CONSUMPTION AND ACCOUNT BALANCES IN CRISES: HAVE WE NEGLECTED COGNITIVE LOAD?

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Research question

- Covid-19 represents a stressor that generates cognitive load: a tax on the brain that drives attention towards urgent needs while people have to make choices, such as consumption, saving, and borrowing.
- Such stressors are not unique to covid:
  - *major general crises (economic, geopolitical, climatic)*
  - *taxing aspects of people's everyday life:*
    - stressful work environments
    - young kids
    - health problems
    - marriage problems
- **Question:** Can the presence of background cognitive load associated with multi-tasking typical in crises affect
  - *economic behavior*
  - *The ability of our purely economic workhorse models to capture, explain, and forecast such behavior?*

More specifically

- During the onset of covid, lower consumption and higher account balances were observed.
  - *They were attributed solely to lockdown/supply constraints, labor market risks, and uncertainty about future borrowing constraints.*
- Could cognitive load account for part of such phenomena, in the absence of these economic factors or controlling for them?
- Could cognitive load induce deviations from behavior implied by our workhorse models and in which direction?
- Are specific demographic groups more sensitive to cognitive load in terms of behavior adjustment or deviations from the model?
- Policy implications could be vastly different!

What we do 1

- We conduct an online RCT experiment with **1881** people drawn from the general French population from December 17, 2021 to January 29, 2022.
- We divide them into 4 groups (control and treatment) and ask them to choose consumption over a 20-year life cycle, given an exogenous labor income process. This determines also their account balances.
- We incentivize them to approximate preferences of a standard workhorse model (CRRA) that allows saving and borrowing, subject to a quantity constraint known from the start.
- Two of the treatment groups are told that they face each working life period a 10% probability of furlough (30% drop in income).
- The effects of furlough can be distinguished from those of the cognitive load (a simultaneous task of responding to appearance of numbers)
- Subjects are incentivized to pay attention both to the main task and to the cognitive load.

What we do 2

- We compare average group responses across different treatments.
- We estimate econometrically the effect of each treatment on the average consumption and balance choices of a subject over the 20 periods.
- We then estimate the effects of each treatment on the deviations of consumption from the model and decompose those into:
  - *Deviations from the optimal policy rule*
  - *Deviations from optimal behavior resulting solely from a suboptimal endogenous state (balances)*
- We test econometrically whether any demographic characteristics interact to make the effect of each treatment more pronounced.

Most relevant literature 1

- Covid:
  - *Labor market outcomes of Covid crisis, even within countries, exacerbate existing inequalities (Adams-Prassl et al., 2020).*
  - *Lockdowns have had profound effects on consumer spending, account balances, and subjective expectations (Coibion et al., 2020).*
- Experimental economics: consumption experiments with incentivized preferences but without cognitive load:
  - *Meissner (2016) on debt aversion*
  - *Duffy and Li (2019) on pension replacement ratios and C*
  - *Ballinger et al (2011) on cognitive scores and saving decisions.*
  - *Enke and Graeber (2022) on cognitive uncertainty (difficulty of valuing payments at different points in time):*
    - Such uncertainty is related to
      - *behavior inelastic with respect to time delays*
      - *seeking financial advice*
    - Increased complexity (inclusion of a math problem in the task) contributes to hyperbolic discounting

Most relevant literature 2

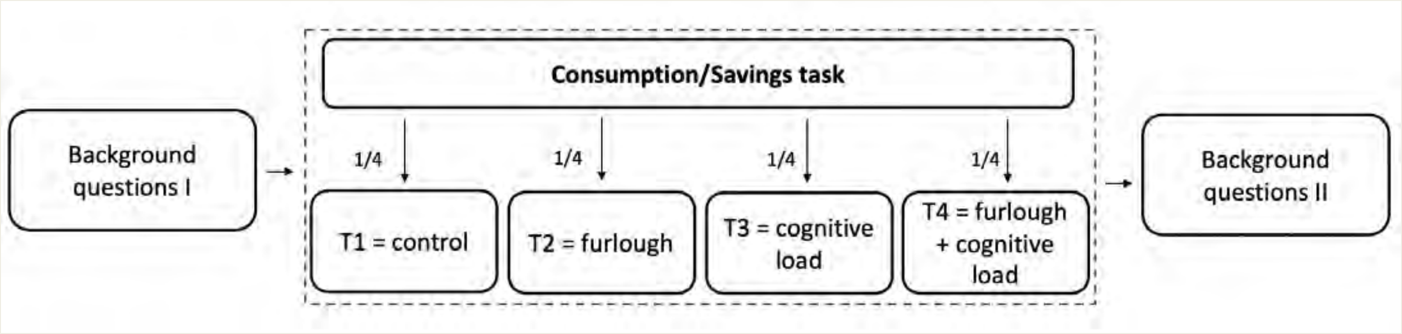
- Existing experimental research on the effect of cognitive load on economic decisions: from risk taking and intertemporal choice to math ability and generosity: review by Deck and Jahedi (2015)
  - *Under cognitive load:*
    - subjects tend to take fewer risks than in its absence (Whitney et al.,2008; Benjamin et al., 2013)
    - effect on impatience is less clear (Hinson et al., 2003; Franco-Watkins et al., 2006, 2010) pointing to more random behavior.
      - *Inconsistent with cognitive literature suggesting a positive relationship of cognition and patience: literature review in Shamosh and Gray (2008))*

Treatments and controls

	Cognitive load	Furlough
T1	No	No
T2	No	Yes
T3	Yes	No
T4	Yes	Yes

- T1-Benchmark:
  - *respondents make consumption/saving decisions according to the baseline model.*
- T2-furlough shock treatment:
  - *Subjects are told that a furlough shock may hit them during their working years: in every period t there is a 10% probability that the shock occurs such that the agent's income equals 70% of the level of income in the period immediately preceding the start of the furlough spell.*
- T3-cognitive load treatment:
  - *a permanent cognitive load hits in each and every period with random frequency.*
- T4-combined shocks treatment:
  - *a combination of T2 and T3.*

Structure:
Survey and the Experiment



Median completion time: 24.33 minutes
Includes short training phase with the task and screens

THE MODEL

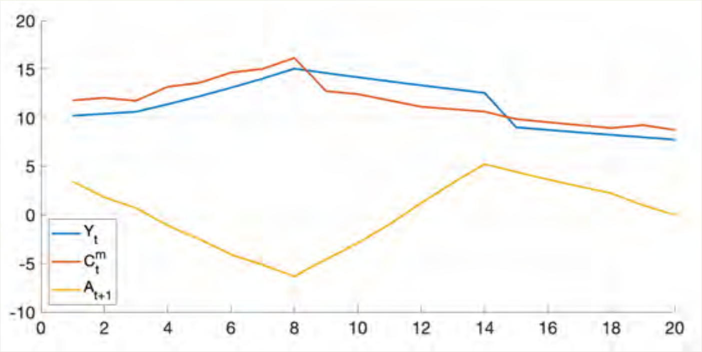
$$
\begin{aligned}
\max_{\{C_t\}} \quad & \mathbb{E}_0 \quad \sum_{t=0}^{T-1} \beta^t U(C_t) \\
\text{s.t.} \quad A_{t+1} & = (1+r)A_t + \theta_t Y_t - C_t \\
A_{t+1} & \geq \phi Y_t \\
C_t & \geq 0, \quad A_{T-1} = 0
\end{aligned}
$$

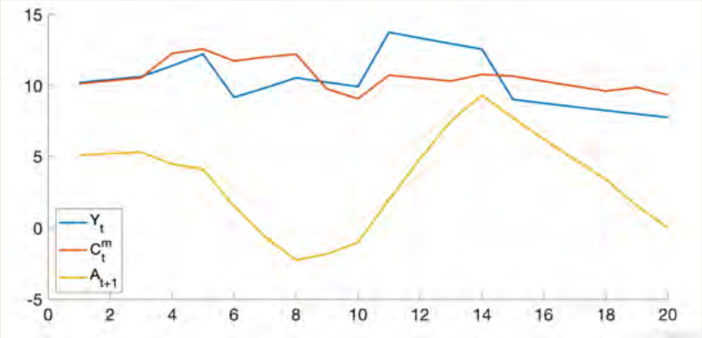
where $Y_t = (1+g)Y_{t-1}e^{x_t}$; $x_t \sim AR(1)$; θ is a furlough shock that lowers income by 30% when it materializes, while being equal to one, otherwise; ϕ is the borrowing constraint parameter; r is a risk-free rate that can take a low $(r = r_f)$ or high value $(r = r_c)$ when the agent is saving or borrowing respectively.

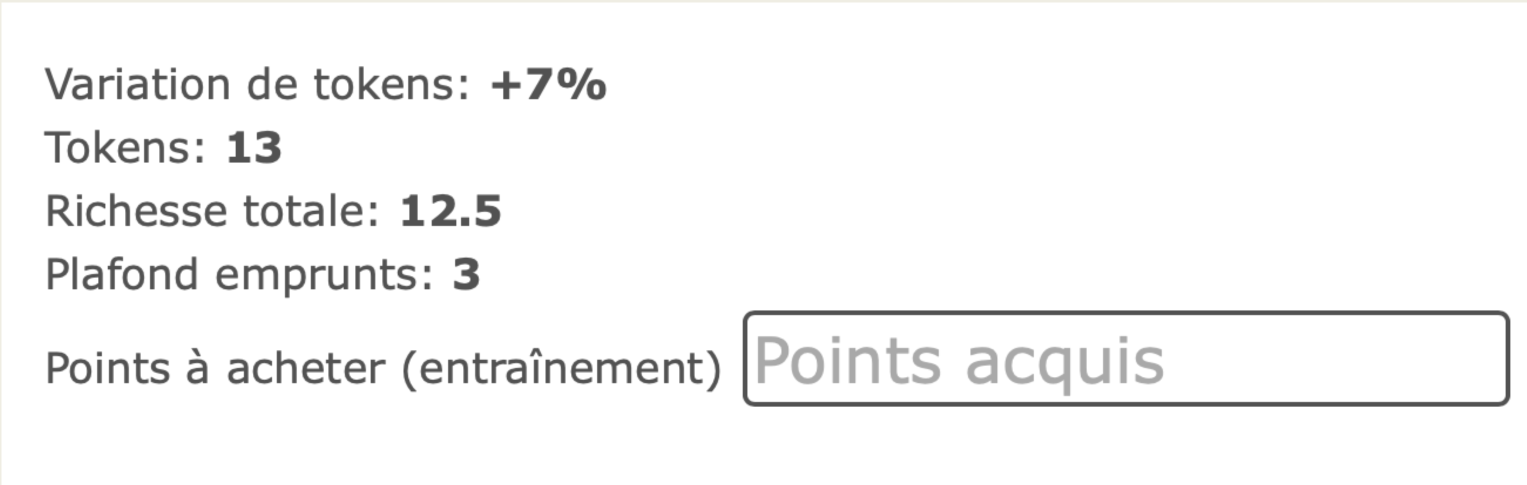
CRRA utility function $U(C_t) = \dfrac{C_t^{1-\sigma}}{1-\sigma}$

- Life: 20 periods
- Working life: 14 periods
- Replacement rate: 74% of last labor income

Optimal behavior
in the absence and in the presence of furlough







SCREENSHOT OF DECISION TASK

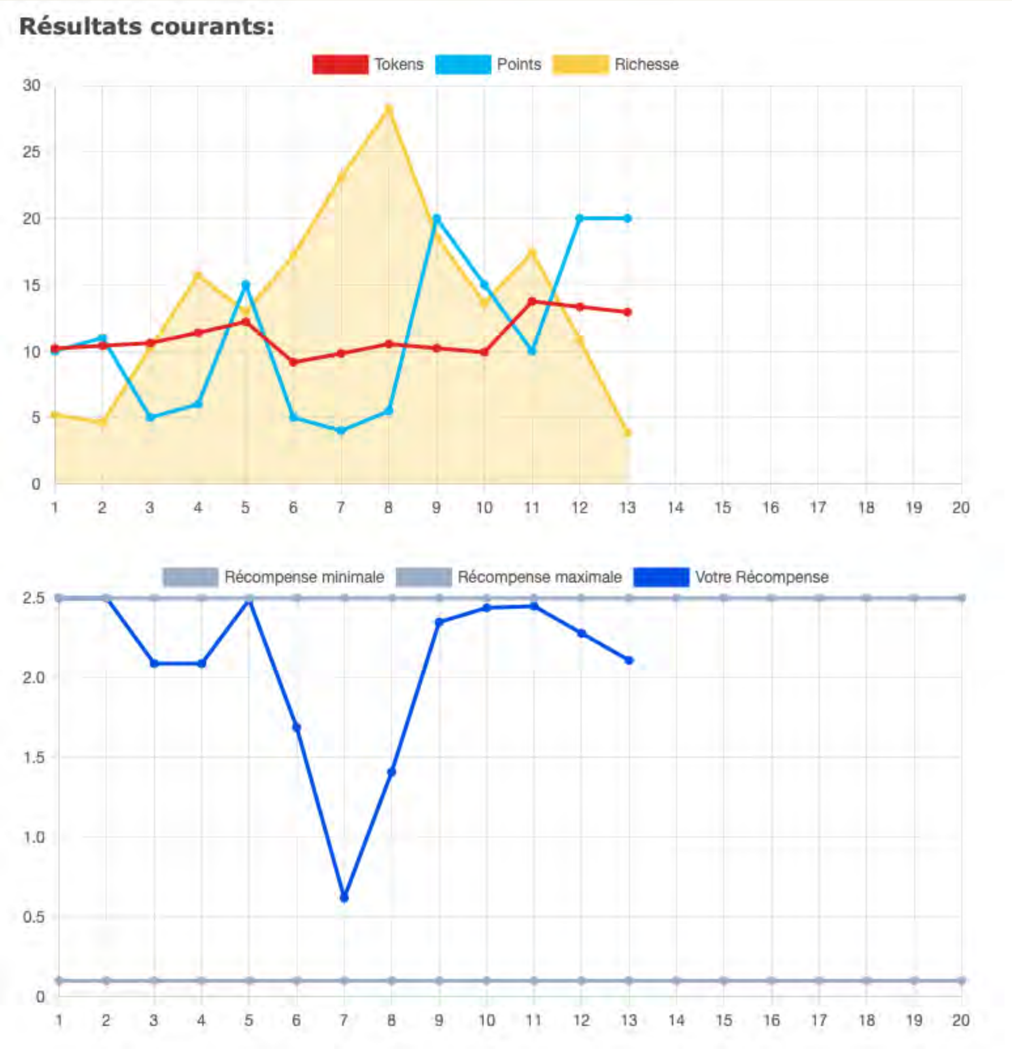
From tokens to points

- Subjects are told that their choice of tokens to spend to buy “points” (consume) will be evaluated taking into account both
  - *the current decision*
  - *and the maximum points they can optimally attain in the future based on what they leave aside today*

$$P_t = -\frac{1}{2(Tokens_t)^2} + 0.96EP^r$$

Info to participants

- This is a screenshot of the information provided to participants after making each choice.



Average group behavior
Consumption and Account balances

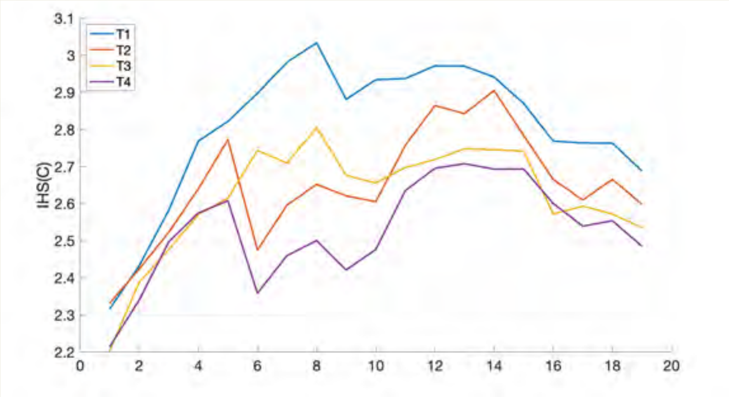


Figure 4: Average consumption (in IHS) per treatment.

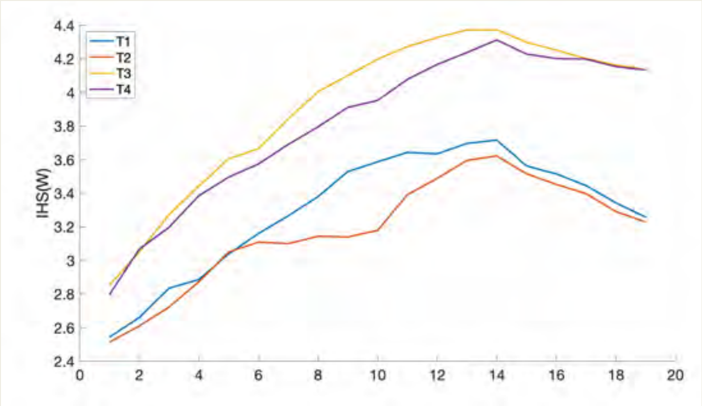


Figure 5: Average account balances (in IHS) per treatment.

Average group behavior:
Deviations from the model

- **Deviation from model consumption**

$$dev_t^m = \left\{ \frac{1}{N} \sum_{i=1}^{N} [\text{arsinh } C_{i,t}^m(a_{i,t}^r) - \text{arsinh } C_{i,t}^{xp}(a_{i,t})]^2 \right\}^{\frac{1}{2}}$$

- **Suboptimal policy rule**
  Deviation of actual choices from optimal choices conditional on the endogenous state:

$$dev_t^r = \left\{ \frac{1}{N} \sum_{i=1}^{N} [\text{arsinh } C_{i,t}^r(a_{i,t}) - \text{arsinh } C_{i,t}^{xp}(a_{i,t})]^2 \right\}^{\frac{1}{2}}$$

- **Suboptimal endogenous state**
  Deviation of conditionally rational consumption from model consumption:

$$dev_t^s = \left\{ \frac{1}{N} \sum_{i=1}^{N} [\text{arsinh } C_{i,t}^m(a_{i,t}^r) - \text{arsinh } C_{i,t}^r(a_{i,t})]^2 \right\}^{\frac{1}{2}}$$

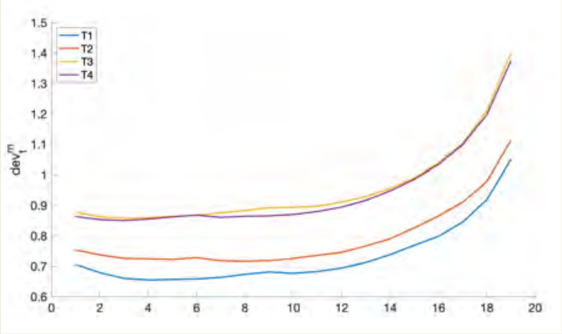


Figure 6: Average value of dev_t^m per treatment.

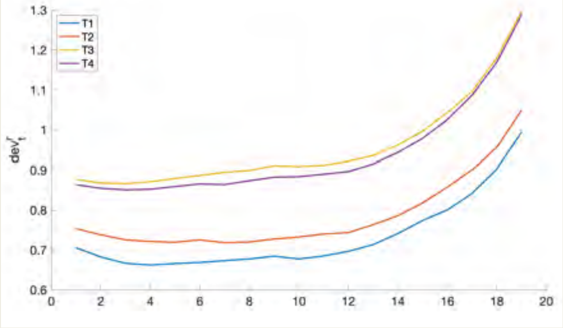


Figure 7: Average value of dev_t^r per treatment.

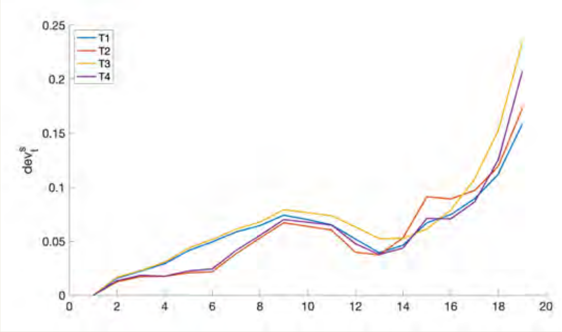


Figure 8: Average value of dev_t^s per treatment.

AVERAGE GROUP BEHAVIOR
MODEL, POLICY RULE, ENDOGENOUS STATE DEVIATIONS

Average individual behavior: Deviations from the model

- **Deviation from model consumption**

$$dev_i^m = \left\{ \frac{1}{T} \sum_{t=0}^{T-1} [\text{arsinh } C_{i,t}^m(a_{i,t}^r) - \text{arsinh } C_{i,t}^{xp}(a_{i,t})]^2 \right\}^{\frac{1}{2}}$$

- **Suboptimal policy rule**
  Deviation of actual choices from optimal choices conditional on the endogenous state:

$$dev_i^r = \left\{ \frac{1}{T} \sum_{t=o}^{T-1} [\text{arsinh } C_{i,t}^r(a_{i,t}) - \text{arsinh } C_{i,t}^{xp}(a_{i,t})]^2 \right\}^{\frac{1}{2}}$$

- **Suboptimal endogenous state**
  Deviation of conditionally rational consumption from model consumption:

$$dev_i^s = \left\{ \frac{1}{T} \sum_{t=0}^{T-1} [\text{arsinh } C_{i,t}^m(a_{i,t}^r) - \text{arsinh } C_{i,t}^r(a_{i,t})]^2 \right\}^{\frac{1}{2}}$$

OLS estimation

- Regression:

$$Y_i = \alpha_0 + \alpha_1 T_i + \beta \mathbf{Z}_i + \epsilon_i$$

- Controls:
  - *Age group, gender, income group, educational attainment, work status, residential area, marital status, and religion as a proxy for culture.*
  - *We expand this list with indicators of subject performance during the experiment in the robustness section.*

Treatment Effects 1

- A. Negative effect of furlough:
  - *Precautionary saving*
- B. Cognitive load only
  - *14.5% lower C*
  - *56.3% higher balances*
  - *Significant model deviations resulting mostly from policy rule*
  - *No supply constraints or change in borrowing constraints*
  - *ctd*

	(1) Consumption	(2) account balances	(3) dev_i^m	(4) dev_i^r	(5) dev_i^s
Panel A: T2 vs T1					
Treatment	-0.141***	-0.143	0.0494	0.0429	-0.0018
	(-6.81)	(-1.40)	(1.65)	(1.46)	(-0.96)
Observations	984	984	984	984	984
Adjusted R^2	0.049	0.026	0.003	0.002	0.004
Panel B: T3 vs T1					
Treatment	-0.145***	0.563***	0.232***	0.224***	0.0183***
	(-7.17)	(6.22)	(7.81)	(7.73)	(7.83)
Observations	913	913	913	913	913
Adjusted R^2	0.061	0.056	0.069	0.068	0.071
Panel C: T4 vs T2					
Treatment	-0.0914***	0.633***	0.171***	0.165***	0.006***
	(-4.30)	(6.53)	(5.95)	(5.92)	(3.54)
Observations	968	968	968	968	968
Adjusted R^2	0.016	0.045	0.033	0.033	0.020
Panel D: T4 vs T3					
Treatment	-0.0904***	-0.0885	-0.00984	-0.0151	-0.0135***
	(-4.40)	(-1.07)	(-0.35)	(-0.55)	(-6.15)
Observations	897	897	897	897	897
Adjusted R^2	0.027	0.003	0.005	0.005	0.051
Controls	Yes	Yes	Yes	Yes	Yes

Notes. OLS estimates of the treatment effect. All specifications control for age group, gender, income group, education attained, work status, residential area, marital status and religion. Robust standard errors in parentheses. $p < 0.10^{*}$, $p < 0.05^{**}$, $p < 0.01^{***}$

Treatment Effects 2

- C. Cognitive load under furlough:
  - *Somewhat smaller reduction in C, bigger increase in balances for people already facing furlough*
  - *Model deviations somewhat smaller than in absence of furlough, but again mostly due to the policy rule*
- D. Furlough under cognitive load:
  - *Lowers consumption but by less than in the absence of cognitive load (A)*
  - *Significant deviation from the model due to the evolution of balances, but*
  - *Not significant deviation of actual from model behavior, because furlough enters the model!*

	(1) Consumption	(2) account balances	(3) dev_i^m	(4) dev_i^r	(5) dev_i^s
Panel A: T2 vs T1					
Treatment	-0.141***	-0.143	0.0494	0.0429	-0.0018
	(-6.81)	(-1.40)	(1.65)	(1.46)	(-0.96)
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The role of heterogeneity

- **Exploratory approach:**
  - *an interaction term of the treatment dummy with one of a series of individual level socio-demographic factors, preferences and attitudes in turn.*
  - *Here: only the significant estimates*
- **A, B:** only scattered effects
- **C:**
  - *College educated subjects facing cognitive load on top of furlough:*
    - lower their consumption less in response to cognitive load
    - exhibit smaller deviations from model and from consumption rule under conditions of furlough.
  - *Those with greater short-term patience:*
    - lower their consumption even more
    - depart even more from the prescriptions of the model, mostly because of departures from the policy rule for consumption.
  - *Financial literacy indicator does not record pervasive effects:*
    - Insignificant effect on deviations from the model!
- **D: When facing cognitive load:**
  - *The more patient or more forward biased lower consumption more when also faced with furlough*
  - *The forward-biased tend to*
    - deviate more from model-implied optimal behavior, mostly in terms of the consumption policy rule.

Table 5: Treatment effects with interactions

	(1) Consumption	(2) account balances	(3) dev_i^m	(4) dev_i^r	(5) dev_i^s
Panel A: T2 vs T1					
Treatment x CRT		0.217**			
		(2.23)			
Observations	984	984	984	984	984
Panel B: T3 vs T1					
Treatment x P-bias					
Observations	913	913	913	913	913
Panel C: T4 vs T2					
Treatment x CRT		-0.183**			
		(-2.11)			
Treatment x FL		-0.224*			
		(-1.95)			
Treatment x β_1	-0.205***		0.252**	0.243**	0.0177***
	(-2.62)		(2.26)	(2.25)	(2.69)
Treatment x β_2					0.0164**
					(1.99)
Treatment x aged 41-65		0.403**			
		(1.99)			
Treatment x College	0.0763*		-0.122**	-0.119**	
	(1.83)		(-2.17)	(-2.17)	
Observations	968	968	968	968	968
Panel D: T4 vs T3					
Treatment x β_1	-0.178**		-0.174*		0.0182**
	(-2.25)		(-1.72)		(2.15)
Treatment x F-bias	-0.140**		0.164**	0.160**	0.0148**
	(-2.48)		(2.15)	(2.15)	(2.55)
Observations	897	897	897	897	897
Controls	Yes	Yes	Yes	Yes	Yes

Notes. OLS estimates of the treatment effect, interacted with the score in the Cognitive Reflection Test (CRT), a dummy equal to 1 if subjects are present-biased (P-bias), the financial literacy score (FL), the short-run discount factor (β_1), the medium-run discount factor (β_2), the age category (= 41–65), a dummy equal to 1 if subjects have college education (College), a dummy equal to 1 if subjects are future-biased (F-bias). Significant coefficients only. All specifications control for age group, gender, income group, education attained, work status, residential area, marital status and religion. Robust standard errors in parentheses. $p < 0.10^{*}$, $p < 0.05^{**}$, $p < 0.01^{***}$

Is it simply risk aversion of subjects?

- In the Appendix, we find no statistically significant interaction of measured risk aversion with any of the treatment effects
  - *on consumption*
  - *on overall deviation from model consumption behavior*
  - *on the deviation from the model policy rule*
- This is also largely true for deviations resulting from the evolution of the endogenous state
  - *with three small exceptions of low statistical significance.*

Conclusions

- Cognitive load has a significant downward effect on consumption and an upward effect on chosen account balances
  - *the former being proportionately bigger for online workers*
  - *the latter being more pronounced for workers facing furlough.*
  - *These effects do not arise from supply constraints or worsening of borrowing constraints.*
- In the absence of cognitive load, the introduction of furlough risk tends to reduce consumption, as implied by precautionary models, but does not lead to significant deterioration of the model's ability to explain behavior.
- In the presence of cognitive load, however, furlough risk has
  - *a more moderate downward effect on consumption*
  - *but a higher effect on balances*
- Cognitive load worsens the ability of the workhorse model to describe consumption behavior
  - *Mostly in terms of policy rule rather than of the underlying endogenous state*
  - *Deviations are proportionately bigger for those who do not face furlough, such as online workers.*
- Subject heterogeneity:
  - *college educated subjects facing furlough tend to lower their consumption less in response to cognitive load and to exhibit a smaller deviation from optimal model behavior and from the optimal consumption rule.*
  - *Those who face furlough and exhibit greater short-term patience respond to cognitive load by lowering their consumption and deviating from the model and the optimal policy rule even more than their less patient counterparts.*
  - *Interestingly, financial literacy per se, as measured by our indicator, does not register pervasive significant effects in our experiments.*
  - *Nor does risk aversion.*

Additional material

Representativeness of sample

- The table compares figures from INSEE for 2021 to those from our survey
- Imposed quota dimensions: age, gender, education.
- Also representative on non-targeted quotas such as income, the employment rate or the region of residence

	(1) France	(2) Survey
Female	51.64%	51.83%
Median age	41.28	46.63
Married or domestic partnership(*)	58.8%	64.75%
Average household size(*)	2.19	2.62
Employment rate	67.30%	63.00%
Income(*)		
€0–€14,999	12.95	11.96
€15,000–€24,999	25.19	21.48
€25,000–€49,999	40.85	44.07
€50,000–€74,999	11.53	12.81
€75,000–€99,999	1.35	3.46
€100,000–€149,999	2.71	2.97(+)
€150,000–€199,999	2.71	1.75(+)
€200,000+	2.71	1.49(+)
Region of residence (%)		
Auvergne-Rhône-Alpes	0.12	0.12
Bourgogne-Franche-Comté	0.04	0.05
Bretagne	0.05	0.05
Centre-Val de Loire	0.04	0.05
Corse	0.005	0.003
Grand Est	0.08	0.09
Hauts-de-France	0.09	0.12
Île-de-France	0.19	0.16
Normandie	0.05	0.05
Nouvelle-Aquitaine	0.09	0.08
Occitanie	0.09	0.09
Pays de la Loire	0.06	0.05
Provence-Alpes-Côte d'Azur	0.08	0.08
COVID: two doses of vaccine received(−)	78.30%	83.63%

Notes. The table reports French representative statistics from the INSEE in the year 2021 (column 1) alongside summary statistics from our survey (column 2). (*) latest data available 2018. The data for income distribution for France are obtained through interpolation of the survey data with the true data (expressed in deciles). (+) We assume that the 4.15% of respondents choosing "Prefer not to answer" are equally distributed in the three last categories of higher income. The median age in France population is determined over the total population, while in our survey is calculated only over the population of 18 years old and over. The employment rate in France is calculated over the population aged between 15 and 64 years old, in our survey is calculated over the population of 18 years old and over. (−) Data on January 30, 2022 (source: ameli.fr)

Balance across treatment and control groups

	(1) T1	(2) T2	(3) T3	(4) T4
Age	47.38	46.86	45.73	46.42
Women	48.23	52.67	52.76	53.78
Married or domestic partnership	66.39	60.99	66.59	65.44
Income (€25,000 - €49,999)	47.81	41.98	42.63	43.84
College education	42.59	44.16	41.94	38.23
Currently employed	62.84	61.58	62.21	65.44
Observations	479	505	434	463

Notes. Share of subjects in each condition across socio-demographic variables [for Age: average value].

Payoff functions

- Each period, the agent's points, *P*, are compared to those of an agent who would behave optimally, conditional on the current endogenous state, P^r.

$$x_t = \frac{P_t - P_t^r}{P_t^r} * 100\%$$

$$0 \leq PO_t \leq 2.5 \text{ Euro.}$$

- The payoff function for 1 and 2 is:

$$PO_t = \begin{cases} 0.10 & \text{if } x_t \geq 100\% \\ 2.5 - 0.025x_t & \text{if } 0\% \leq x_t < 100\% \end{cases}$$

- The score on the cognitive load:

$$z_t = \frac{Tot_t - Errors_t}{Tot_t} * 100\%$$

- The payoff function for 3 and 4:

$$PO_t = \begin{cases} 0.001z_t & \text{if } x_t \geq 100\% \\ (2.5 - 0.025x_t)0.01z_t & \text{if } 0\% \leq x_t < 100\% \end{cases}$$

Robustness to performance indicators

- Further controls for:
  - *whether the subject reported not having answered randomly at any point during the survey (**Non-random responses**)*
  - *the average time spent in each model period in the task (**Time**)*
  - *the normalized score in the questions aimed at controlling the understanding of the instructions (**CQ score**).*
- Size, direction, and significance of treatment effects remains, except:
  - *Spending more time and not answering at random reduces model deviations in treatment and in control group: as expected!*
  - *Even a bigger deviation:*
    - Introducing furlough (T2 vs T1) increases deviations from the model and from the policy rule among subjects that spend similar time on the tasks and give the same response to whether they answered at random.