42-day window on either side of a calendar date. Solid grey vertical lines indicate the mean daily frequency or discount rate across stores on non-paydays, while blue dashed lines show the mean across stores on paydays. The K-S p-value shows the two-sided exact p-value from a Kolmogorov-Smirnov test of equality for the payday vs. non-payday distributions.

Store-Level Temporary Sales Frequency and Discounts on Below-Median Price Goods [Main deck](#)

Rolling Mode Sales Frequency

V-Shaped Filter Sales Frequency

Rolling Mode Discount Rate

V-shaped Filter Discount Rate

Notes: Includes only products which have a below-median average price within their four-digit goods category. The left-hand side panels show the frequencies and discount rates under the rolling mode filter, while the right-hand side panels show the distributions when we use the V-shaped filter to identify sales. In both algorithms we search for temporary sales over a 42-day window on either side of a calendar date. Solid grey vertical lines indicate the mean daily frequency or discount rate across stores on non-paydays, while blue dashed lines show the mean across stores on paydays. The K-S p-value shows the two-sided exact p-value from a Kolmogorov-Smirnov test of equality for the payday vs. non-payday distributions.

Statistics for Branch vs. Non-Branch Office Cities Main deck

	Branch (N = 239)	Non-branch (N = 424)	Difference	p-value
Log Census population	12.16 (0.06)	11.07 (0.03)	1.09 (0.06)	0.00
CBD population density (1000/m ²)	7.66 (0.46)	5.11 (0.15)	2.55 (0.38)	0.00
Fraction population > 65 y.o. (%)	10.71 (0.17)	11.17 (0.18)	0.46 (0.26)	0.09
Fraction population > 75 y.o. (%)	4.05 (0.07)	4.26 (0.08)	0.21 (0.12)	0.07
% 75-85 population > 65 y.o.	43.00 (0.94)	46.73 (1.12)	3.73 (1.65)	0.02
Fraction female residents (%)	51.14 (0.00)	51.09 (0.00)	0.05 (0.00)	0.63
Fertility rate	2.33 (0.02)	2.28 (0.02)	0.05 (0.03)	0.04
Log per capita income	7.82 (0.01)	7.79 (0.01)	0.03 (0.01)	0.01
Labor force participation rate (%)	50.24 (0.21)	49.71 (0.16)	0.53 (0.28)	0.06
Unemployment rate (%)	3.48 (0.09)	3.08 (0.06)	0.40 (0.10)	0.00
Ratio of govt. expenditures to revenues	0.97 (0.00)	0.97 (0.00)	0.00 (0.00)	0.89
Log welfare spending per person 65 y.o.	4.10 (0.03)	4.05 (0.02)	0.05 (0.04)	0.18
Log welfare spending per person 75 y.o.	5.08 (0.03)	5.03 (0.02)	0.05 (0.04)	0.19

Effect of Pension Frequency Reform on Municipal Admin Costs Main deck

	(1)	(2)	(3)	(4)	(5)	(6)
Branch Post	0:043 (0.017)	0:012 (0.014)	0.034 (0.023)	0:003 (0.016)	0:073 (0.026)	0:021 (0.017)
City & year FEs	✓	✓	✓	✓	✓	✓
Incl. Tokyo	✓		✓		✓	
Incl. major cities	✓		✓		✓	
1985 population bin year FEs			✓	✓	✓	✓
1985 per capita income bin year FEs					✓	✓
N	11,111	10,635	11,111	10,635	11,111	10,635
# Municipalities	663	635	663	635	663	635
Adj. R ²	0.517	0.554	0.856	0.863	0.863	0.866

Notes: The dependent variable in each regression is log expenses on elderly welfare per resident at or above age 65. Branch $\text{Post}_{jt} = 1$ if municipality j contains a Japan Pension System branch office. $\text{Post}_{jt} = 1$ for years 1988{1996. All regressions include observations for years 1980 { 1996 and a full set of year fixed effects. Robust standard errors clustered at the municipality level in parentheses. Tokyo consists of the 23 central wards for which separate expenditure time series are available. Major cities consist of the historically five most populous cities outside of Tokyo: Yokohama, Nagoya, Kyoto, Osaka, and Kobe. 1985 population bin refers to quintiles of 1985 Census population. 1985 per capita income bin refers to quintiles of per taxpayer taxable income in 1985. ** $p < 0.01$; * $p < 0.05$; $p < 0.1$

Policy parameters (based on FY 2011 data from JPS)

- Average daily payment per claimant $\bar{p} = 3,462$ JPY (\$32.50)
- Fraction of participants who receive benefits $\alpha = 0.3766$

Administrative cost function

- Positive cost function takes form $(T) = \gamma T^\eta$ where $\eta > 1$
- For each η calibrate scale factor γ such that (T) matches reported administrative costs: 300.722 billion JPY (\$3.07 billion)

QH discounting

- Set $f(t) = \alpha e^{-\beta t}$ $t = 0:002T$ to match estimated 10% spike at payday
- Avg. daily decline of 0.2% of consumption over pay cycle after stripping out seasonality

Payday liquidity

- Set magnitude of spike $\alpha x = 0.1$ or $x(T) = 0.0023T$ to match baseline estimates for raw foods (perishables consumption)

Optimal frequency concave w.r.t. convexity of admin costs

Main Deck

Quasi-hyperbolic Discounting

Payday Liquidity

Calibration: suppose $(T) = \dots = T'$ and for each power set \dots so that (60) equals the administrative service costs reported for FY 2011

For $\dots < 0.5$ daily frequency ("continuous trickle") would be optimal Full calibration

Model Derivations

Fraction p of people receive a (pension) benefit every days equal $b(T) = \bar{b} - T$

Other $1 - p$ fraction are workers who earn exogenously $w(t)$ and pay lump-sum tax (b)

Continuous time setup because T is the government's choice variable

Government runs balanced budget for each $t \in [0; T]$:

$$(1 - p) (b) = p (b(T) + (T)) \Rightarrow (b) = \frac{p \bar{b} - T + (T)}{1 - p}$$

(T) is an administrative cost function assumed to be weakly convex

- Captures program costs that vary with T : authorizing/delivering benefits, redeeming benefits, investigating fraud

Govt. picks T to minimize welfare loss subject to balanced budget

Can write this compactly as

$$\min_T \quad p \cdot \phi(T) + \lambda [p \cdot b(T) + (T)^0 - \bar{B}] \quad \text{with} \quad \frac{\partial U}{\partial R} = \frac{\partial W}{\partial R}$$

λ is the marginal cost of funds (MCF), equal to unity under lump-sum taxation of workers

Govt. sets length of pay cycle \bar{T} to equate marginal reduction in the welfare loss to marginal cost of reducing \bar{T}

$$\frac{p \cdot \phi'(T)}{\text{marginal benefit}} = \frac{\phi'(T) + \lambda \bar{B}}{\text{marginal cost}} \quad (6)$$

Sufficient statistics: fraction of pensioners, the average daily benefit amount, slope of welfare loss and cost function

Working households face standard consumption-saving problem:

$$\max_{\{C(t)\}_{t=0}^T} \int_0^T u(C(t)) dt \quad \text{s.t.} \quad C(t) = S(t) + w(t) \quad \frac{(b)}{T}$$

Solution to this problem is full smoothing $C(t) = C^* ; \forall t$

Optimal consumption for pensioners is also $C(t) = C^* ; \forall t$, but suppose instead actual choice follows:

$$C(t) = c_0(T) \exp(-f(t))$$

$f(t)$ captures how path deviates from optimum over pay cycle

Budget constraint $\int_0^T C(t) dt = b(T)$ pins down the value of consumption on payday $c_0(T)$ with $f(0) = 0$

Welfare loss from non-smoothing

Main deck

Welfare loss from non-smoothing is sharewilling to give up to achieve $C_t = C$

$$\int_0^T u^r(c_0(t)) \exp(-\int_0^t r(s) ds) dt = \int_0^T u^r(\bar{C}) dt$$

(1) is the **compensating variation** or welfare loss from non-smoothing a la Lucas (1987), which depends on \bar{C}

For any invertible $u(\cdot)$ we can rewrite (1) as

$$(1) = \frac{\int_0^T u^{-1}\left(\frac{1}{T} \int_0^T u(c_0(t)) \exp(-\int_0^t r(s) ds) dt\right) dt}{\int_0^T c_0(t) \exp(-\int_0^t r(s) ds) dt}$$

Numerator: total consumption where daily consumption is s.t. receive average daily utility over the actual consumption path

Denominator: actual total consumption over the pay cycle

Write compensating variation (T) as a function of total observed consumption C^{tot} and total certainty equivalent consumption \bar{C} :

$$(T) = \frac{T \bar{C}}{C^{\text{tot}}} \Rightarrow q(T) = \frac{(T \bar{C})^0 C^{\text{tot}} (T \bar{C}) (C^{\text{tot}})^0}{(C^{\text{tot}})^2}$$

$$(C^{\text{tot}})^0 = \frac{\partial}{\partial T} \int_0^T c_0(t) \exp(-\rho t) dt = c_0 \exp(-\rho T)$$

$$(\bar{C})^0 = \frac{\partial}{\partial T} \int_0^T \frac{1}{T} \int_0^T u(c_0(t) \exp(-\rho t)) dt$$

$\bar{U}(T)$

"

#

$$= u^{-1} \bar{U}(T) (u^{-1})^0 u(\bar{U}(T)) \frac{1}{T} \int_0^T u(c_0(t) \exp(-\rho t)) dt \bar{U}(T)$$

Suppose utility function takes the form:

$$u(c_0) + \sum_{t=1}^T \beta^t u(C_t)$$

Individuals with these preferences exhibit present bias: sequence of discount rates is $\beta; \beta^2; \beta^3; \dots$, with $\beta < 1; \beta < 1$

With $u(\cdot)$ isoelastic with inverse IES, log consumption decreases over time

$$\frac{\partial \log(C_t)}{\partial t} = \frac{1}{T} \log \left(\frac{1}{t+1} + \frac{1}{t+1} \right) < 0$$

For $\beta < 1$ but $\beta > 0$ this decrease is approximately linear

Embed these preferences in the general model by assuming $\beta = 1 - \delta$ where δ is the **daily decline in consumption over the pay cycle**

Source: Mastrobuoni & Weinberg (2009)

Main deck

With $\bar{B} = T$ to spend over the time period $[0; T - 1]$, budget constraint pins down payday consumption $c_0(T)$:

$$\int_0^T c_0(T) \exp(-\delta t) dt = \bar{B} = T \Rightarrow c_0(T) = \frac{\bar{B} = T}{1 - \exp(-\delta T)}$$

Assuming isoelastic utility with inverse IES the welfare loss is:

$$W(T) = \begin{cases} 1 - \frac{1}{B} \exp(-\delta T) & \text{if } \beta = 1 \\ 1 - \frac{\beta}{B} \frac{1 - \exp(-\delta T)}{\delta (1 - \beta)} & \text{if } \beta < 1 \end{cases}$$

By Interval Length

By Inverse IES

With QH discounting, internality problem because individual overconsumes in earlier periods and underconsumes in later periods

Three features of the welfare loss $W(T)$:

Welfare loss is increasing in govt. choice of T

- For higher T , welfare loss will be greater because integral between the optimal smooth path and QH path larger

Welfare loss is increasing in

- Higher β means consumption less substitutable between periods, so individual willing to pay more to get closer to consumption smoothing

Optimal T is decreasing in

- Govt.'s MB curve of decreasing T becomes steeper for higher

Directly modeling quasi-hyperbolic discounting in continuous time is challenging because there is no clear "today" and "tomorrow"

Following Webb (2016), define τ as present period, and Δt 1 interval length:

$$V(C) = \int_{\tau}^{\infty} (\beta e^{-\rho t})^t u(C(t)) dt + \int_{\tau+\Delta t}^{\infty} \beta e^{-\rho t} u(C(t)) dt$$

|-----{z-----}
|-----{z-----}

instant gratification
geometric discounting

Utility at $t = 0; 1; 2; \dots$ weighted by $1; \beta; \beta^2; \dots$

Extra parameter β captures time interval before present bias kicks in

Present bias in continuous time is akin to instant gratification

Implied consumption path is similar to path in discrete time setting

Recent papers find that individuals exhibit "payday liquidity"

- | Spike in expenditures on payday across the income distribution
- | Unrelated to expectations of future liquidity constraints
- | Expenditures are smooth for the rest of the pay cycle

Simple consumption rule where $t=0$ is payday and interval $T > 1$:

$$C_t = \begin{cases} (1 + x) \bar{c} & \text{if } t = 0 \\ \bar{c} & \text{if } t \in [1; T - 1] \end{cases}$$

If this C_t is the result of utility maximization then no welfare loss

One possible utility function where this is optimal:

$$u(C) = (1 + x) \log u(C_0) + \sum_{t=1}^{T-1} \log(C_t)$$

If underlying preferences do not put extra weight on C_0 there will be a welfare loss

- | Can think of this as mental accounting under myopia

With convex administrative costs the welfare loss goes to zero as

- | Trivial case where govt. faces no tradeo
- | Intuition: loss is concentrated on the initial spike, so as $T \rightarrow 1$ loss is small relative to total consumption over the cycle

If instead allow spike to depend on pay cycle length with $\alpha(T) > 0$, then $T < 1$

- | Stephens & Unayama (2011): some evidence that $\alpha(T) > 0$, since MPC out of pension payments lower when $T = 90$! 60
- | We need evidence to support this case using high frequency data

To keep things simple, focus on log utility (= 1)

Welfare loss expression is the same, but now the marginal loss is:

$$Q(T) = \frac{(\bar{c}-\bar{B})(1+x(T))^{1-T}}{T^2} \log(1+x(T)) - T x^0(T)$$

Now decreasing \bar{T} can improve welfare if:

$$\left| \frac{1+x(T)}{T^2} \log(1+x(T)) \right| > \frac{x^0(T)}{T} \tag{7}$$

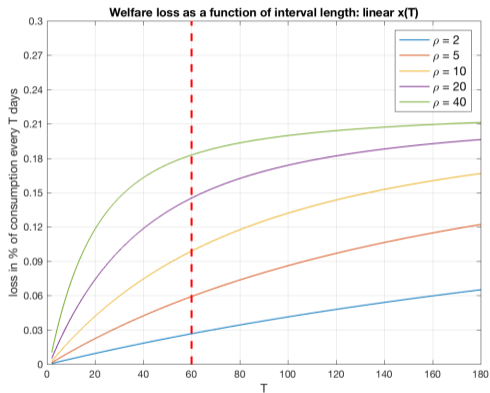
"loss from spike magnitude as T"
"gain from subdivision as T"

Spike grows with T due to pent-up demand (LHS), but daily loss falls as interval length increases (RHS)

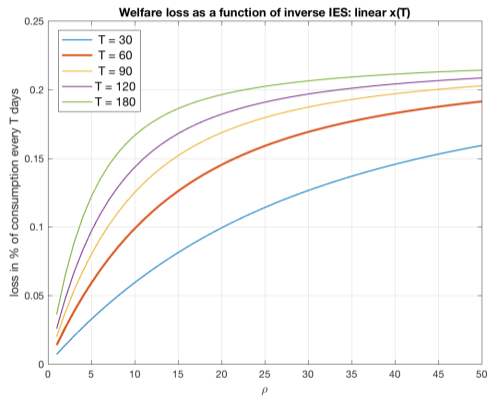
Our empirical evidence suggests linear $x(T) = 0.0023 T$ => welfare higher for lower T

WELFARE LOSS UNDER PAYDAY LIQUIDITY WITH PENT-UP DEMAND $x(T)$

By Interval Length



By Inverse IES



- 1 (T) is now concave vs. convex in the QH discounting case
- Importantly, $\theta(T)$ has similar shape for both cases

EXTENSIONS & COUNTERFACTUALS

- Baseline framework assumes consumers fully naive about overspending around payday
 - ┆ Alternatively they could internalize temptation to spend earlier and adjust consumption to limit overspending by future self / "sophistication"
 - ┆ If sophisticated might also want to commit to not overspending (Bryan, Karlan, Nelson 2010)
- Forms of commitment devices: layaway, retirement/education savings accounts, timing services payments (e.g. utilities, mortgage) to coincide with income
- Idea: more infrequent payments makes it easier for consumers to save up for large durable purchases like appliances (Zhang 2023)
- **Key result:** allowing for commitment via durables purchases leads to T^* , but not by much unless IES is very low (β is very high)
 - ┆ IES determines preference for commitment and lower T makes it harder to commit

- Simulate for range of β and T consumption path for three types of consumers who overspend on payday
 - | Parameterize as present-bias problem, but can map back to mental accounting via
- ① Naive: consumers in our baseline model who choose consumption plan $\{c_t, g_{t=0}^T\}^1$
- ② Sophisticated: are aware of present-bias and solve for the optimal consumption plan via backwards induction to obtain $\{c_t, g_{t=0}^T\}^1$
 - | Algorithm: solve naive problem and iterate backwards to obtain c_0^{**}
- ③ **Sophisticated + commitment (SC)**: given access to a **commitment device** z_0 which allows withholding on payday and (linearly) amortizing in future periods
 - | Give up z_0 initially to gain $z_0 = T - 1$ in future when consumption is below the smooth level due to overspending on payday
 - | Linear subdivision proxies for economic depreciation of durables

- Sophistication + commitment problem collapses to:

$$\max_{z_0} \sum_{t=0}^{T-1} \beta^t u(c_t + z_0) + \beta^T u(c_T + z_0) \quad \text{s.t.} \quad z_0 = 0, \quad c_0 + z_0 > 0 \quad (8)$$

- For log utility ($\beta = 1$) well-known result that no preference for commitment, so $z_0 = 0$, meaning the slackness or "no borrowing" constraint binds
- Continuous time approximation of c_t is then

$$C(t) = \exp(-\rho t) + \int_0^t f(t-s) \exp(-\rho(t-s)) ds \quad (9)$$

- Cumulative "pull-back" towards the optimum $Z(T) = \int_0^T f(t) dt$ has the property $Z'(T) > 0$! it becomes more difficult to commit with shorter pay cycles

↳ $f(t)$ can be non-monotonic in t , depending on T and

- Baseline model assumes price P of consumption bundle does not vary w.r.t. T
 - | Consistent w/empirical findings of minimal retailer pricing response when averaged over entire basket of commonly purchased goods
- Consider two extensions with monopolistic retailers:
 - ① Single monopolistic chain providing the entire basket C at price P
 - ② Continuum of monopolistic chains specializing in varieties
- Retailers face fixed real inventory cost Γ and **menu cost** for changing prices
 - | Both versions of model illustrate that allowing for fixed cost of changing prices $\Rightarrow T^* \neq$
 - | \Rightarrow baseline calibration results provide upper bound on T^*

Lemma (neutrality result)

Consider optimal frequency model with single monopolistic chain that price discriminates on the extensive margin (i.e. P changes only on the time dimension, but not by demographics) and pays menu costs in units of wage labor.

Then there exists a set of parameters $(p; A; \dots)$ s.t. for any T , consumer welfare the same regardless of whether there is price discrimination.

- Intuition: loss in utility over consumption associated with the price hike is completely offset by the reduction in disutility from labor supply
- Relies on idea that menu costs are mostly labor costs (Blinder et al. 1998)

- Retailer sets sequence of prices P_t to maximize profits:

$$\max_{\{P_t\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \left(P_t Y_t - W_t L_t - W_t \mathbb{1}_{\{P_t \neq P_{t-1}\}} \right) - \Gamma$$

- Labor L_t used to satisfy non-recipient demand $F(L_t) = C_t^{NR}$
- Menu cost W_t units of wages paid if change regular price ($\mathbb{1}_{\{P_t \neq P_{t-1}\}}$)
- Non-recipients work and incur disutility from providing labor to the retailer:

$$\max_{\{C_t, L_t\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \left(u(C_t) - \psi(L_t) \right) \quad \text{s.t.} \quad P_t C_t = S_t + W_t L_t \quad \frac{(b)}{T}$$

$$\min_T \left\{ \underbrace{p(T) + \frac{p b(T) + (T)}{Z}}_{\text{welfare loss from non-smoothing + taxes}} + \underbrace{\frac{U(C^{1;NR}(T)) - U(C^{0;NR}(T))}{Z}}_{\text{welfare loss from price discrimination}} \right\}$$

- If T s.t. retailer finds it unprofitable to price discriminate, $\theta = 0$, and non-recipients experience no utility loss
- If instead admin costs (T) are sufficiently convex, then govt. may set T s.t. price discrimination occurs in equilibrium
- Parameterization: suppose payday liquid benefit recipients, non-recipients have $u(C_t) = \log(C_t) - \beta L_t$, and production is linear in labor $F(L_t) = A L_t$

- Combine FOCs from the non-recipient's problem to get profits over the pay cycle:

$$\sum_{t=0}^{\infty} \beta^t C_t \leq C_t^{NR} \frac{C_t^{NR}}{A} \leq C_t^{NR} \quad t \in \Gamma$$

- Aggregate demand is the sum of the recipient (R) and non-recipient (NR) demands:

$$C_t = p C_t^R + (1 - p) C_t^{NR}$$

- Equilibrium real expenditures of non-recipients:

$$C_t^{NR} = \begin{cases} \frac{A}{2} & \text{if } t = 0 \\ \frac{A(1-p)}{2(1-p)} & \text{if } t = 1 \end{cases}$$

$$P_t = \begin{cases} \infty & \text{if } t = 0 \\ \frac{2W_t}{A} & \text{if } t = 0 \\ \frac{2W_t(1-\rho)}{A(1-\rho)!} & \text{if } t = 1 \end{cases}$$

- Payday liquid recipients \Rightarrow price discrimination if it does occur will only be profitable on payday $\Rightarrow P_t = 2W_t/A$ for $t \neq 0$
 - ▮ Logic: C_t^R is smooth except for $t = 0$ when people decide to splurge
 - ▮ Assume $! < (1 - \rho)$ since $P_t > 0$ (disutility from labor or menu costs cannot be too large)
- Comparing profit functions, price discrimination occurs if and only if:

$$x(T) > \frac{1-\rho}{p\bar{c}} \left(A + \frac{A(1-\rho)!}{(1-\rho)!} p\bar{c} + \frac{A(1-\rho)!}{2!} \right)$$

$$x(T) > \frac{1-p}{\rho c} \left(A + \frac{A(1-p)!}{(1-p)} \rho c + \frac{A(1-p)!}{2!} \right)$$

- Gain from price discrimination = excess demand from price-inelastic pensioners receiving income ! quantified by spike $x(T)$ in the data
- Loss from price discrimination = menu cost + reduced demand from non-recipients
- Setting $T \neq \infty \Rightarrow x(T) \neq 0$ and menu cost becomes a larger fraction of profits
- Difference in non-recipients' optimized level of utility when there is price discrimination is:

$$\log(C_0^{NR,1}) - \log(C_0^{NR,0}) + \rho L_0^1 - \rho L_0^0 = 0$$

- Punchline: price discrimination is welfare neutral \Rightarrow govt. can ignore retailer!

Counterfactual exercise

What would be the increase in pay cycle length $\Delta T > 0$ required to reduce costs by an equivalent amount to raising the NRA from 65 to 70?

- Calculate increase in **penalty rates** imposed on early pensioners aged 60-69 compared to current NRA of 65
 - | Current penalty: 0.4-0.5% per month until the month of 65th birthday, capped at 30%
 - | Under shift in NRA to 70, overall penalty would max out at 60%
- Assume the early claiming rate of 10.8% persists for 65-69 age group...
 - | \Rightarrow fraction of eligibles p decreases from 0.377 to 0.307
- Cost savings are lower if retain 30% penalty cap: 28.07 billion JPY vs. 36.12 billion JPY

- **Result:** raising retirement age pushes up the optimal pay cycle length T
- Raising NRA results in $p^{new} < p^{old} \Rightarrow$

$$\frac{1}{p^{new}} \theta(T) = \frac{1}{p^{old}} \theta(T) \quad \Rightarrow T^{new} > T^{old}$$

- $\theta(T) < 0$, so as $p \#$, MC of increasing frequency dominates the MB (welfare gains) from consumption smoothing

Admin cost convexity	$T (p^{new})$	$T (p^{old})$
$\lambda = 1$	7.55 days	6.72 days
$\lambda = 2$	19.63 days	18.27 days
$\lambda = 3$	28.81 days	27.32 days