Hysteresis in alcohol and tobacco consumption patterns after lockdown: the power of time-preferences

Work in progress

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Overview

Context

- The Covid-19 pandemic led most countries in the world to implement lockdowns.
- There is ample evidence that it caused **variations** in health lifestyle behaviors in general, and **substance use** in particular, for a significant part of people.

- For instance:

  - Koopmann et al. (2021). The effects of the lockdown during the COVID-19 pandemic on alcohol and tobacco consumption behavior in Germany. *European Addiction Research*, 1-15.
  50% of cigarette smokers ↗ their use, 19% ↘ 36% of drinkers ↗, 21% ↘

  - Vanderbruggen et al. (2020). Self-reported alcohol, tobacco, and cannabis use during COVID-19 lockdown measures: results from a web-based survey. *European addiction research*, 26(6), 309-315. (Belgium)
  45% of cigarette smokers ↗, 15% ↘ 45% of drinkers ↗, 20% ↘
  56% of cannabis smokers ↗, 29% ↘

Research question(s)

- **These changes (+ or -) can be explained by several factors:**
  - changes in the availability of products (closing of restaurants and bars, limitation of travel leading to a limitation of possible sales outlets, etc.)
  - changes in the contexts of consumption (coffee breaks at work, family gatherings, social events, etc.)
  - changes in the motivations for use (e.g. coping with stress, boredom, loneliness, anxiety, see Martinez-Cao et al., 2021).
- An important question, especially from a public health perspective, is **whether these changes will have long lasting effects.** This effect is plausible because of the addictive nature of substances such as tobacco and alcohol.
- **This work has two main goals**:
  1. Document how consumption of addictive substances has evolved since the first lockdown shock and identify whether there has been **hysteresis**, i.e. long lasting effects.
  2. Study the link of hysteresis with economic preferences such as **time preferences**.

Research question(s)

- **« Hysteresis » - definition; and precision on the research question**

  A transitory disturbance in a system can cause a permanent change in the description of the system. In our data: $y_{i,0}, y_{i,1}, y_{i,2,}$ levels of consumption before, during and after the lockdown: disturbance $|y_{i,1} - y_{i,0}|$ (the lockdown Δ) remains longer, in the value of $y_{i,2}$

- **Link with time preferences**

It is well-established that Present-Bias individuals, or individuals who heavily discount the future, are more prone to addictive behavior (see Story et al., 2014, Amlung et al., 2017, and Weinsztok et al., 2021, for reviews).

These findings apply to smoking behavior (e.g., Kan, K., 2007, Takanori, 2014, Hofmeyr et al., 2017, Harrison et al., 2018), alcohol consumption (e.g., Odum & Rainaud, 2003, Cheung et al., 2022), food addiction (e.g., Komlos et al., 2004, Richards and Hamilton, 2012, Brown et al., 2016, Amlung et al., 2016) and problematic gambling (Ring et al., 2021).

Do we have the same result?

Method

- **RESPIRE project** (ANR Résilience Covid-19) "Resilience-after-crises in risk, time and social preferences? A behavioral economics study with a focus on cooperativeness" (coordinator: Bruno Ventelou)
- Continuation of **ConfinObs Project** (ANR Flash Covid-19) "Barrier and Containment Compliance and Observation: A Behavioural Economics Approach" (coordinator: Marc Willinger)
- **Main objective**: to measure to what extent economic and social preferences have been impacted by COVID-19 exposure. Three online surveys conducted on a representative sample of the French population using a partly renewed sample: **V1** in April/May 2020 (first lockdown), **V2 in September 2021** (N=1038; 338 in common with V1), V3 forthcoming (September 2022)
- **Participants**:
  Thierry Blayac, Dimitri Dubois, Sébastien Duchêne, Marlène Guillon, Marc Willinger (CEE-M, Montpellier U.)
  Sophie Massin (LEM, Artois U.)
  Phu Nguyen-Van (Economix, Paris Nanterre U.)
  Ismael Rafai (GREDEG, Côte d'Azur U.)
  Bruno Ventelou (AMSE, Aix-Marseille U.)

Topics covered by the survey (V2)

- 5 experimental tasks:
  - Time preference: Andreoni & Sprenger
  - Risk (and ambiguity) preference: Gneezy & Potters
  - Social preference: Public good + SVO (Social Value Orientation)

- Consumption of addictive goods: tobacco, alcohol, cannabis (small sample),
- Respect of preventive measures
- Proximity with Covid infection
- Situation wrt Covid vaccination
- Evolution of economic/financial situation since the beginning of the health crisis
- Mindfullness score (and intervention proposal)
- Socio-demographic characteristics
- Risk (general, health, money), patience and trust scales

Questions documenting the consumption of addictive goods

- Declarative data
- 3 moments:
  - Pre-lockdown (January 2020) (t_0)
  - During the lockdown (May 2020) (t_1)
  - Post-lockdown (September 2021) (t_2)
- 2 retrospective measures
- Antechronological order
- The respondents had to choose the scale (per day, per week, par month).
- The respondents could visualize their answers and modify them if needed.
- The respondents were asked how confident in their answers they were.

Consommation d'alcool

Quel que soit le type: bière, vin, alcool fort etc.

Avez-vous déjà bu de l'alcool au cours de votre vie ? —

Dans les questions suivantes nous allons vous demander d'estimer votre consommation d'alcool à trois moments différents (actuellement, en mai 2020 et en janvier 2020). Veuillez choisir l'échelle de mesure dans laquelle vous souhaitez répondre, entre un nombre de verres par jour, par semaine ou par mois. Cette échelle de mesure s'appliquera pour les trois moments. —

Combien de verres buvez-vous actuellement ? → $y_{i,2}$

Cette consommation a-t-elle lieu le plus souvent seul(e) ou en compagnie d'autres personnes (physiquement ou en visio) ? —

Remontons un peu dans le temps: en mai 2020, pendant le premier confinement, combien de verres buviez-vous ? → $y_{i,1}$

Cette consommation avait-elle lieu le plus souvent seul(e) ou en compagnie d'autres personnes (physiquement ou en visio) ? —

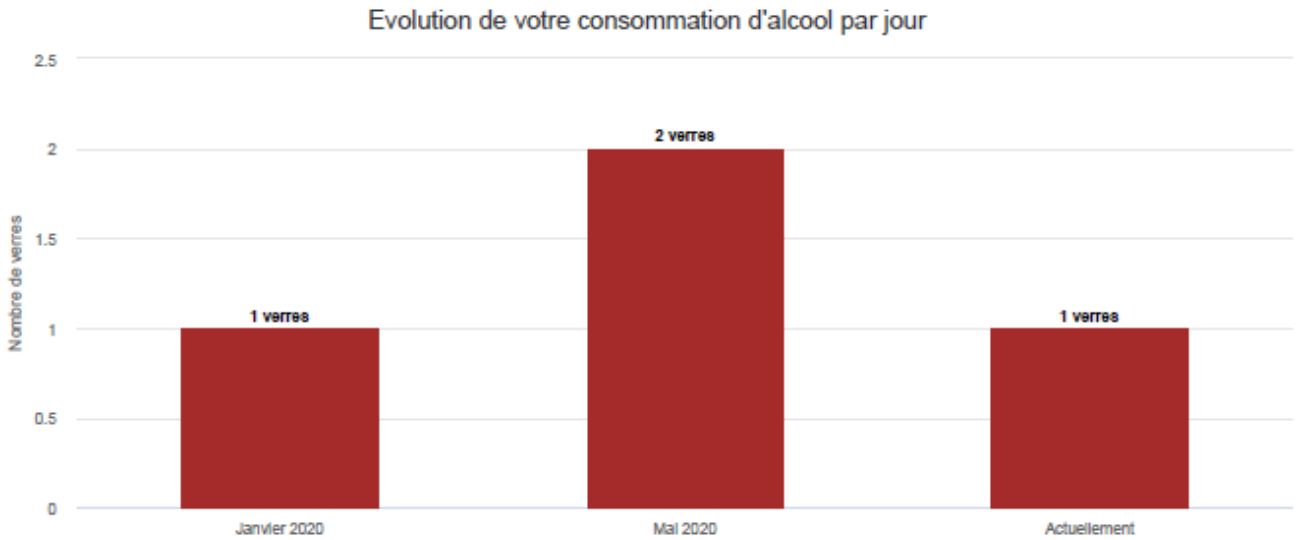
Remontons encore un peu plus dans le temps: en janvier 2020, avant le premier confinement, combien de verres buviez-vous ? → $y_{i,0}$

Cette consommation avait-elle lieu le plus souvent seul(e) ou en compagnie d'autres personnes (physiquement ou en visio) ? —

Suivant

Consommation d'alcool

Le graphique ci-dessous a été construit avec les données de consommation que vous avez indiquées pour chaque période.



Ce graphique est-il conforme à la perception que vous avez de l'évolution de votre consommation entre janvier 2020 et aujourd'hui ?

——

Si non, vous pouvez corriger en renseignant le nombre de verres par jour pour les trois périodes considérées

Janvier 2020:	Mai 2020:	Actuellement:	
1	2	1	Actualiser le graphique

Suivant

Assessment of the quality of data

- Less than 9% of respondents say they are not confident in their answers.
- **Comparison with other studies**:
- (next slide)
  - Baromètre Santé for prevalence data
  - CoviPrev survey (Santé Publique France) and Rossinot et al. (2020) for the evolution during the first lockdown

Rossinot, H., Fantin, R., & Venne, J. (2020). Behavioral changes during COVID-19 confinement in France: a web-based study. *International journal of environmental research and public health*, 17(22), 8444.

https://www.santepubliquefrance.fr/etudes-et-enquetes/coviprev-une-enquete-pour-suivre-l-evolution-des-comportements-et-de-la-sante-mentale-pendant-l-epidemie-de-covid-19

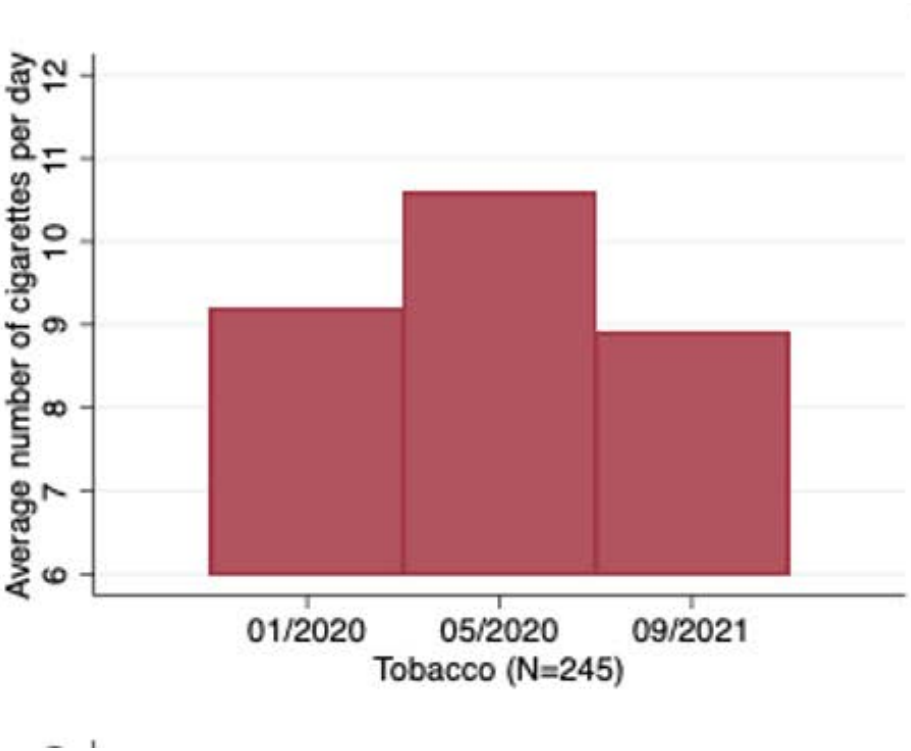
Quality of data: comparison with other studies

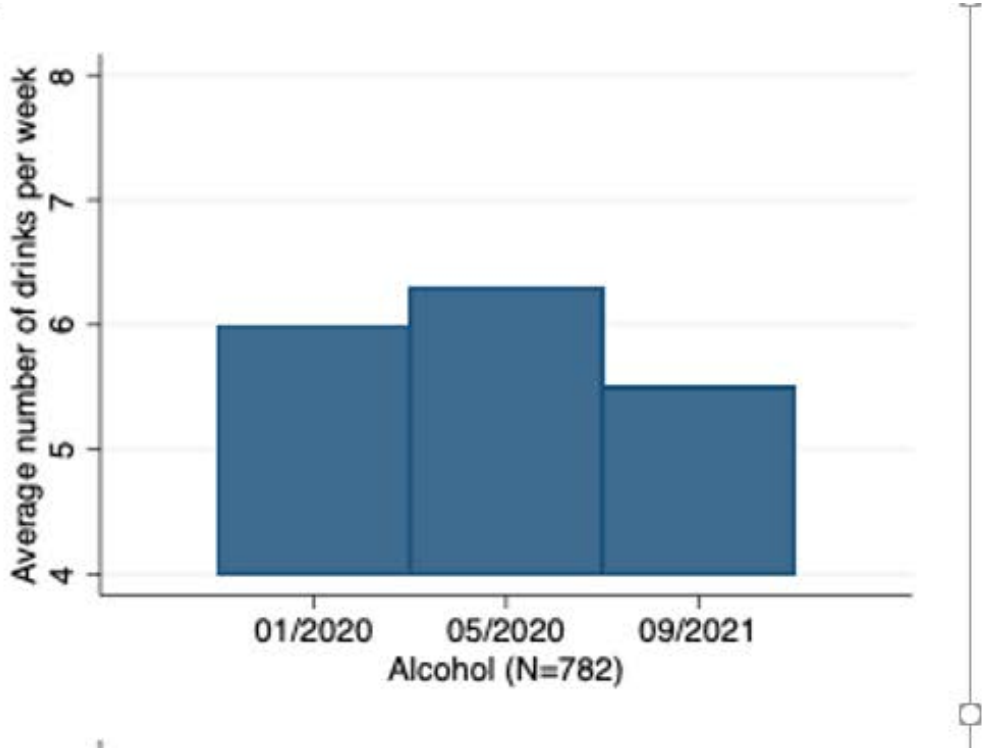
	Pre-Covid % of users in population		Pre-Covid % of daily users among users	
Sources	RESPIRE	Baromètre Santé	RESPIRE	Baromètre Santé
Tobacco	24.0	30.4	82.9	81.1
Alcohol	76.4	84.5	17.1	11.6

	% of users who have increased their use during the lockdown		
Sources	RESPIRE	CoviPrev	Rossinot et al.
Tobacco	30	27	40
Alcohol	19	11	31

	% of users who have decreased their use during the lockdown		
Sources	RESPIRE	CoviPrev	Rossinot et al.
Tobacco	11	19	23
Alcohol	22	24	17

Sample sizes and overall evolution of quantities





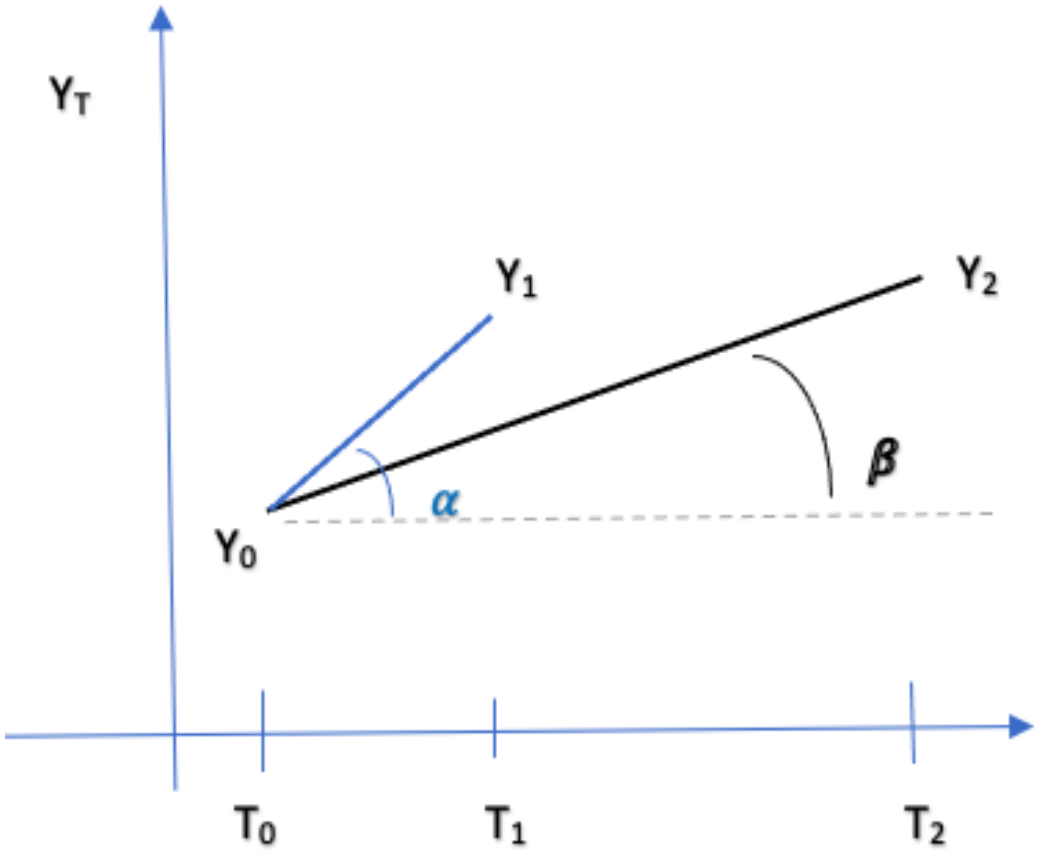
Econometric approach to hysteresis

Approach 1: direction-vectors analysis (variation approach)

Approach 2: level approach based on Wooldwridge (2005)

Wooldridge, J.M. (2005), Simple solutions to the initial conditions problem in dynamic, nonlinear panel data models with unobserved heterogeneity. J. Appl. Econ., 20: 39-54.

Approach 1: Direction-vectors analysis



$$\beta_{i,0} = \frac{y_{i,2} - y_{i,0}}{T_2 - T_0} \; ; \alpha_{i,0} = \frac{y_{i,1} - y_{i,0}}{T_1 - T_0}$$

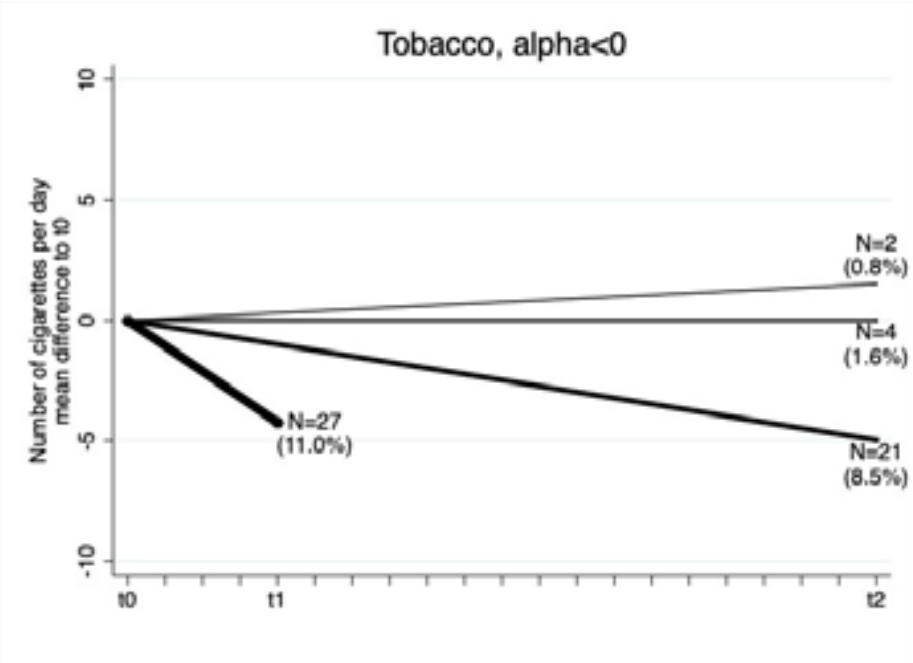
Checking whether the slope $\alpha_{i,0}$ (observed during lockdown) and slope $\beta_{i,0}$ (the long-run variation) are linked together. We can estimate: $\beta_{i,0} = b(\alpha_{i,0}) + \varepsilon_i$ and test whether b is different from 0.

$b > 0 \Leftrightarrow$ hysteresis

$b = 0 \Leftrightarrow$ perfect catch-up

$b < 0 \Leftrightarrow$ overcompensation

Illustration at the macro-level (whole sample)



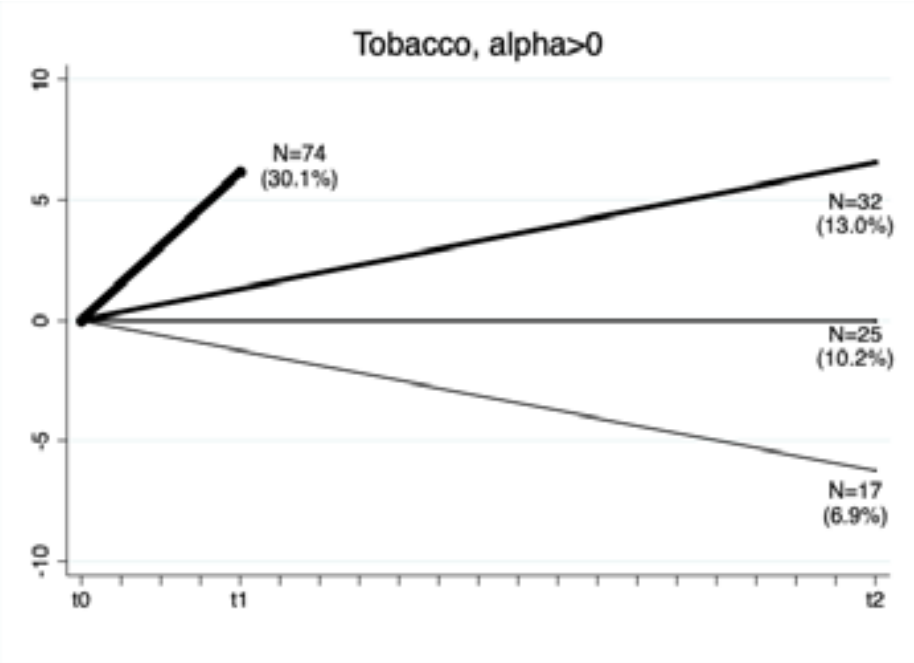
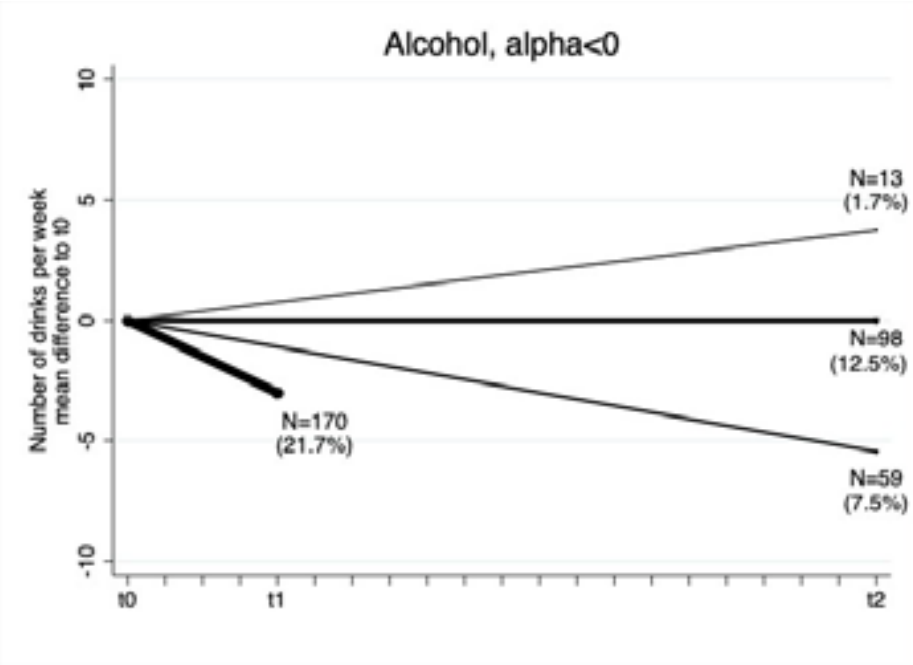
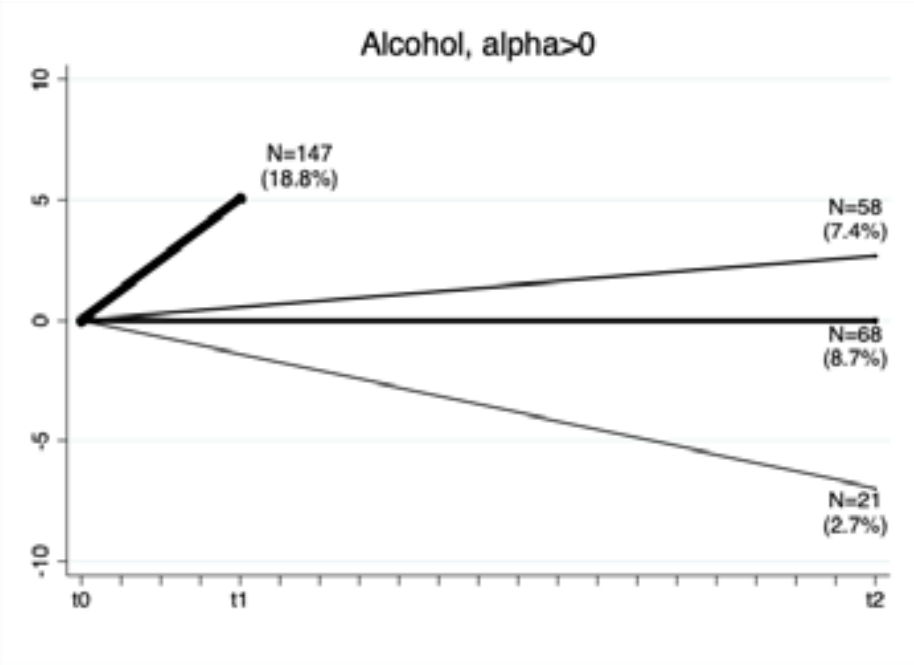


Illustration at the macro-level (whole sample)





Approach 2: Wooldwridge approach

Dynamic panel data model: $y_{i,t} = \rho y_{i,t-1} + \gamma X_{i,t} + \mu_i + \varepsilon_{i,t}$

Following Wooldridge (2005), we adopt a flexible specification for the individual effects μ_i as correlated random effects:

$$\mu_i | y_{i,0}, Z_i \sim N(\alpha_0 + \alpha_1 y_{i,0} + \alpha_2 y_{i,0} y_{i,1} + Z_i' \vartheta, \sigma_\mu^2)$$

The model reduces to: $y_{i,2} = \alpha_0 + \alpha_1 y_{i,0} + \alpha_2 y_{i,0} y_{i,1} + \rho y_{i,1} + \gamma X_{i,2} + Z_i' \vartheta + v_{i,2}$

The persistent behavior is represented by $\frac{\partial y_{i,2}}{\partial y_{i,1}} = \rho + \alpha_2 y_{i,0}$

Its mean value can be calculated by using the sample mean of $y_{i,0}$.

Results: tobacco

$$\frac{\partial y_{i,2}}{\partial y_{i,1}} = \rho + \alpha_2 y_{i,0}$$

	Dep. Var.: Tobacco use t2		
	(1)	(2)	(3)
VARIABLES	full sample	decrease	increase
alpha			
use t0	0.282***	0.612***	-0.135
	(0.104)	(0.187)	(0.292)
use t1	0.432***	0.541	0.473***
	(0.089)	(0.525)	(0.154)
use t0 x use t1	0.000	-0.001	0.000
	(0.000)	(0.001)	(0.000)
coef. of interest (computed from above)	0.434***	0.256	0.576***
	(0.075)	(0.328)	(0.145)
Observations	246	27	74
R-squared	0.549	0.551	0.538

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Results: alcohol

	Dep. Var. : Alcohol use t2		
	(1)	(2)	(3)
VARIABLES	full sample	decrease	increase
alpha			
use t0	0.619***	0.424***	1.008***
	(0.031)	(0.065)	(0.124)
use t1	0.439***	0.605***	-0.013
	(0.031)	(0.146)	(0.080)
use t0 x use t1	-0.002***	-0.002***	-0.001***
	(0.000)	(0.000)	(0.000)
coef. of interest (computed from above)	0.394***	0.557***	-0.032
	(0.029)	(0.142)	(0.078)
Observations	782	170	147
R-squared	0.764	0.518	0.697

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Result (a first step view)

- **Tobacco:**

Hysteresis in general (whole sample)

Hysteresis in case of **in**creased use during the lockdown

- **Alcohol:**

Hysteresis in general (whole sample)

Hysteresis in case of **de**creased use during the lockdown. No hysteresis in case of increase.

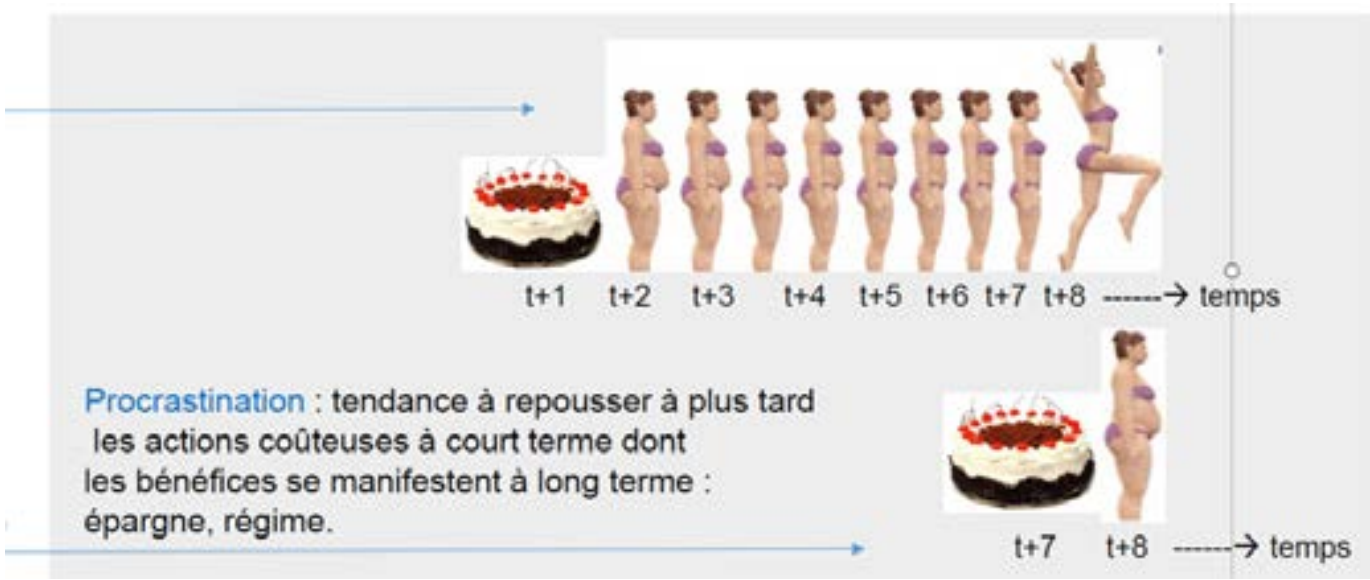
Link with time-preferences

Time-inconsistency is, classically, used to explain that people have difficulties with substance-use control

Link with time-preferences

Time-inconsistency
&
substance-use control

« Present bias » =
My slide, in Licence
Procrastination



Behavioral economics (post Becker-Murphy rational addiction theory)

$\Rightarrow$ Addiction could be rational, and irrational, at the same time

(Addictive trajectories from rational calculations // Hyperbolic discounting creates inconsistencies)

Gruber, J., & Kozegi, B. (2001). Is addiction "rational"? Theory and evidence. *The Quarterly Journal of Economics,* 116(4), 1261-1303.

Time inconsistency and addiction: math model

$$\varepsilon.U(y_t - \mu.\overline{y_{t-1}}) + \beta.[\delta.U(y_{t+1} - \mu.y_t) + \delta^2.U(\overline{y_{t+2}} - \mu.y_{t+1})]$$

The agent likes the product

Time inconsistency and addiction: math model

$$\varepsilon.U(y_t - \mu.\overline{y_{t-1}}) + \beta.[\delta.U(y_{t+1} - \mu.y_t) + \delta^2.U(\overline{y_{t+2}} - \mu.y_{t+1})]$$

The agent likes the product

…but the agent is sensitive to the **stock** (/past consumptions)
Parameter μ is giving the habituation effect
(O'Donoghue and Rabin (2002) = « **negative internalities** »)

Time inconsistency and addiction: math model

$$\varepsilon.U(y_t - \mu.\overline{y_{t-1}}) + \beta.[\delta.U(y_{t+1} - \mu.y_t) + \delta^2.U(\overline{y_{t+2}} - \mu.y_{t+1})]$$

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…but the agent is sensitive to the **stock** (/past consumptions)
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…+ for $\beta \neq 1$ the agent is present biased / future biased

Time inconsistency and addiction: math model

$$\varepsilon.U(y_t - \mu.\overline{y_{t-1}}) + \beta.[\delta.U(y_{t+1} - \mu.y_t) + \delta^2.U(\overline{y_{t+2}} - \mu.y_{t+1})]$$

The agent likes the product

…but the agent is sensitive to the stock (/past consumptions)
Parameter μ is giving the « negative internalities »

…+ for $\beta \neq 1$ the agent is present biased / future biased

[**Covid19 lockdown: shock on ε**
Changes in the motivations for use (e.g. coping with stress, boredom, loneliness, anxiety, see Martinez-Cao et al., 2021]

In the notations used before, change in ε for a given $\overline{y_0}$:

$$\varepsilon.U(y_1 - \mu.\overline{y_0}) + \beta.[\delta.U(y_2 - \mu.y_1) + \delta^2.U(\overline{y_3} - \mu.y_2)]$$

What will be: y_2 *and* y_1 ?

Time inconsistency and addiction: math model

$$\varepsilon.U(y_t - \mu.\overline{y_{t-1}}) + \beta.[\delta.U(y_{t+1} - \mu.y_t) + \delta^2.U(\overline{y_{t+2}} - \mu.y_{t+1})]$$

The agent likes the product

…but the agent is sensitive to the stock (/past consumptions)
Parameter μ is giving the « negative internalities »

…+ for $\beta \neq 1$ the agent is present biased / future biased

Choice on y_t, y_{t+1}. First order conditions (for unbiased, $\beta = 1$):

$$\varepsilon.\frac{\partial U(y_t - \mu.y_{t-1})}{\partial y_t} = \delta.\mu.\frac{\partial U(y_{t+1} - \mu.y_t)}{\partial y_t}$$

$$\frac{\partial U(y_{t+1} - \mu.y_t)}{\partial y_{t+1}} = \delta.\mu.\frac{\partial U(y_{t+2} - \mu.y_{t+1})}{\partial y_{t+1}}$$

Time inconsistency and addiction: math model

$$\varepsilon.U(y_t - \mu.\overline{y_{t-1}}) + \beta.[\delta.U(y_{t+1} - \mu.y_t) + \delta^2.U(\overline{y_{t+2}} - \mu.y_{t+1})]$$

The agent likes the product

…but the agent is sensitive to the stock (/past consumptions)
Parameter μ is giving the « negative internalities »

…+ for $\beta \neq 1$ the agent is present biased / future biased

Optimal responses to shock dε (for $U(C) = log\ C, \beta = 1$):

FOC + Differential equations

$$\frac{dy_t}{d\varepsilon} = \frac{(y_{t+1} - \mu.y_t)}{\mu.(\delta + \varepsilon\left(\frac{1}{1+\delta}\right))}$$

$$\frac{dy_{t+1}}{d\varepsilon} = \frac{(y_{t+1} - \mu.y_t)}{(\delta + \varepsilon\left(\frac{1}{1+\delta}\right))}\left(\frac{\delta}{1+\delta}\right)$$

Slopes > 0,
for any d$\varepsilon > 0$

Time inconsistency and addiction: math model

$$\varepsilon.U(y_t - \mu.\overline{y_{t-1}}) + \beta.[\delta.U(y_{t+1} - \mu.y_t) + \delta^2.U(\overline{y_{t+2}} - \mu.y_{t+1})]$$

The agent likes the product

…but the agent is sensitive to the stock (/past consumptions)
Parameter μ is giving the « negative internalities »

…+ for $\beta \neq 1$ the agent is present biased / future biased

For biased individual: optimal responses (for $U(C) = log\ C$):

$$\frac{dy_t}{d\varepsilon} = \frac{(y_{t+1} - \mu.y_t)}{\mu.(\beta.\delta + \varepsilon\left(\frac{1}{1+\delta}\right))}$$

$$\frac{dy_{t+1}}{d\varepsilon} = \frac{(y_{t+1} - \mu.y_t)}{(\beta.\gamma + \varepsilon\left(\frac{1}{1+\delta}\right))}\left(\frac{\beta\delta}{1+\beta\delta}\right)$$

…for $\beta < 1$ the agent responds more

Time inconsistency and addiction: math model

$$\varepsilon.U(y_t - \mu.\overline{y_{t-1}}) + \beta.[\delta.U(y_{t+1} - \mu.y_t) + \delta^2.U(\overline{y_{t+2}} - \mu.y_{t+1})]$$

Hysteresis = how much the variation in y_t (dy_t) remains in y_{t+1}

$$\frac{dy_{t+1}}{dy_t} = \frac{\delta}{1+\delta} \text{ for unbiased}$$

$$\frac{dy^b_{t+1}}{dy^b_t} = \frac{\beta\delta}{1+\beta\delta} \text{ for biased individuals}$$

Comparison biased/unbiased on their hysteresis :

$$\frac{\frac{dy^b_{t+1}}{dy^b_t}}{\frac{dy_{t+1}}{dy_t}} = \frac{\frac{\beta\delta}{1+\beta\delta}}{\frac{\delta}{1+\delta}} = \frac{1+\delta}{1+\beta\delta}$$

$\frac{1+\delta}{1+\beta\delta} < 1$ for $\beta > 1$

$\frac{1+\delta}{1+\beta\delta} > 1$ for $\beta < 1$

Proposition: the lasting effect of the shock on y_{t+1} is proportional to the bias β

Link with time-preferences, **back to the data**

Simplified Andreoni Sprenger task to measure time preferences. (Incentivized)

Participants classified in 3 categories :

		Freq.	Percent
	Consistent	**576**	55.49
$\beta > 1$	**Inconsistent/ future oriented**	**218**	21.00
$\beta < 1$	**Inconsistent/ present oriented**	**244**	23.51
	Total	1,038	100.00

Link with time-preferences, **back to the data**

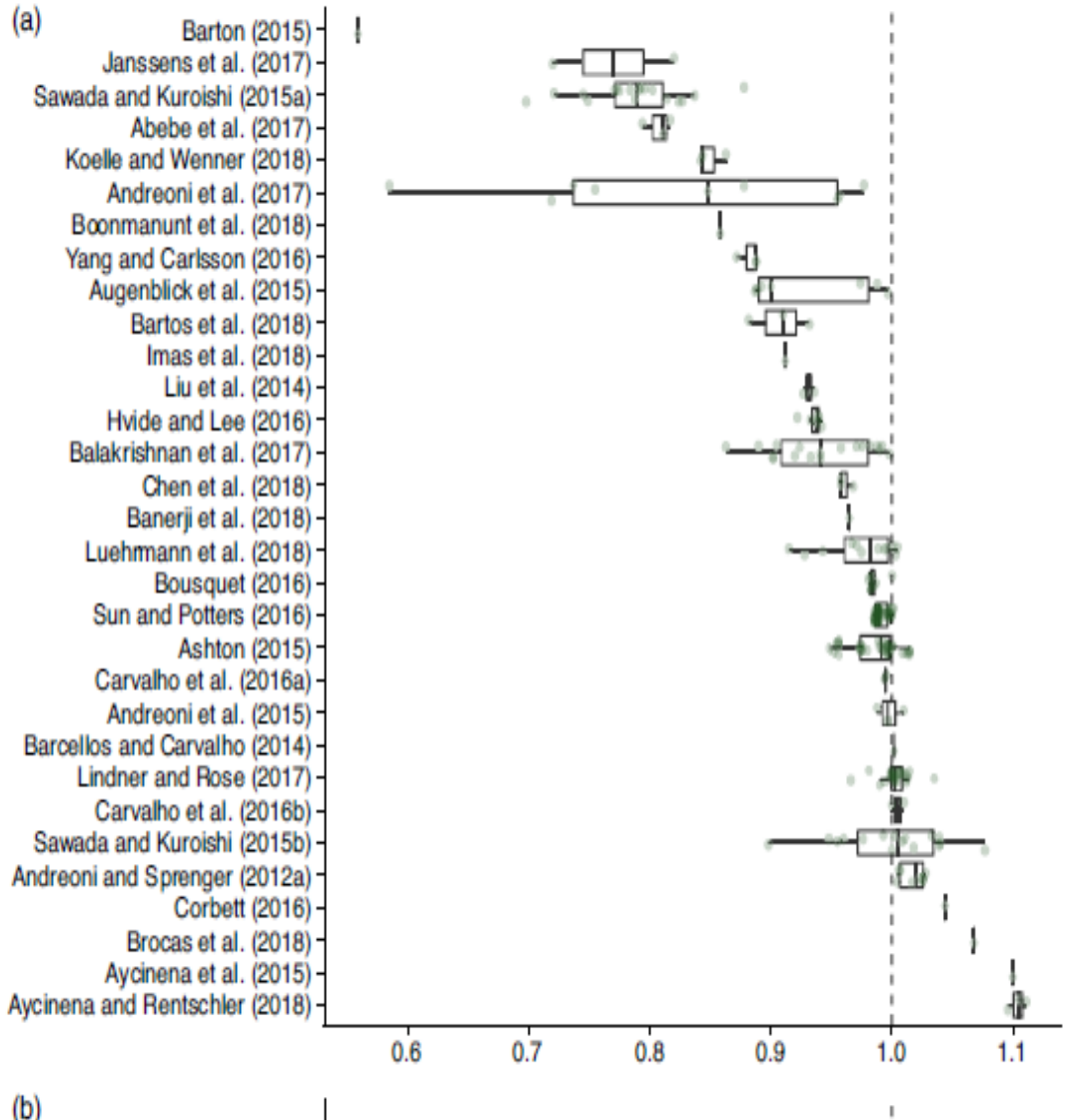
Simplified Andreoni Sprenger task to measure time-preferences.

Comparison with lit'

$\bar{\beta}<1$

Imai, T., Rutter, T. A., & Camerer, C. F. (2021). **Meta-Analysis** of Present-Bias Estimation using Convex Time Budgets. *The Economic Journal*, *131*(636), 1788–1814.

$\bar{\beta}>1$



Link with time-preferences, **back to the data**

Direct estimation of:

$\frac{\partial y_{i,2}}{\partial y_{i,1}} = \rho + \alpha_2 y_{i,0}$ (thanks to normalization on $\overline{y_{i,0}}$ by sub-groups)

	Smokers			Drinkers		
VARIABLES	coherent N=118	future biased N=51	present biased N=59	coherent N=418	future biased N=133	present biased N=171
Tabac_t2_std_byPT	0.447***	0.307	0.654***			
	(0.127)	(0.346)	(0.187)			
Alcool_t2_std_byPT				0.343***	0.070	0.196***
				(0.066)	(0.123)	(0.039)

Link with time-preferences, **back to the data**

Direct estimation of:

$$\frac{\partial y_{i,2}}{\partial y_{i,1}} = \rho + \alpha_2 y_{i,0}$$

Expected (nil result)

	Smokers			Drinkers		
VARIABLES	coherent N=118	future biased N=51	present biased N=59	coherent N=418	future biased N=133	present biased N=171
Tabac_t2_std_byPT	0.447***	0.307	0.654***			
	(0.127)	(0.346)	(0.187)			
Alcool_t2_std_byPT				0.343***	0.070	0.196***
				(0.066)	(0.123)	(0.039)

Link with time-preferences, **back to the data**

Direct estimation of:

$$\frac{\partial y_{i,2}}{\partial y_{i,1}} = \rho + \alpha_2 y_{i,0}$$

Expected (gradient)

	Smokers			Drinkers		
VARIABLES	coherent N=118	future biased N=51	present biased N=59	coherent N=418	future biased N=133	present biased N=171
Tabac_t2_std_byPT	0.447***	0.307	0.654***			
	(0.127)	(0.346)	(0.187)			
Alcool_t2_std_byPT				0.343***	0.070	0.196***
				(0.066)	(0.123)	(0.039)

Link with time-preferences, **back to the data**

Direct estimation of:

$$\frac{\partial y_{i,2}}{\partial y_{i,1}} = \rho + \alpha_2 y_{i,0}$$

Expected (gradient)

UNEXPECTED

	Smokers			Drinkers		
VARIABLES	coherent N=118	future biased N=51	present biased N=59	coherent N=418	future biased N=133	present biased N=171
Tabac_t2_std_byPT	0.447***	0.307	0.654***			
	(0.127)	(0.346)	(0.187)			
Alcool_t2_std_byPT				0.343***	0.070	0.196***
				(0.066)	(0.123)	(0.039)

Conclusion

- **Tobacco**: Hysteresis in case of **in**crease of use during the lockdown.
- **Alcohol**: Hysteresis in case of **de**creased use during the lockdown. No hysteresis in case of increase.

- **Time inconsistency (measured in money context!) might play a role :**

Future-biased individuals are more likely to catch-up. No hysteresis for them.

Present-biased are more trapped in their past behaviour => long lasting effects

…except for alcohol / BUT alcohol is made of people decreasing (or able to catch-up when they were increasing during lockdown…).

- …to be further explored.