Confidence must be earned

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The Impact of Robo Advising on Individuals' Savings and Investment Decisions

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The Context

- **Individuals are more and more responsible of their pension savings' decisions**
  - Reduction in pay-as-you-go pension benefits
  - Gradual shift from DB to DC pension funds

- **Individuals' saving and investment decisions are key**

- **Recent advances in technologies: possibilites to offer financial services in an innovative way**

- **Can robo-advisors help ?**

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Outline

- **Part 1: Individual investors' needs**
  - Structural weakness in individuals' investment
  - The role of financial advisors
- **Part 2: Robo-advisors: Promises and open questions**
  - Personalisation, reduced biases, financial inclusion
  - Trust in robots, human/robot interaction?
- **Part 3: Impact of robo-advisor introduction on employee savings' plans**

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01

Individual Investors’ Needs

Structural Weaknesses in Individuals' Investment

- **Low participation to the stock market**
  - Higher allocation for more wealthy households, more financially educated, with lower risk aversion (Calvet et al., 2007, 2009 ; Van Rooij et al., 2011)

- **Insufficient diversification**
  - Households investing directly in equities hold in average 2 stocks (Polkovnichenko, 2005)
  - Large allocation to employer stock
  - Misunderstanding of diversification benefits (von Gaudecker, 2015 ; Reinholtz et al., 2016)

- **Large investment biases**
  - Home bias (Coval and Moskowitz, 1999 ; Bekaert et al., 2015).
  - Familiarity bias : geographically/professionally (Grinblatt et Keloharju, 2001 ; Massa et Simonov, 2006 ; Bianchi and Tallon 2018)

- **Especially for investors with low financial literacy**
  - Guiso et al., 2003 ; Lusardi and Mitchell, 2014; Bianchi, 2018

Limited Attention

- **Investors observe their portfolios infrequently**
  - Investors with **high attention have superior performance** (Gargano, Antonio, and Rossi, 2016)
  - Investors monitor their portfolios **more frequently in rising markets** than when markets are flat or falling, or volatile (Karlsson et al., 2009; Sicherman et al., 2016)

- **Rational / behavioral theories of attention?**
  - **Behavioral models** of information aversion (Andries and Haddad, 2017 ; Pagel 2018).
  - Irrespective of the shape of transaction costs, investors may observe and trade **more frequently in particular states**, **when information is less painful** ("ostrich effect")

Financial Advice

– Financial advice is key in investment decisions

- 73% of U.S. retail investors **consult a financial adviser before purchasing shares** (Hung et al., 2008)
- In Europe, 80% of purchasers of investment products made their purchase in a face-to-face meeting with an employee of an investment provider or professional adviser (Chater, et al. 2010)

- Investors with **higher financial literacy** are more likely to **seek financial advice** (Hackethal, Haliassos, and Jappelli 2012; van Rooij, Lusardi, and Alessie 2011)

– Trust is important

- Trust: “Subjective probability individuals attribute to the possibility of being cheated”
- Less trusting individuals are **less likely to buy stocks** (Guiso, Sapienza, and Zingales, 2008)

- **Trust in financial advice** significantly affects the likelihood of less-educated households to **hold risky assets** (Georgarakos and Inderst, 2011)

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Financial Advice

But financial advice does not reduce biases

- Advised portfolios don't have **higher performance/less bias** (Mullainathan et al., 2012 ; Hoechle et al., 2014)
  - Additional biases due to advisors' **conflicts of interests** (Mullainathan et al., 2012)
  - They encourage chasing returns, push for actively managed funds
- Financial advisors tend to recommend **portfolios close to their own investment**, independently of clients' preferences and life cycle situation (Foerster et al., 2017 ; Linnainmaa et al., forth)
- Advised portfolios tend to be **more risky / with higher turnover** (Hackethal et al., 2012)
- **Unfair clients' treatment**: women and young individuals receive less personalized advice
  - Less asked about their age, salary, retirement situation etc. (Mullainathan et al., 2012)

Financial advisors can easily exploit these biases

- Consumers tends to ignore biases related to conflicts of interest
- Disclosure of conflicts increases confidence in the advisor, advisor's biases perceived as more morally acceptable (Cain et al., 2005)

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Insufficient Client Knowledge

- **MiFID Directive aims to protect individual investors according to their level of financial knowledge**
  - MiFID I (2007) requires that clients be sent a questionnaire assessing their level of financial knowledge, their assets and their investment objectives.
  - MiFID II (2018) provides for a strengthening of the requirements for board independence and transparency (on the costs of the board, on the available investment vehicles, etc.).

- **MiFID questionnaires are insufficient**
  - Insufficient customer profiling due to **lack of suitable scoring techniques**
  - Great **heterogeneity of the questionnaires**: a “prudent” profile can be assessed “dynamic” by another bank (Palma and Picard, 2011; Marinelli and Mazzoli, 2012; Linciano and Soccorso, 2012)

02

The promises of robo-advisors

Robo-advisors: A rapidly Growing Market

- **A “robo-advisor” is an online platform providing financial advice or allowing the automated management of a portfolio of assets**
  - Direct digital relationship (subscription, reporting, rebalancing)
  - Intuitive interface, accessible at any time, can establish a dialogue based on the client's project
  - Access to a large choice of funds and ETFs
  - Asset allocation and rebalancing advice at limited cost

- **Global market is around $1 trn (Buisson, 2019)**
  - AUMs worldwide are projected to reach $2.5 trn in 2024 (Statista)
  - Number of users is expected to amount to 436M by 2024 (Statista)

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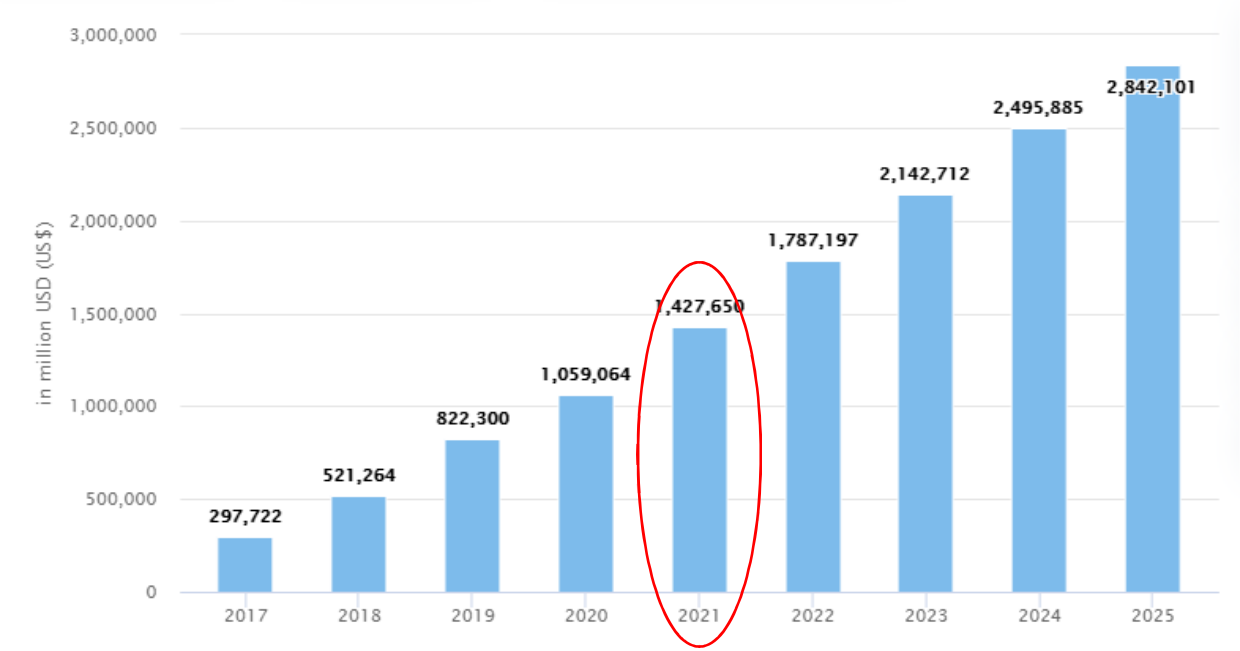
Robo-advisors: A rapidly Growing Market

– Worldwide assets under management projections



Notes: Data is shown using current exchange rates. The applied current exchange rates are displayed in the Key Market Indicators below. This replacement of the 2017 constant exchange rate with current exchange rates was carried out in October 2021.

Source: Statista, Dec 2021

https://www.statista.com/outlook/337/100/robo-advisors/worldwide

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Robo-advisors: How They Work

- **Three types of robo-advisors (European Parliament, 2021)**

Generic Robo-advice	Personnalized Robo-advice	Managed account
– Do not consider the personal situation of the client – Platform suggesting attractive investments like an online broker	– Software provides investment advice based on clients preferences – Client **makes investment decision**	– Software manages financial instruments on behalf of the client, rebalancing the portfolio – The robo-advisor **does not need client approval** for investment decisions

Relies on **human-robot interaction**

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Robo-advisors: How They Work

- **Define goals**
  - Combination of wealth / consumption objectives constrained by budgetary conditions and risk budgets

- **Assess personal preferences**
  - Preferences (risk aversion etc.) and personal risks (salary, real estate) are crucial to take into account, in addition to market risks (Merton, 1971, 1973)
  - Substantially changes dynamic asset allocation decisions

- **Construct and communicate an optimal investment strategy**
  - Typically based on sample portfolios or an optimization (Markowitz, Black Litterman), rarely more sophisticated techniques (full scale optimization, etc.)
  - Alerts are sent / portfolios are rebalanced automatically when they drift from the target asset allocation

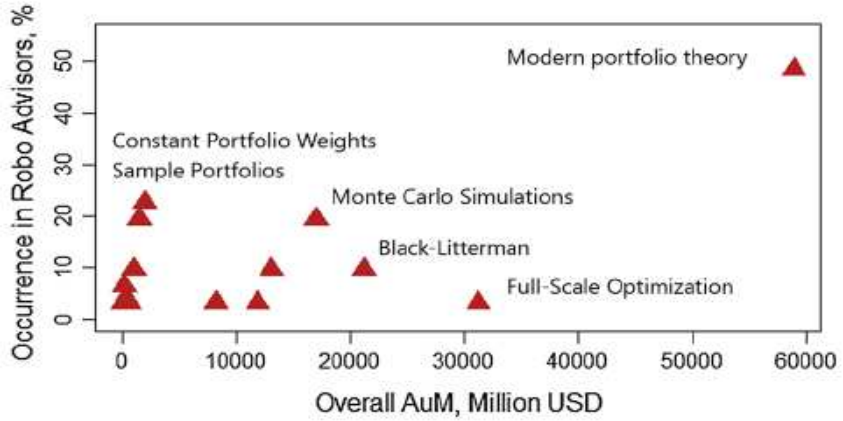
Robo-advisors: How They Work

- **Robo advisors rely on a small number of portfolio construction methods**

Table 1: Occurrence of Different Methodologies in Robo-Advisory

Methodological framework	Occurrence (%)	Methodological framework	Occurrence (%)
Modern Portfolio Theory	39.7	Risk Parity	1.4
Sample Portfolios	27.4	Full-Scale Optimisation	1.4
Constant Portfolio Weights	13.7	Constant Proportion Portfolio Insurance	1.4
Factor Investing	2.7	Mean Reversion Trading	1.4
Liability-Driven Investing	2.7	Other	8.2

Beketov, Lehmann and Wittke (2018: 366)



Source: Beketov et al. (2018)

The Promises of Robo Advisors

– Improved clients' knowledge and personalisation

- Detailed **questionnaire**
- Partnerships between robo-advisors and **financial account aggregators**, digital platforms of investment, lending, and tax calculation
  - Wealthfront and Venmo, Redfin, Coinbase, Lending Club, Turbotax
  - Yomoni & Bankin ; Linxo & Grisbee ; Vanguard & Yodlee
- But lack of understanding of some individuals' characteristics: consumption habits, human capital risk, 1st pillar pension

– Reduced bias in clients' treatment

- No differences by gender, age etc.
- But in practice, robots are mainly used by **young people**
  - In the US, 38% of individuals between 18 and 34 who invest outside of their pension fund have used a robo, compared to 4% of individuals over 55 (FINRA survey 2016a)

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The Promises of Robo Advisors

– Financial inclusion

– **Large fixed costs in traditional financial services, unprofitable to serve poorer consumers**

– **By reducing costs, new technologies can reach traditionally under-served (Philippon, 2019)**

- Robo-advisors require **lower initial capital** to open an account

  Ex: Bank of America requires US$25,000 / 5000 to open an account with a private financial / robo-advisor

- They charge **lower fees** than human advisors

– **Robo advice improves the situation of individuals not covered by traditional financial advice**

- Minimum account size reduced from $5,000 to $500 by a U.S. robo-advisor led to a 59% **increase in the share of "middle class" participants** (Reher and Sokolinski, 2020)
- Participants increase their risk exposure and risk-adjusted returns, especially those with smaller portfolios (Bianchi and Briere, 2021)

Can People Trust Robots?

- **Robo-advisors rely on algorithm in different part of their process**
  - **Investor's profiling**
    - Robo advisors are estimating investors' characteristics to define the asset allocation
    - Many individuals have a low understanding on their preferences and goals and low visibility about their future situation (unemployment, retirement age, retirement benefits etc.).
  - **Optimal asset allocation definition**
    - The optimal ptf crucially depend on expected returns/risk hypotheses
    - Reliance of portfolio optimization process
- **Merton (2017), "What you need to make technology work is to create trust."**

Can People Trust Robots?

- **Algorithm aversion**
  - General **lack of trust** in algorithm (HSBC, 2019)
    - Only 8% of respondents would trust a robot programmed by experts to offer mortgage advice, 41% trusting a mortgage broker. 9% would be likely to use a horoscope to guide investment choices!
    - **19% said they would trust a robo-advisor**
    - Large differences across countries
  - **Algorithm complexity** problematic for those with **lower financial capabilities** (Ryan, Trumbull and Tufano, 2011 ; Lerner and Tufano, 2011)
- **Algorithm aversion can be reduced by giving people some control**
  - Forecasters more likely to choose the imperfect algorithm when they could **modify its forecasts**, even if severely restricted in the modifications (Dietvorst, Simmons and Massey, 2018)
  - One way to build trust is to let humans and robots interact, with the robot proposing an advice and the **human being the ultimate decision maker**

How will Humans Interact with Robots?

– Robots: complements of substitutes of human decision ?

Substitutes?

In experiments (emergency situation), users put **too much faith in robots** (Robinette et al. 2016)

Robo-advisors reduce investors' demand for human financial advice (Brenner and Meyll, 2020)

Complements ?

A number of platforms that were entirely digital **reintroduced human advisors**. For example, Scalable Capital, Nutmeg

– Open questions

- Should one **delegate the entire decision** to the robot or let individuals keep an eye on it, to monitor/intervene if necessary?
- How does **trust evolve** when investors experience market shocks / new investment opportunities arise ?

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Open questions

- **Can robo-advisors help improve individuals' financial decisions?**
  - Accountable procedures, real time and tailored recommendation
  - Fine understanding of clients preferences, limiting behavioral biases
- **Can robo-advisors promote financial inclusion?**
  - Lower operating costs (minimal capital requirements, fees), so possibly more inclusive
- **Broader question: human-robot interaction**
  - Trust is key: higher algo aversion for financial services (HSBC 2017, Merton 2017)
  - Replace or promote human judgment or advice?

Related Literature

- **Growing literature on the effects of robo advising on portfolio choices (D'Acunto and Rossi 2020, Bianchi and Brière 2021)**
  - D'Acunto et al. (2019) robo in an Indian brokerage house has a beneficial impact on less diversified investors but not on diversified investors
  - Rossi and Utkus (2019) robo increases investors' exposure to low-cost indexed mutual funds, improve diversification and risk-adjusted performance
  - Similar findings in Braeuer et al. (2017) and Loos, Previtero, Scheurle and Hackethal (2020), not in Reher and Sun (2016)
  - Reher and Sokolinski (2020) robo improves market participation of middle class investors

- **Key distinctive features**
  - Sample: investors with **small portfolios**, little experience and no access to financial advising
  - Robo-advisor let individuals take the final decision: **dynamic human/robot interactions**
  - Exploit **knowledge of the robo rules**
  - Focus on portfolio choices over time and **reactions to alerts**

03

Case Study: Robo-advisor Introduction on Employee Savings' Plans

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This Paper

- **Robo-advisor introduced by AMUNDI on Employee Savings Plans**
  - Distinctive feature: gives advice, both at the time of the subscription and over time, while leaving investors **free to follow or to ignore it**

- **Who takes the robot**
  - Even small investors attracted
  - Differences with human advice: large portfolio changes are accepted

- **Effects on attention, investment, portfolio choice, trading activity and performance**
  - Robo increases human attention (complementarity?) and investment
  - Increased risk-taking and risk-adjusted returns
  - More rebalancing, reduced distance from target allocation, impact of alerts

- **Financial inclusion**
  - Effects are larger on investors with smaller portfolios

Data

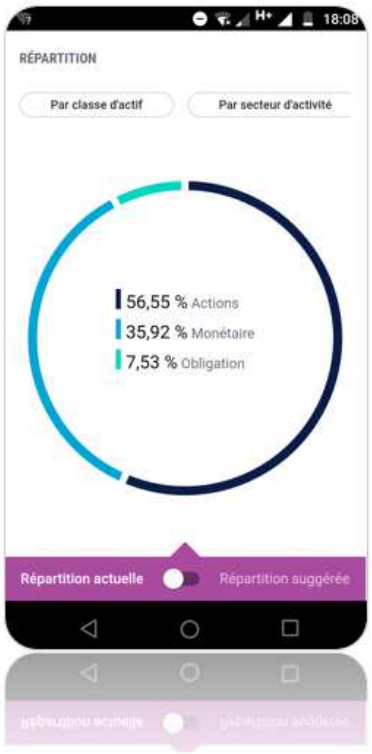
- **Employee Savings Plans**
  - Representative sample of the French population employed in the private sector, small portfolios and little experience in the stock market
  - Each year, employees receive a sum of money allocated between a menu of funds proposed by their employer
  - Investment is locked in either for 5 years or until retirement
  - Employees can increase their investment and rebalance their portfolio over time

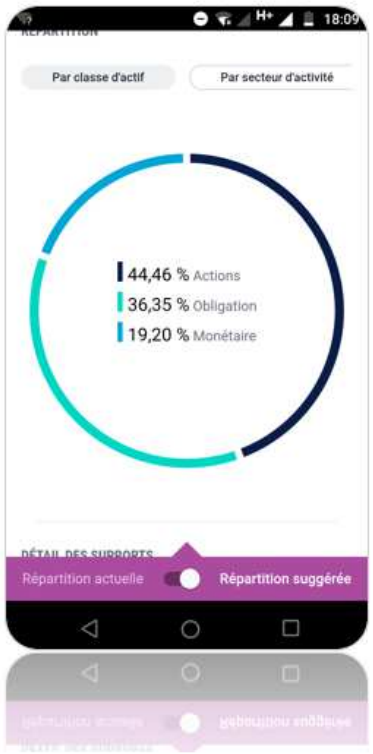
- **Sample period Sept 2016/November 2018 (monthly frequency)**
  - Robo introduction in Sept 2017

- **Our sample: all robo-takers (14,576 employees - out of 600,000 exposed) and random samples of 20,000 non-exposed / exposed not-takers / curious**
  - Account level data (portfolio choices, returns, risk) + digital footprints (connections) + robo data (profile, proposed allocation)

Data

- **Robo treatment**
  - Elicits information (risk-aversion, financial knowledge, horizon)
  - Proposes an allocation, and if accepted implements it
  - Sends email alerts if current allocation is too far from proposed allocation





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Basic Specification

– **Difference-in-difference (OLS) regressions**

$$y_{i,t} = \alpha_i + \beta T_{i,t} + X'_{i,t}\gamma + \mu_t + \varepsilon_{i,t}, \qquad (1)$$

α_i and μ_t are individual and time fixed effects
$T_{i,t} = 1$ if individual i has taken the robo in period t
$X_{i,t}$ portfolio characteristics (past risky share, past returns, account value, ...)
standard errors are clustered at the individual level
control group are individuals not exposed to the robo

Who Trusts the Robo?

– Q1: Who takes the robo and who delegates a large share of his portfolio?

	(1)	(2)
Dep. Variable	Taker	Share
Age	6.56e-05	0.000194
	(0.000107)	(0.000509)
Female	-0.00444**	-0.0204***
	(0.00209)	(0.00561)
Account value (ln)	0.000860	-0.0325***
	(0.00186)	(0.00378)
Equity share	0.0116	-0.0912**
	(0.00812)	(0.0434)
Variable remuneration	2.80e-06***	-3.47e-06
	(9.91e-07)	(2.46e-06)
Returns	-0.126*	-2.132***
	(0.0711)	(0.420)
Connexions	0.00184	-0.00126
	(0.00112)	(0.00176)
Sample	Takers + Exposed	Takers

– **Robo attracts** all kinds of employees: slight bias towards **male** investors with **larger variable remuneration** and lower returns

– Male, **smaller** investors, with higher risk exposure and **lower performance** are willing to delegate a **larger portion** of their portfolio to the robo

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Who Trusts the Robo?

– **Q2: What is the impact of the first advice on robo take-up ?**

	(3)	(4)
	Taker	
Robo equity distance	0.154***	
	(0.0494)	
Robo equity change		0.160***
		(0.0400)
Sample	Takers+Curious	

– **In contrast to typical human advisers, investors seem to be attracted by robo allocations that are far away from their current allocation and riskier**

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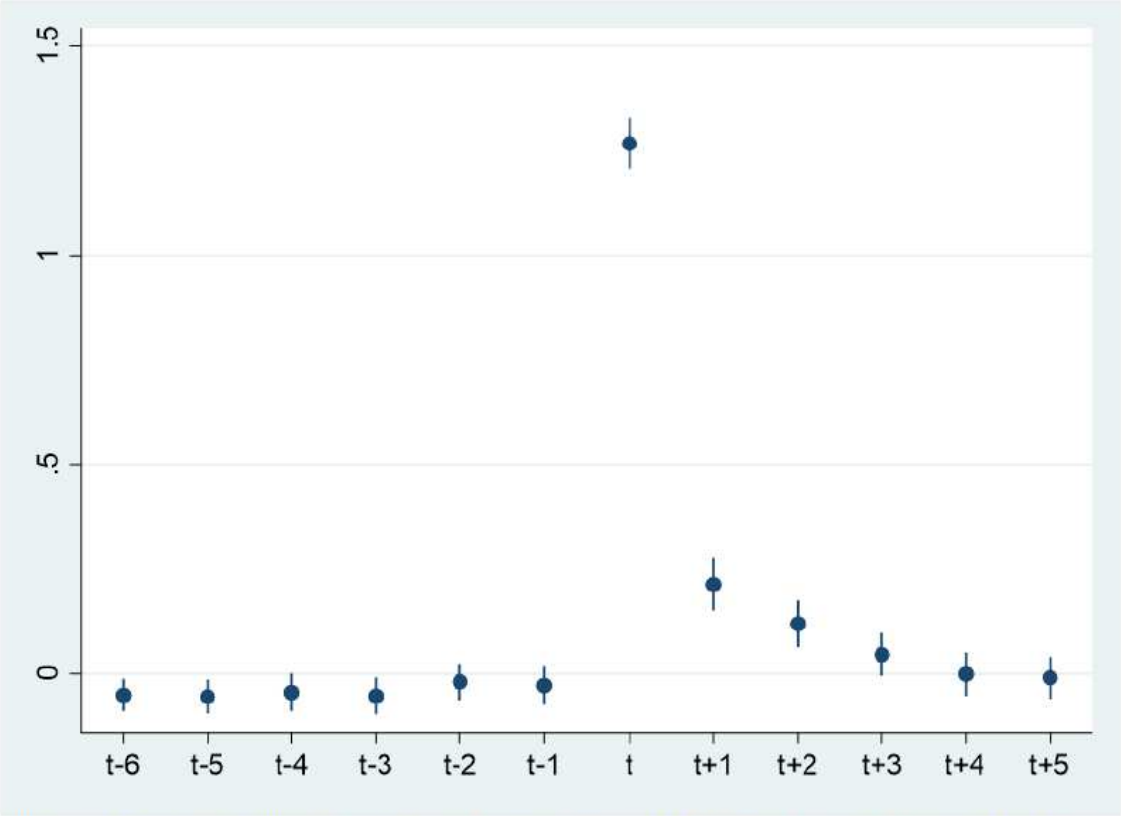
Impact on Attention

- **Robo is associated to an increased level of attention**
  - +0.28 connexions per month (avg=0.5)
  - Investors do not take the robo as **a substitute for their own attention**
  - True even beyond the time of its subscription and the time of reception of the variable remuneration

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Variable	Connexions		Minutes		Pages	
Robo treated*after	0.277***	0.278***	4.042***	4.717***	5.082***	5.869***
	(0.0205)	(0.0156)	(0.162)	(0.133)	(0.146)	(0.108)
Robo treated	0.761***		5.634***		5.671***	
	(0.0199)		(0.135)		(0.113)	
Fixed Effects	No	Yes	No	Yes	No	Yes
Observations	879,041	782,234	879,041	782,234	879,041	782,234
R-squared	0.048	0.021	0.046	0.029	0.080	0.059
Number of Clusters	34,441	34,441	34,441	34,441	34,441	34,441

Impact on Attention

– Investor's attention dynamics (number of connexions per month)



NOTE: This figure displays how the changes in the number of connections to the platform differ between robo takers and non-takers, before and after the robo subscription. T-5/T-1 correspond to months before the treatment, T/T+5 correspond to months after the treatment. The points correspond to the estimated beta coefficients of equation (3), the bars correspond to 95% confidence intervals.

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Impact on Trading Activity

- **Robo is associated to more trading and increased net inflows**
  - More **rebalancing** (due to robo advice): +0.21 asset allocation changes by month (avg =0.05)
  - Average increase in **net inflows** by EUR 84

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Variable	Changes	Robo(>t)	Individual	Contributions	Redemptions	Net inflows
Robo treated*after	0.214***	0.0402***	0.000116	0.00550***	-0.000623	83.77***
	(0.00141)	(0.000682)	(0.000990)	(0.00113)	(0.000523)	(7.598)
Observations	1,567,958	1,567,958	1,567,958	1,567,958	1,567,958	1,567,958
R-squared	0.057	0.027	0.001	0.058	0.006	0.015
Number of Clusters	34,441	34,441	34,441	34,441	34,441	34,441

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Impact on Risk Taking

- **Robo is associated to an increased asset allocation to risky assets**
  - **+ 8.7% in total equity share** (relative to an average 15.7%)
  - +2.7% in equity funds, +22.8% in balanced funds

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Variable	Equity Sh.	Equity	Balanced	Employer	Bond	Money
Robo treated*after	0.0866***	0.0272***	0.228***	0.00234***	-0.155***	-0.0916***
	(0.00220)	(0.00183)	(0.00318)	(0.000721)	(0.00292)	(0.00250)
Observations	1,450,851	1,450,851	1,450,851	1,450,851	1,450,851	1,450,851
R-squared	0.069	0.010	0.199	0.005	0.118	0.058
N. of Clusters	34,398	34,398	34,398	34,398	34,398	34,398

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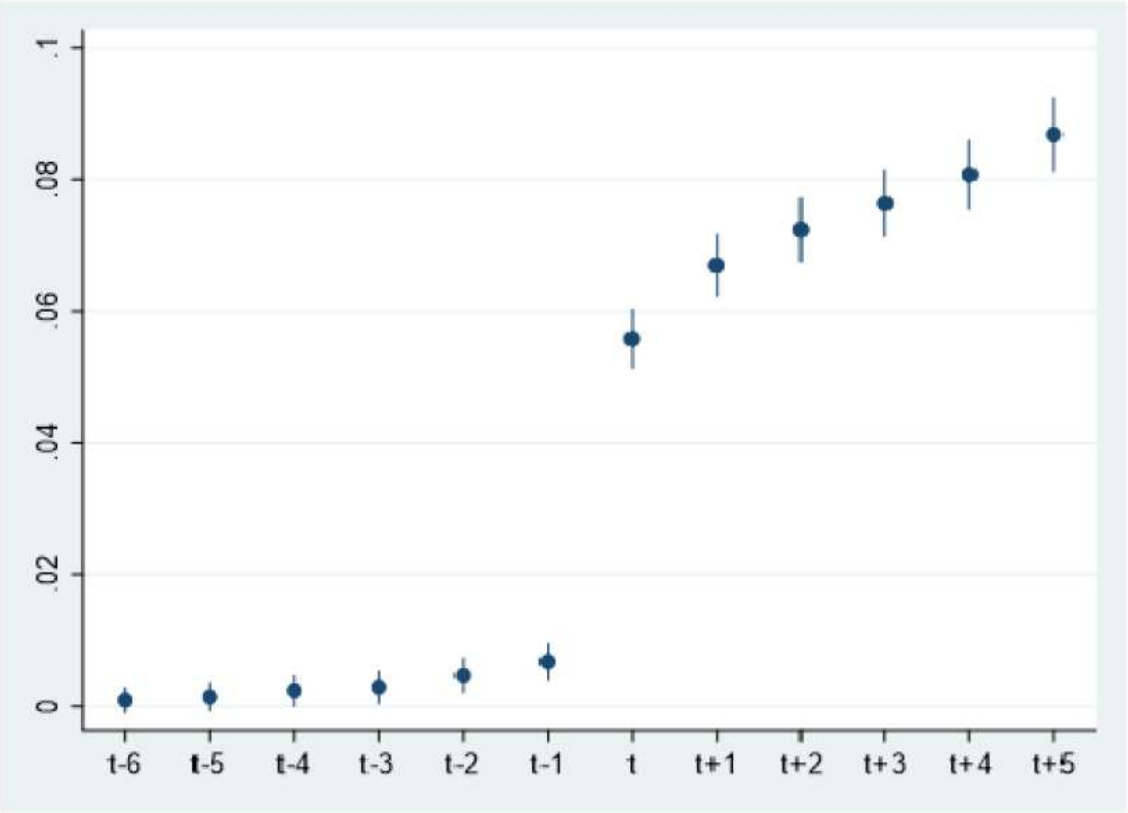
Impact on Risk Taking



NOTE: This figure displays how the changes in equity exposure differ between robo takers and non-takers, before and after the robo subscription. T-5/T-1 correspond to months before the treatment, T/T+5 correspond to months after the treatment. The points correspond to the estimated beta coefficients of equation (3), the bars correspond to 95% confidence intervals.

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Impact on Risk Taking (Regression Discontinuity)

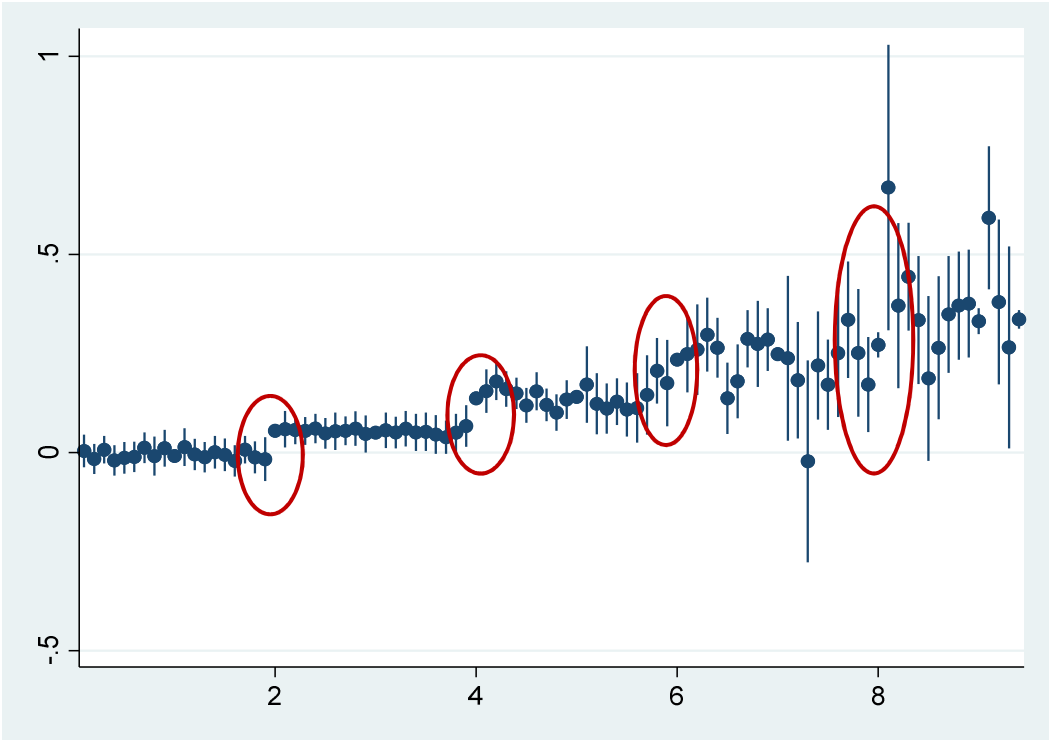
- **To better address if the change is driven by the robo, we exploit a discontinuity in the robo algorithm**
  - Algorithm aggregates investors' characteristics into a risk score that is mapped to the recommended allocation

$$y_{j,t} = \alpha + \beta D_j + \gamma_1 (S_j - c) + \gamma_2 D_j (S_j - c) + H'_{j,t}\delta_1 + H'_{j,t} D_j \delta_2 + \varepsilon_{j,t}.$$

S_j the score that the robo has assigned to individual i in contract j
c the closest discontinuity threshold
D_j a dummy equal to one if $S_j > c$ and zero otherwise.

Impact on Risk Taking (Regression Discontinuity)

- **Most of the impact on risk-taking (5% increase in equity exposure) is due to being assigned above a given risk score threshold**



NOTE: This figure plots investors' equity share as a function of the risk score assigned by the robo, controlling for investors' horizon. The points correspond to the estimated beta coefficients of equation (6), the bars correspond to 95% confidence intervals.

	(1)	(2)
Dep. Variable	Equity Sh.	
I(score>cutoff)	0.0514***	0.0506***
	(0.0158)	(0.0145)
Score -cutoff	0.0313	0.0340
	(0.0417)	(0.0383)
Score -cutoff*I(score>cutoff)	-0.128***	-0.136***
	(0.0451)	(0.0414)
I(score>cutoff)*horizon	0.00546***	0.00587***
	(0.000889)	(0.000817)
Horizon	0.0462***	0.0466***
	(0.00248)	(0.00228)
Horizon-sq	-0.00137***	-0.00138***
	(0.000209)	(0.000192)
Horizon-cub	4.78e-06	5.30e-06
	(4.91e-06)	(4.51e-06)
Observations	5,038	5,041
R-squared	0.488	0.540

Note: (1) equity share in t, bandwith=1
(2) average equity share t, t+1, bw=1

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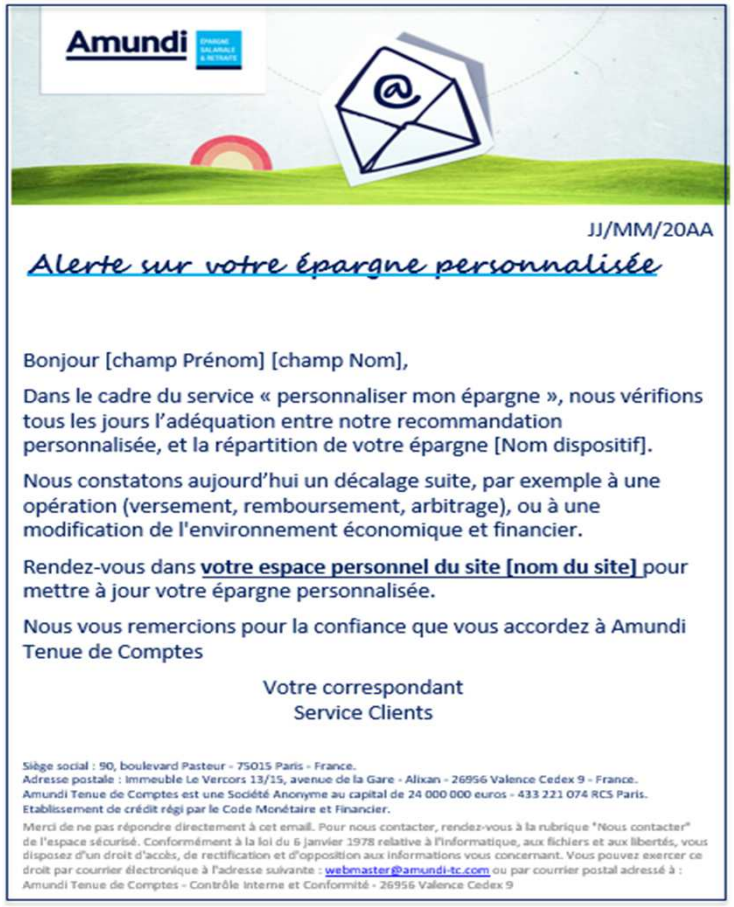
Alerts and Rebalancing

- **Do individuals follow the robo-alerts?**
  - Do alerts induce investors to rebalance their portfolio to stay closer to the target ?
  - Reaction to alerts provides (indirect) evidence on whether they trust the robot recommendation



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JJ/MM/20AA

Alerte sur votre épargne personnalisée

Bonjour [champ Prénom] [champ Nom],

Dans le cadre du service « personnaliser mon épargne », nous vérifions tous les jours l'adéquation entre notre recommandation personnalisée, et la répartition de votre épargne [Nom dispositif].

Nous constatons aujourd'hui un décalage suite, par exemple à une opération (versement, remboursement, arbitrage), ou à une modification de l'environnement économique et financier.

Rendez-vous dans **votre espace personnel du site [nom du site]** pour mettre à jour votre épargne personnalisée.

Nous vous remercions pour la confiance que vous accordez à Amundi Tenue de Comptes

Votre correspondant
Service Clients

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Alerts and Rebalancing

- **Alerts are effective in making investors rebalance their portfolio to bring them closer to their target allocation**

	(1)	(2)	(3)
Dep. Variable		Change in Distance Actual - T	
Robo treated*after*alert	-0.0489***	-0.0693***	-0.0492***
	(0.00300)	(0.00544)	(0.00430)
Robo treated*after	0.0203***	0.0176*	0.0249***
	(0.00368)	(0.0103)	(0.00482)
Alert	0.00989***	0.0326***	0.0147***
	(0.00239)	(0.00421)	(0.00375)
Sample		Robo takers+curious	
		Actual>Target	Actual<Target
Observations	139,598	59,097	64,204
R-squared	0.031	0.063	0.026
Number of Clusters	25,337	14,386	17,736

For robo-curious, we consider counterfactual alerts

- **Alerts are associated with a reduction of the distance to the target equity share**
- Robo-takers decrease their distance **by 4.9%** more than robo-curious
  - Large effect: conditionally on being alerted, average distance 11.6%, average change in distance 2.3%
- Investors **more likely to follow the robot** when a **reduction in equity exposure is prescribed**

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Alerts and Rebalancing

- **Ending up just above the threshold (receiving the alert) induces a 1.27% larger decrease in distance between current and target equity share**

I(distance>cutoff)	-0.0127**
	(0.00527)
Distance (SRRI)	0.474***
	(0.0487)
Distance*I(dist>cutoff)	-0.407***
	(0.0862)
Sample	Robo takers

- RDD exploiting the discontinuity around the alerts threshold
- Restrict to clients at a distance of 0.1 around the threshold

Impact on Performance

- **What is the robot impact on individuals' performance?**
  - **Robo associated to a 5.4% ann. return increase (average return 6.7%)**
  - Controlling for risk, increase between 3% and 4%
  - Robo fees are about 0.05%

	(1)	(2)	(3)	(4)	(5)
Dep. Variable	Annual return				alpha
Robo treated*after	0.0539***	0.0507***	0.0306***	0.0423***	0.0197***
	(0.00160)	(0.00160)	(0.00117)	(0.00150)	(0.00178)
Equity share		0.102***			
		(0.00610)			
Volatility			1.171***		
			(0.0249)		
Beta				0.0299***	
				(0.00268)	
Observations	1,362,797	1,362,797	1,362,797	776,564	776,564
R-squared	0.104	0.104	0.479	0.190	0.028
Number of Clusters	70,656	70,656	70,656	62,136	62,136

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Impact on Performance

- **Static effect of robo-taking accounts for a 2% increase, rest in different rebalancing**

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Variable		Static Effect (1)			Static Effect (2)	
Robo treated*after	0.0200***	0.0105***	0.0217***	0.0232***	0.0101***	0.0202***
	(0.00107)	(0.00101)	(0.00125)	(0.000952)	(0.00103)	(0.000962)
Volatility		0.479***			0.660***	
		(0.0518)			(0.0552)	
Beta			0.00428			0.00302
			(0.00354)			(0.00242)
Observations	1,362,797	1,362,797	776,564	1,362,797	1,362,797	776,564
R-squared	0.014	0.151	0.020	0.019	0.309	0.032
Number of Clusters	70,656	70,656	62,136	70,656	70,656	62,136

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Impact on Financial Inclusion

– **Does the robot promote financial inclusion?**

	Equity Exposure	Annual return
Dep. Variable		
Robotreat*after*assets<q25	0.133***	0.0472***
	(0.00348)	(0.00153)
Robotreat*after*assets(q25,q50)	0.0789***	0.0226***
	(0.00407)	(0.00185)
Robotreat*after*assets(q50,q75)	0.0557***	0.0252***
	(0.00492)	(0.00215)
Robotreat*after*assets>=q75	0.0270***	0.0144***
	(0.00600)	(0.00270)

– **The robot is able to induce larger portfolio changes for smaller investors** (less able to receive traditional advice and invest in the stock market)

  – **Increase in equity exposure** is larger for investors with smaller portfolios, lower variable remuneration, lower equity exposure at the baseline

  – **Increase in returns** is larger for investors with smaller portfolios variable remuneration, lower, lower returns at the base line

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Summary of the Results

- **Robot allows to induce significant asset allocation changes**
  - Increased **inflows and attention, risk taking, trading activity**
  - Change in dynamic behaviors (**rebalancing** towards the target allocation)
  - **Improved performance**
- **Robot can promote financial inclusion**
  - All investors are attracted
  - Larger impact on small investors' **risky exposure and performance**
- **Open questions**
  - **Long term** effects? Effects in **bad times?**

The Next Generation of Robo Advisors

Most robo advisors use simple procedures

Technological constraints or **regulatory constraints** ?

- **U.S. discipline**: a registered investment advisor has a fiduciary duty to its clients (1940 Advisers Act, adapted by the SEC in 2017
- **Recent EU regulation (GDPR):** right to explanation, users can inquire about the logic involved in an algorithmic decision affecting them (say, through profiling)

Lack of clients' **trust** ?

More automation, more data and more complex models ?

OR

Alternative path: XAI (explainable artificial intelligence)

- **Algorithms easily interpreted and evaluated**
- **Allowing effective human-robo interactions**
  - Rather than full transparency, possibility to **explain the recommendation** (e.g. evaluating the sensitivity of the recommendation when changing one of the inputs)
- A way to **improve financial literacy** ?

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DISCLAIMER

The data used to carry out this study come from the processing of record keeping and account keeping of AMUNDI ESR employee and pension savings accounts. These data have been analyzed anonymously for scientific, statistical or historical research purposes.

MENTIONS LÉGALES

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