



E. Barucci

QFinLab-Dipartimento di Matematica

Politecnico di Milano

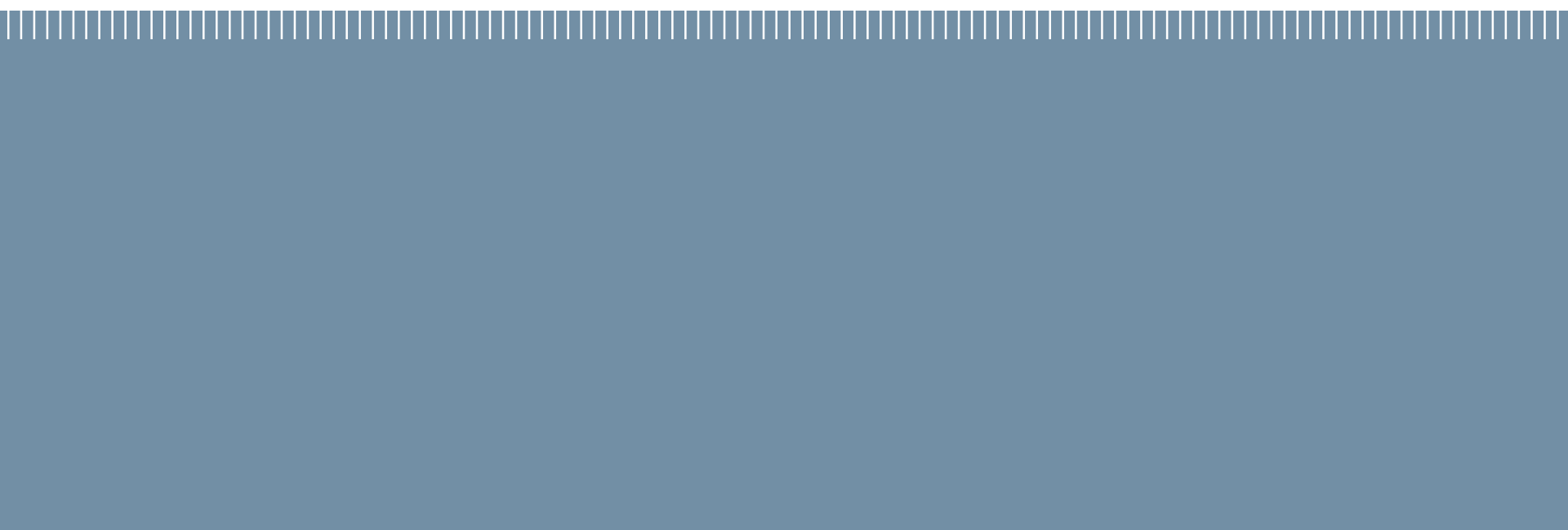
# The effects of online financial education on student achievement: evidence from a randomized trial


Joint paper with T. Agasisti, M. Canistrà, D. Marazzina, M. Socin

# Outline:

1. Aims and main results of the paper
2. Review of the literature
3. The experiment
4. Data
5. Results
6. Conclusions

# 1. Aims and main results of the paper





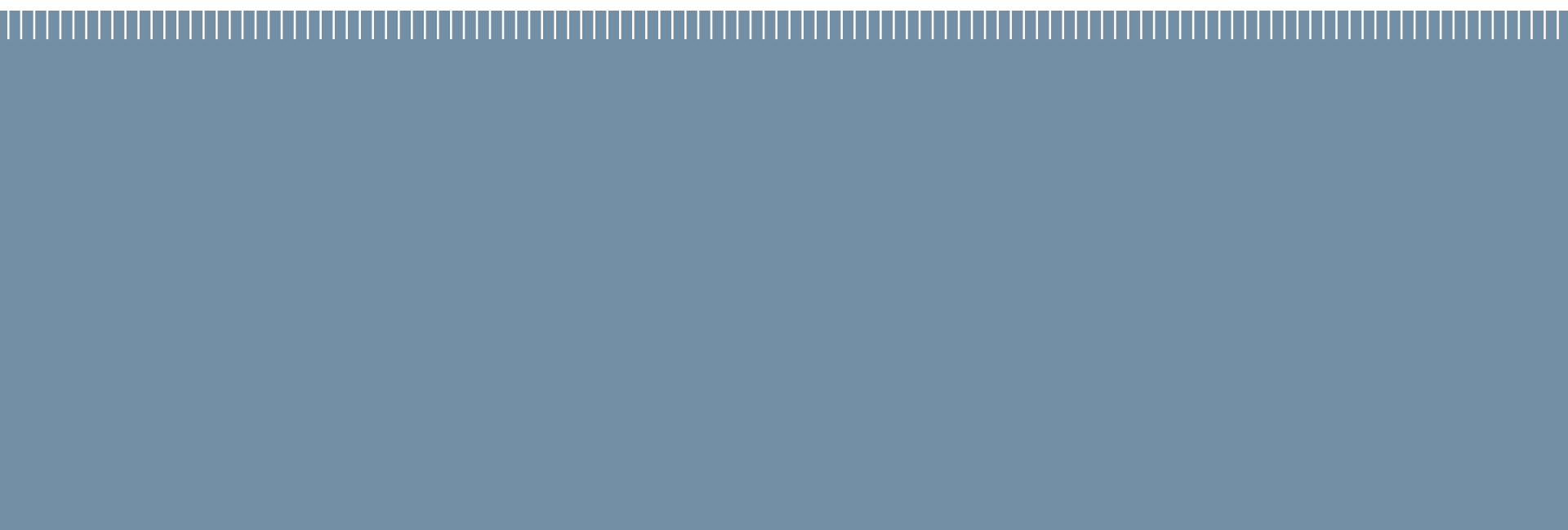
To assess whether an effective financial education lecture can be conducted with the same effects online or in traditional in-presence mode.

The target of the initiative is a cohort of freshmen enrolled to a course of Business Economics in the first year of the BSc in “Mathematical Engineering”.

The results highlight that both groups of students experienced an increase in their knowledge of financial concepts, on line teaching leads to a negative effect but there are not statistically differences between the two groups on improvement of knowledge.

Policy implication: online learning for developing low-cost, effective, short interventions on financial education.

## 2. Review of the Literature



- Experimental evidence is available for the use on online education at Universities.
- Such evidence shows a null or negative effect of online education (on student achievement) in comparison with traditional learning modes.
- Heterogeneity of the outcome within the sample is usually relevant; specifically, the lack of in-person interaction is particularly detrimental for low-ability students, who instead benefit the most from class attendance. Students with weak academic preparation and those from low-income and under-represented backgrounds underperform in fully-online environments.
- Employers, students, faculty, academic leaders, and the public attribute lower value to online than to classroom degrees.

# Traditional vs online teaching

Figlio *et al.* (2013). In a class of “Principles of Microeconomics” of a USA public college: no statistically significant difference was observed on student achievement. The effect was heterogeneous by ethnicity, gender and ability level. (+-!)

Bowen *et al.* (2014) expanded the randomization to six USA campuses and found no statistically significant difference (success rates, student achievement) between the in-presence and the blended format. (+-)

Joyce *et al.* (2015) considered 725 students into a traditional or a “compressed” class of introductory microeconomics in a public USA college, where a weekly lecture substituted the standard twice-a-week format. The same online materials were made available to both classes. The effect on student achievement was mixed, given that the grades in the mid-term exam of the students in the traditional format were 0.21 standard deviations higher than those in the compressed format, though this difference was not statistically significant in the final grade. (+-!)

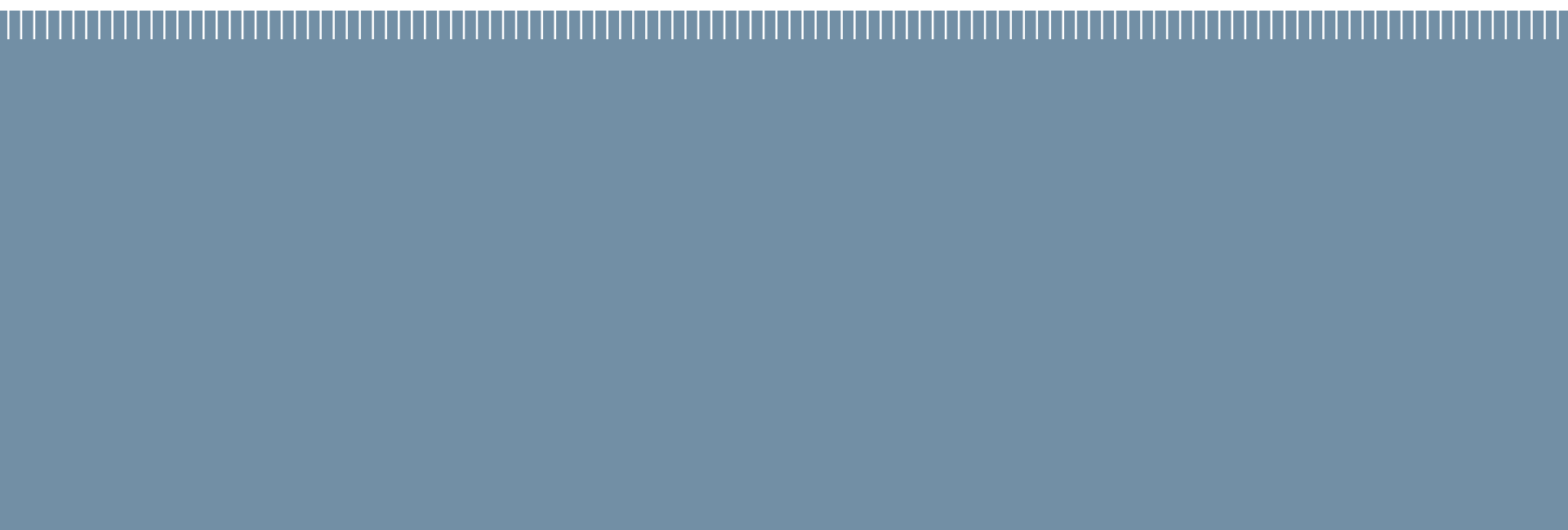
Alpert *et al.* (2016) compared three delivery modes by randomly assigning students to a traditional, a blended (i.e. a mix between online and in-live activities) or an online-only class of economics principles in a USA college. Students attending online performed 5 to 10 points lower than those in the traditional format, while the blended delivery did not report any significant difference. (-)

Bettinger et al. (2017) examine more than 700 courses (230,000 students), and students at a non-selective for-profit college. Students in online courses perform substantially worse than students in traditional in-person courses, larger negative effects of online course-taking for students with lower prior GPA. Students are less likely to remain enrolled at the university. (-)

Cacault *et al.* (2019) provided empirical evidence on the take-up and the effect of live video streaming in the University of Genève (Switzerland). For high-ability students, the proper counterfactual was no-attendance and the effect of streaming the lectures was positive to the extent of a 2.5% increase in the exam grade. For low-ability students, class attendance was the most convenient counterfactual and the negative effect amounted to a 2% decrease in the exam grade.(-)



# 3. The experiment



# Main features

- Students at Politecnico di Milano. First-year students enrolled in a BSc course of Mathematical Engineering, Business Economics course offered on Spring 2019.
- Development of a Massive Open Online Course on financial education (<https://www.pok.polimi.it/>)
- Along with normal course scheduling, a lecture about basic financial contents was introduced.
- Students were divided into two classes based on their last name: A-L in the first class and M-Z in the second one. The total number of students was 403. The first class was assigned to the online-treatment group, attending a MOOC-based lecture, while the second one attended the live-only lecture.
- The scheduled lesson lasts about three hours for the live class, or the equivalent workload delivered through online fruition, that is a combination of videoclips for a total of 55 minutes.

- The structure of the experiment is divided into three steps: pre-test, training and post-test.
- Pre-test aims at capturing the initial financial literacy level of participants, together with assessing their baseline attitudes in terms of financial trust, spending habits or competency in financial topics.
- The live-only class attended the lecture while the other class attended a lecture of Business Economics.
- The third step is the post-test, one week after the pre-test, where students were asked to fill a test about the topics taught in the lectures/videos.
- Students filled the tests during a Business Economics lecture.
- Students correctly answering to 50% of the questions in the post-test got 1 extra point in the Business Economics grade (over a 30).
- Pre- and post-test were identical for both classes.
- Check participation to the online platform: students assigned to the online treatment actually attended the lectures/and those assigned to the live-only class.

# Pre-test questionnaire

## Personal information

1-5. Name, Surname, University personal code, Gender, Age

## About yourself

### **6. Which of these statements best describes your situation?**

- I live with my family
- I am an off-site student, I live in a shared apartment / college
- I am an off-site student, I live in an apartment alone

### **7. Which of these statements best describes your situation?**

- I am a full-time student
- I do some part-time jobs while studying
- I am a working student

### **8. Do you hold stocks or bonds (such as government bonds)?**

- Yes
- No
- I don't know

**9. Mark the statements (even more than one) that best describe your current situation**

- I have a bank account
- I have a credit card and/or a debit card
- I use my credit card and/or debit card frequently
- I have subscribed a mortgage or made an instalment buying
- I read / listen economic opinions regularly

**10. With which of these statements do you think you agree more?**

- Doing financial transactions means taking risks that can be analysed before doing them
- Some knowledge of finance is a good way to make wise choices
- Only those who have studied finance should deal with finance, others should put their savings on the bank account
- Better not to trust financial operators

**11. With which of these statements do you think you agree more?**

- I am interested in finance
- I will never be able to deal with finance; someone else will take care of my savings
- It is necessary to inquire before making financial choices: it is not easy, but I can do it.

Measure your financial knowledge

**12. If you invest 100 euros in a fund that has an annual rate of return (net of taxes and charges) equal to 1%, after 5 years ...**

- I will have little more than 100 euros
- I will have 105 euros
- I will have little more than 105 euros
- I will have around 150 euros
- I don't know

**13. How long does it take to double the capital invested at the annual rate of 2%?**

- About 70 years
- About 35 years
- About 10 years
- I don't know

**14. Suppose the interest rate on your bank account is 2% per annum and that inflation is equal to 1% always in a year. After one year, how many goods do you think you can buy with the money in your account compared to how many you can buy today?**

- Exactly the same quantity
- More
- Less
- I don't know

**15. The best indicator to compare two loans is**

- The spread
- The APR, because it does not take into account all the expenses
- The EAPR, because it takes into account all the expenses
- The Euribor rate
- I don't know

**16. Assume that you buy a house and the bank offer you a fixed rate mortgage with an APR equal to 1.8%.**

- This information is sufficient to evaluate how convenient the loan is
- It is necessary to know the EAPR to evaluate the offer
- It is necessary to read the opinions online about the lender
- I don't know

**17. The advertising regarding loans must always indicate the economic conditions, however the Italian law does not require that EAPR and APR must be given explicitly.**

- True
- False
- It depends on the institution that provides the loan
- It depends on the loan amount
- I don't know

**18. An instalment loan with an interest rate of 0.2% each month has an APR of**

- 2.4%
- 12%
- 24%
- 1.2%
- None of the previous answers
- I don't know

**19. Assume that you want to open a bank account. Bank A provides a fixed fee of 12 euros per month, while Bank B provides you a free account, but the cost for each operation (money transfers, etc.) is 1 euro. Which offer do you choose?**

- Bank A is the most convenient
- Bank B is the most convenient
- Bank A is convenient if I will do few operations
- Bank B is convenient if I will do few operations
- I don't know

**20. Consider the compound interest, which of these statements is correct?**

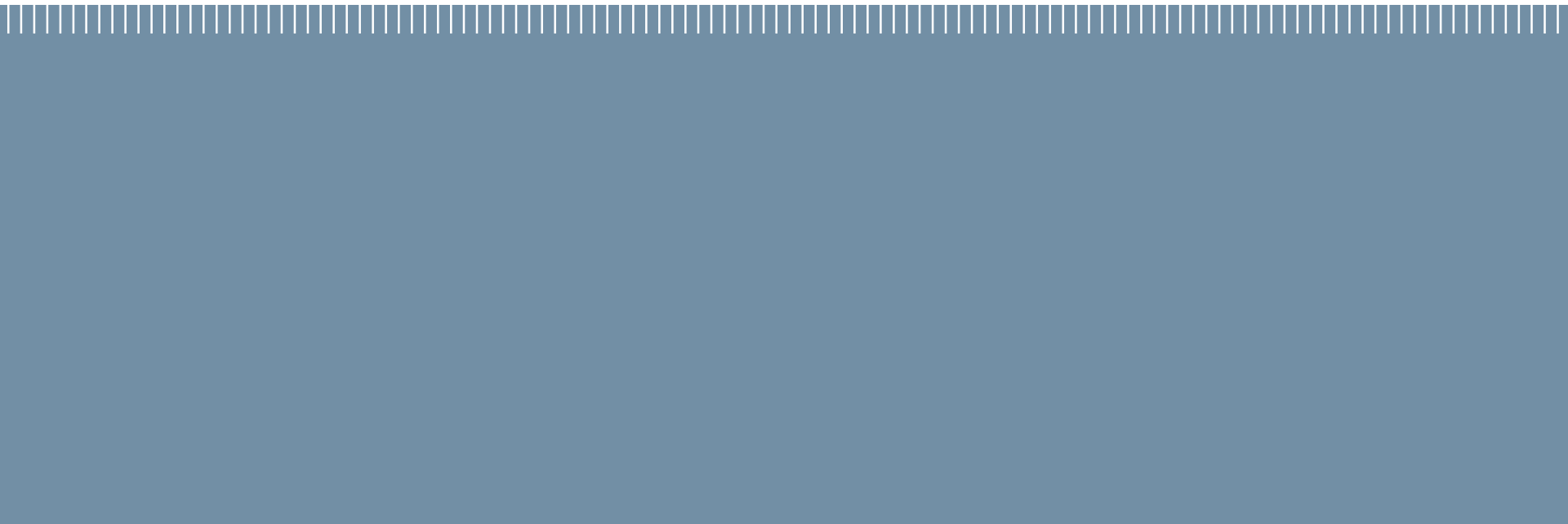
- The 1% annual rate is equivalent to a half-yearly rate of 0.5%
- The 1% annual rate is more advantageous than a half-yearly rate of 0.5%
- The 1% annual rate is less advantageous than a half-yearly rate of 0.5%
- I don't know




# The content of the lecture/videos

- (a) The flow of time and interest rates (the differences between simple and compound interest);
- (b) Interest rate and time horizon (dealing with annual, semi-annual, quarterly interest rates);
- (c) Bonds and ratings (internal rate of return of a coupon bond, spread and ratings of government bonds);
- (d) The market interest rate curves and their relationship with bond prices;
- (e) Loans (internal rate of return, annual percentage rate and nominal interest rate);
- (f) Mortgages/loans payment calculation (how to compute rates in a fixed interest rate framework).

## 4. The data





The total number of students who attended both the pre and post-tests was 365: 158 in the live-only class and 207 in the online-only class, with a retention rate higher than 90%.

Non-compliant students: online-only (n=181), live-only (n=114), no treatment (n=17) double treatment (n=28).

**Personal information:** age, gender, if he or she comes from another city (i.e. different from Milan) or not, if he/she has a part- or full-time job, student's high school typology and socioeconomic status (allocation of student to a fee scale, based on their family's income) from 0 (fee exemption) to 10 (maximum contribution)

**Education information:** GPA reported on a scale from 18 (the minimum grade to pass an exam) to 30; total amount of credits obtained in the first semester (all students are freshmen); admission test score (on a scale 0-100) and the no-show exam rate (student's absenteeism per exam).

Variables	Treatment group (Assigned to online)	Control group (Assigned to f2f)	t-test (p-value)
<b>Individual characteristics</b>			
Deviation from standard age	0.035 (0.234)	0.035 (0.402)	0.997
SES (Index of socioeconomic status)	6.106 (3.392)	6.092 (3.443)	0.969
Male (dummy=1)	0.606 (0.490)	0.627 (0.485)	0.699
Off-site student (dummy=1)	0.379 (0.486)	0.418 (0.495)	0.463
Part-time working student	0.167 (0.374)	0.169 (0.376)	0.813
Full-time working student	0.005 (0.071)	0.007 (0.084)	0.954
<b>Individual attitudes and beliefs about finance</b>			
Not interested (from PCA)	-0.008 (0.998)	0.011 (1.006)	0.869
Risk prone (from PCA)	0.059 (0.994)	-0.082 (1.006)	0.203
Cardholders (from PCA)	0.033 (1.028)	-0.047 (0.961)	0.567
<b>Academic performance and results</b>			
GPA in the 1st semester	20.664 (8.862)	22.832 (6.644)	0.010
Credits in the 1st semester	19.253 (14.310)	20.268 (12.047)	0.479
Admission test score	74.631 (9.943)	73.59 (9.489)	0.332
Scientific high school	0.904 (0.295)	0.817 (0.388)	-
No-show exam rate	0.083 (0.19)	0.057 (0.169)	0.188
<b>Results from finance tests</b>			
Pre-test score	0.516 (0.211)	0.527 (0.194)	0.621
Post-test score	0.911 (0.095)	0.935 (0.114)	0.036
Delta (Post – Pre test)	0.395 (0.232)	0.408 (0.226)	0.611

- There are no structural differences between students in the treatment and control group (online vs live-only).
- Students who are not in the median age of the cohort are around 3.5%
- Male students are around 60%
- The average index of socio-economic scale is 6 (out of 10)
- About 40% of students are off-site
- 16% work part time and less than 1% instead work full-time
- Students obtained on average between 19 and 20 formative credits (out of a maximum of 30 available)
- The admission test score is around 74 (out of 100) in both groups
- The proportion of those from a scientific high school is higher than 80%
- The no-show exam rate is between 5% and 8%.
- The only dimension under which the two groups of students look statistically different is the average GPA obtained in the first semester, which is 20.6 for the students assigned to the online course and 22.8 for those assigned to the group of live-only class.

On the basis of the answers provided by students in the questionnaire, about their beliefs and attitudes, we classify them in three archetypes through a Principal Component Analysis.

We select the first three components of the model, with eigenvalue greater than one and explaining more than 50% of the total variance.

We look at the component loadings. We identify three groups.

“not interested” students: negative interest in financial topics, agreement with the idea that financial topics will never be interesting, ability to cope with financial concepts;

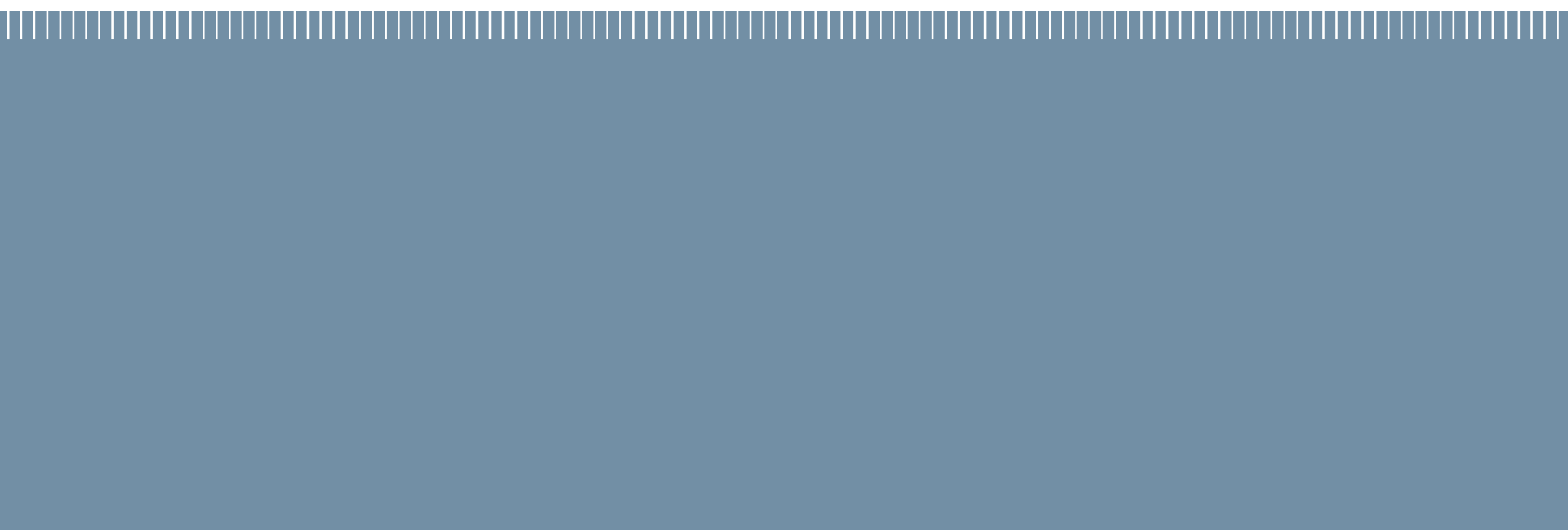
“risk-averse” students: financial investments are judged as unmanageable, absolute necessity of acquiring a lot of information before making financial decisions;

“card-holders” students: holding of bank account and credit card.

We insert these values into the econometric models as explanatory variables with the goal of capturing the association between students' current financial attitudes and their results.

Variable	Component 1: 'not interested'	Component 2: 'risk-adverse'	Component 3: 'card holder'
I have a bank account	0.028	0.222	<b>0.488</b>
I have a credit card	0.03	0.193	<b>0.529</b>
I frequently use the credit card	-0.163	0.128	<b>0.489</b>
I have a mortgage or funding	-0.03	0.067	0.155
I read/listen to economic news on a regular basis	-0.177	-0.017	-0.286
Making financial operations imply assuming manageable risks	-0.013	<b>-0.649</b>	0.295
Financial knowledge is relevant for making proper choices	0.046	<b>0.682</b>	-0.153
Only those who studied finance should make financial operations	-0.04	-0.021	-0.133
It is better not to trust financial market participants	<b>-0.053</b>	-0.058	-0.092
I am interested in financial topics	<b>-0.552</b>	0.019	0.026
I will never be able to cope with financial issues	<b>0.564</b>	-0.025	0.017
Once you get informed, you can deal with financial issues	<b>0.557</b>	-0.019	0.017

# 5. Results





# Model estimation

Pre-test scores

$$y_{PRE_i} = \beta_0 + \beta_1 X_{1_i} + \beta_2 TREAT_i + \varepsilon_i$$

The performance  $y_{PRE_i}$  is regressed against a set of student level covariates  $X_{1_i}$  related to individual characteristics, academic ability and relative attitude in finance (component loadings resulting from the PCA), we control for the randomized assignment to the treatment  $TREAT_i$ , a dummy variable equal to 1 when the student is assigned to the online delivery mode and 0 otherwise.

Capture treatment effect:

$$\begin{aligned} & \Delta_{POST-PRE_i} \\ & = \beta_0 + \beta_1 X_{1_i} + \beta_2 TREAT_i + \beta_3 NOTTREAT_i + \beta_4 DOUBLETREAT_i + \varepsilon_i \end{aligned}$$

where the response variable accounts for the difference between the post and the pre-test, Given the existence of a small group of non-compliers, we control for their presence by means of the dummy variables  $NOTTREAT_i$  and  $DOUBLETREAT_i$ .

	Factors associated with pretest scores	Model 1 Delta (Post – Pre test) <i>with non- compliers</i>	Model 2 Delta (Post – Pre test) <i>without non- compliers</i>	Model 3 Delta (Post – Pre test) with non-compliers, Instrumental variables
	(a)	(b)	(c)	(d)
Treatment - course attended online	-0.006 (0.022)	-0.025 (0.027)	-0.029 (0.026)	
Treatment - course attended online Fitted (Second Stage)				-0.020 (0.027)
Individual characteristics				
Deviation from standard age	0.005 (0.037)	-0.065 (0.042)	-0.060 (0.041)	-0.064 (0.042)
SES (Index of socioeconomic status)	0.001 (0.003)	-0.001 (0.004)	0.001 (0.004)	-0.002 (0.004)
Male (dummy=1)	0.072*** (0.022)	-0.084*** (0.025)	-0.083*** (0.026)	-0.084*** (0.025)
Off-site student (dummy=1)	-0.030 (0.023)	0.019 (0.026)	0.034 (0.027)	0.019 (0.026)
Part-time working student	0.009 (0.029)	0.009 (0.033)	0.014 (0.036)	0.007 (0.033)
Full-time working student	0.360*** (0.139)	-0.294* (0.159)	-0.244 (0.154)	-0.293* (0.159)
Individual attitudes and beliefs about finance				
Not interested (from PCA)	-0.047*** (0.011)	0.041*** (0.012)	0.024*** (0.0013)	0.041*** (0.012)
Risk-prone (from PCA)	0.003 (0.011)	-0.002 (0.0012)	0.010 (0.012)	-0.002 (0.012)
Cardholders (from PCA)	0.020* (0.011)	-0.028** (0.012)	-0.017 (0.012)	-0.028** (0.012)
Academic performance and results				
GPA	0.004** (0.002)	-0.004* (0.002)	-0.004* (0.002)	-0.004* (0.002)
Credits acquired in the 1st semester	0.0004 (0.001)	0.0003 (0.001)	0.001 (0.001)	0.0003 (0.001)
Admission test score	0.003** (0.001)	-0.003* (0.001)	-0.002* (0.001)	-0.003* (0.001)
Scientific high school	-0.040 (0.034)	0.076* (0.039)	0.087** (0.040)	0.075* (0.039)
No-show exam rate	0.031 (0.073)	-0.002 (0.083)	0.017 (0.085)	-0.001 (0.083)
Controlling for non-compliers				
No treatment ( <i>non- compliers</i> )		0.003 (0.056)		
Double treatment ( <i>non- compliers</i> )		-0.030 (0.046)		
Constant	0.191** (0.092)	0.691*** (0.106)	0.627*** (0.110)	0.684*** (0.105)
Observations	335	335	290	335
R-squared	0.189	0.161	0.165	0.160

# Pre test performance

There are no differences between students who have been assigned to different treatments.

Male students report higher test scores than female students, corroborating a gender bias that characterizes the financial literacy of young people.

Students who work full-time are on average more financially literate than non-workers (these students represent less than 1% of the overall sample).

Pre-test scores are lower in case of students who are labeled as “not interested” (group 1), and higher in case of students defined as “cardholders” (group 3).

Academic ability matters: both admission test scores and GPA in the first semester are positively associated with higher pre-test scores.


## Pre-post test gains

The dependent variable is the increase in test scores between pre and post treatment, we do not analyze the determinants of financial literacy scores at the end of the program

Male students and full-time workers experience lower gains in test scores when compared with female students and non-workers. The two groups of students are those who reported higher scores in pre-test.

Students with a high value of principal component belonging to the groups of “cardholders” benefit in a more limited way from the training program

Students who were deemed as “not interested” (group 1), on the contrary, have experienced a statistically significant and positive benefit from attending the financial education program.

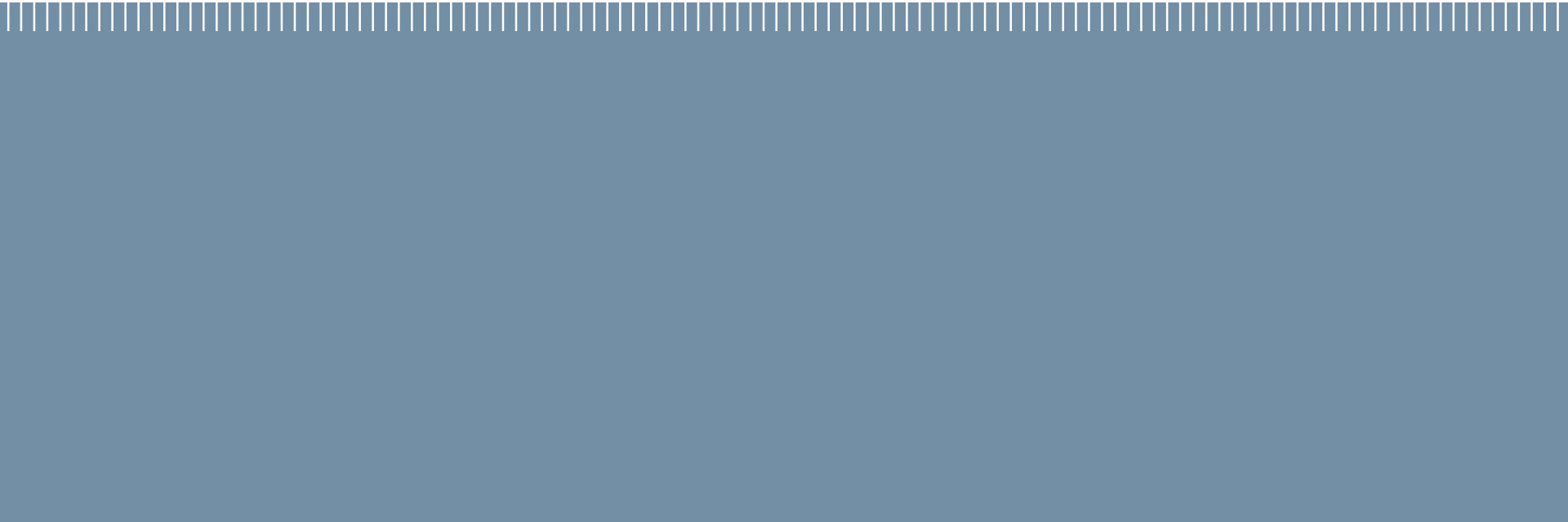



Students who revealed a stronger academic curriculum in the first semester get lower gains in financial test scores, the same relationship holds with the test score obtained in the admission process.

Students with a scientific high school background obtained a positive and statistically significant increase in test scores thanks to the training program.

No statistically significant difference among students assigned to different treatments. Students attending the online course obtained a lower gain in test scores, but such a negative effect is not statistically significant.

## 6. Conclusions





The educational program has been deemed as effective: all the students improved the results in their post-test (i.e. after the program), in a substantial way – on average, 4.0 out of a scale of [0;10].

There is not statistically significant difference between attending the course in-live or online.

Third, when exploring the potential heterogeneity of these differences, the program's effectiveness is associated with gender, academic ability and interest. Specifically, the students who benefit more from the program are female, initially less interested in financial topics and better prepared academically.

Online learning can be an effective substitution to the in-live classes