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Abstract

We study the impact of financial education on intertemporal choice in adolescence. The educational program was randomly assigned among high-school students and choices were measured using an incentivized experiment. Students who participated in the program make more time-consistent choices; are more likely to allocate payments to a single payment date, as opposed to spreading payment across two dates; and display increased consistency of choice with the law of demand. These findings suggest that financial education increases the quality of intertemporal decision-making and decreases narrow bracketing.

JEL-Code: D140, D910, C930.

Keywords: intertemporal choice, financial education, experiment.

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1 Introduction

Many important financial decisions are intertemporal: saving for retirement, credit card debt, and mortgage choice, among others. As financial products have become more complex and the responsibility for retirement provision is increasingly being shifted towards individual households around the world, concerns about poor intertemporal decision-making intensify. A large body of evidence shows that many individuals save too little for retirement (e.g., Lusardi and Mitchell, 2007, 2008), while others accumulate high amounts of credit card debt (e.g., Meier and Sprenger, 2010). Such behaviors have been associated with a lack of financial knowledge (e.g., Hastings, Madrian and Skimmyhorn, 2013; Lusardi and Mitchell, 2014; Lusardi and Tufano, 2015). More broadly, low wealth accumulation and wealth inequality have been attributed to poor financial knowledge among certain segments of the population (e.g., Lusardi, Michaud and Mitchell, 2016).

A central policy implication arising from these findings is that improvements in financial education may yield significant welfare increases. Indeed, this motivation has spurred a substantial increase in the provision of financial education programs in recent years.[1] Yet, the causal effect of financial education on financial decision-making is poorly understood.

Financial education may improve the quality of decision-making by increasing individuals' knowledge about the availability of saving and borrowing instruments. From this perspective, financial education programs might affect intertemporal choice by increasing sophistication in making these choices, and thus help individuals implement their preferences. At the same time, financial education may affect deep time preferences. Becker and Mulligan (1997) suggest that educational programs that emphasize the future, such as financial education, may increase an individual's preference for the

[1]For example, in 2013, an estimated $670 million was spent on such programs (CFPB, 2013).

future. Especially at a young age, elevating an individual's focus on financial planning and achieving future savings goals could decrease impatience and present bias.

In this paper, we examine the effect of financial education on intertemporal choice among adolescents. Targeting financial education programs at adolescents and delivering them in schools holds particular appeal for two reasons: it allows universal population outreach and it is timely, as experimental studies of time, risk and social preferences show that preferences gradually stabilize at the end of adolescence.

We conduct a field experiment among over 900 students in 25 high schools, in which participation in a financial education program is randomly assigned. We then elicit incentivized intertemporal choices, using the Convex Time Budget (CTB) task (Andreoni and Sprenger, 2012). The CTB allows researchers to assess whether and by how much subjects smooth time-dated monetary rewards,[2] and whether their choices are consistent with the law of demand, a measure of the quality of decision-making (Giné et al., 2016).

We identify two main changes in intertemporal choice due to financial education. First, the treatment decreases time inconsistency in students' experimental choices. Treated students are less likely to allocate a larger share of the budget to the sooner payment date when it is immediate, a measure of present bias within the task. Second, the treatment leads to an increase of almost 20% in the frequency with which the entire budget is allocated to a single payment date. In addition, we observe an increase in the share of students who choose to allocate the entire budget to the earlier payment date at low interest rates, and then switch to allocating the entire budget to the later

[2]The CTB task allows individuals to spread the payments offered by the experimenter across two payment dates, or to allocate the entire payment either to the sooner or to the later payment date. Previous experimental tasks using choice lists only allow corner choices, i.e., individuals allocate the entire budget either to the sooner or to the later payment date. Early studies among adults include Coller and Williams (1999) and Harrison, Lau and Williams (2002), while the first study among children was conducted by Bettinger and Slonim (2007). To allow for concave utility when estimating time preference parameters, several studies have elicited risk preferences separately (e.g., Andersen et al., 2008, Sutter et al., 2013).

payment date at higher interest rates.

The treatment leads to changes in two other dimensions of choice, which are related to the understanding of intertemporal choices. We observe a significant increase in the rate of consistency with the law of demand: Treated students are more likely to decrease the allocation to the earlier payment date as the interest rate increases, an indication of increased quality of decision-making (Giné et al., 2016). And, treated students are significantly less likely to exhibit negative discounting. This leads to an apparent increase in impatience (or delay sensitivity) among treated students. This increase can be explained by the fact that treated students are more likely to behave as assumed in standard models of intertemporal choice, where discount rates are zero or positive (see also Chakraborty et al., 2015).

The decrease in time inconsistency is robust to accounting for choice inconsistencies, suggesting that changes in understanding do not directly explain the effect of financial education on time consistency. At the same time, the observed decrease in time inconsistency paired with the increase in allocations of the budget to a single payment date is consistent with an increase in students' consideration of alternative sources of consumption when making intertemporal choices. That is, our findings suggest that treated students are less likely to treat experimental payments as consumption, ignoring rescheduling opportunities available through savings or borrowing vehicles (e.g., Frederick, Loewenstein and O'Donoghue, 2002; Harrison, Lau and Williams, 2002, Cubitt and Read, 2007; Chabris, Laibson and Schuldt, 2008; Sprenger, 2015). When individuals are more "financially sophisticated", and integrate experimental payments with other sources of consumption, they are more likely to make time consistent choices and less likely to smooth intertemporal payments within the task, two behaviors that treated students display.[3]

[3]Further, we examine the correlation between external savings behavior and experimental choices among adolescents. In several studies such a correlation has been considered an indication of the

Taken together, our findings suggest that financial education changes intertemporal decision-making by increasing sophistication and understanding of intertemporal choice. This is a dimension of financial education which has received little attention so far (Ambuehl, Bernheim and Lusardi, 2016). Existing evaluations have mainly focused on changes in behaviors such as savings, and often find no effects among adults (see Hastings, Madrian and Skimmyhorn, 2013, and Fernandes, Lynch and Netemeyer, 2014, for reviews),[4] while results are mixed for adolescents and young adults.[5] Consistent with these findings, survey measures of savings in our data do not indicate a change in savings behavior in response to the program.

Our conclusion is that financial education influences adolescents' intertemporal choices by making them more consistent with standard assumptions of discounted utility models (Samuelson, 1937).[6] These positive effects of financial education on the quality of intertemporal decision-making could have important long-run consequences for an individual's financial situation. For example, there is evidence that better decision-making is associated with higher levels of wealth accumulation (Choi et al., 2014).

Our findings also contribute to the debate on the identification of individual time preferences in experiments using time-dated monetary payments. Students in the control group display significant time inconsistency. The estimated present-bias parameter

validity of experimental tasks in identifying individual time preferences (e.g., Castillo et al., 2011; Sutter et al., 2013). This relationship is weakened among treated students, suggesting that the program makes experimental choices less informative about time preference parameters.

[4]Recent studies suggest that the characteristics of the program may be crucially important. Combining education with grants improves the outcomes of male entrepreneurs (Berge, Bjorvatn and Tungodden, 2015), as does teaching simple financial heuristics (Drexler, Fischer and Schoar, 2014) or using different visual tools (Lusardi et al., 2017).

[5]An increasing number of programs and researchers focus on financial education among youth, for which there are potentially large long-term effects and which take place before individuals have made important irreversible financial decisions (Lusardi, Mitchell and Curto, 2010). The evidence on the impact of such programs, however, is mixed (Bernheim, Garrett and Maki, 2001; Bruhn et al., 2013; Becchetti, Caizza and Covello, 2013; Cole, Paulson and Shastry, 2014; Berry, Karlan and Pradhan, 2015; Lührmann, Serra-Garcia and Winter, 2015).

[6]For an approach based on testing the understanding of opportunity sets, see Ambuehl, Bernheim and Lusardi (2016).

for this group is close to that found when intertemporal choices are elicited in the effort domain (Augenblick, Niederle and Sprenger, 2015). This suggests that using monetary rewards to elicit time preferences can be a valid approach under specific conditions. To the best of our knowledge, our study is the first to identify an important factor, financial education, that may limit the task's validity.[7]

The remainder of the paper proceeds as follows. In the next section we describe the financial education program. In Section 3 we describe the experimental task, the methods used and the conceptual framework. In Section 4 we present the effects of the program on intertemporal choices. In Section 5 we present additional analyses that investigate the potential mechanisms underlying the treatment effects. Section 6 concludes.

2 The Financial Education Program

The financial education program we study is offered by a German non-profit organization, My Finance Coach (2012). Since its start-up in October 2010, it has offered financial education to over 35,000 high school students, ages 13 to 15. The program sends "finance coaches" to schools, who are employees of the (for-profit) firms that sponsor the (non-profit) provider; they are not compensated for the training provided. They conduct several visits of 90 minutes for a total of 4.5 hours dedicated to several training modules. The provider offers a set of materials for each module and trains the coaches, so the educational program is standardized.

[7] A study that is closely related to ours is that by Coller and Williams (1999) who provide subjects with information about market interest rates, and find relatively small changes in elicited intertemporal choices. Recent studies that introduce willpower manipulations (Kuhn, Kuhn and Villeval, 2013) and savings accounts (Carvalho, Prina and Sydnor, 2016) find an increase in the frequency with which individuals choose to allocate their budgets to a single payment date. One interpretation of such results could be that such interventions also affect the extent to which experimental payments are treated as consumption and therefore the ability to identify time preference parameters.

This program is well suited for studying the impact of financial education among adolescents for several reasons. Since it is provided at schools, all students in a class participate, avoiding selection problems (see, e.g., Meier and Sprenger, 2013). Moreover, the materials are standardized, have been developed by educational experts (ranging from education researchers to school directors), and they have been extensively used for several years in Germany. Finally, this educational intervention is scalable: A large number of students can be reached using the same format of the educational program across different schools in potentially different countries.

We measure the joint impact of three training modules provided to all treated students: Shopping, Planning, and Saving. These are the three main modules offered by the provider, who also offers other extension modules focused on topics such as the environment and business. As described in the materials supplied by the provider (see Table A.1 in the Appendix for details),the Shopping module focuses on the informed consumer. It emphasizes prioritizing spending ("needs and wants"), discusses criteria used in purchasing decisions, and advertising. The Planning module addresses aspects of conscious planning, by presenting the concepts of income and expenditure as the basis of financial planning. It also trains students on budgeting skills. The last module, Saving, discusses saving motives and investment options. The training does not take a normative position on saving, but rather discusses *how* to save. Importantly, the training involves no decision directly resembling the tradeoffs in the intertemporal choice task we study, which we describe in what follows.

3 Experimental Design and Conceptual Framework

3.1 Setting and Randomization

The schools in our study pertain to the two lower tracks of the German high school system. Students in these two tracks typically continue with vocational training after graduation (rather than attending college). These types of students constitute 48% of the high-school population (Autorengruppe Bildungsberichterstattung, 2016).[8] They have on average lower socio-economic status than students pursuing the track to attend college (Dustmann, 2004).

Randomization of classes to control and treatment groups was implemented through a web interface designed by the research team. Schools in the treatment group received the training earlier in the school year, while schools in the control group received the program towards the end of the school year.[9]

The CTB task was conducted by the research team independently from the educational program and the coaches that had taught the materials to the students. The task was ran before the schools in the control group participated in the program, and it was scheduled such that all treatment and control schools would complete the task within the same week. Randomization occurred at the school level to avoid spillover effects. Randomization was stratified by city, across the cities of Berlin, Düsseldorf, and Munich in Germany, such that differences in educational systems in the different areas are orthogonal to the treatment allocation. Since we were bound by scheduling constraints stemming from the requirement that all participating schools receive the training by

[8]The school system in Germany has three types of high schools, starting as of age 10. These tracks comprise of schools where students pursue vocational training (*Hauptschule*, *Sekundarschule*, *Mittelschule*), combine both vocational training with the option of attending university later on (*Realschule*, *Gesamtschule*, *Werkrealschule*), or focus on preparation for university studies (*Gymnasium*). All participating students in our study belong to the first two types of schools.

[9]The training took place during regular school hours. The topics of the training are not covered within the regular school curriculum.

the end of the school year, the time between the treatment and the intertemporal choice task was at least 4 weeks after the training and up to almost 12 weeks. We do not find differential treatment effects on students' allocation choices in the CTB task depending on the length of the delay between the treatment and the experiment, suggesting that the effects are not short-lived.

3.2 Method

The CTB task, developed by Andreoni and Sprenger (2012), asks individuals to allocate amounts of money to two points in time. The payment received at the sooner point in time, t, is x_t, while the amount received at a later point in time, $t+k$, is x_{t+k}. The delay between payments is k. The amounts x_t and x_{t+k} satisfy the budget constraint $(1+r)x_t + x_{t+k} = m$, where $1+r$ is the gross interest rate. The CTB method allows for inner choices, i.e., individuals can allocate payments to both payment dates, in addition to corner solutions where the entire payment is allocated to a single payment date.

We elicit choices using three different combinations of t and $t+k$; the tasks for each of these combinations are presented on a separate decision sheet. The first sheet offers payments immediately after the task finishes ($t = 0$, "today") and three weeks later, so the delay is $k = 3$ weeks. The second sheet offers payments today and six weeks later, so the delay is $k = 6$ weeks. The last sheet offers payments in three and in six weeks, such that the delay between payments is $k = 3$ weeks but there is also a "front-end delay" as $t > 0$. On each decision sheet, seven budget constraints are presented to students, where the budget m is 6 Euro. The budget we offer corresponds to about 70% of the average weekly income available to the students. Going from top to bottom of each decision sheet, the price for the sooner payment increases. An overview of the design appears in Table 1.[10]

[10]For example, for a delay of three weeks, the effective yearly interest rate, assuming quarterly compounding, ranges from 0% for gross rate 1.00, to 752.9% for gross rate 1.18, and goes up to

Table 1: Elicitation of time preferences – Design

Decision sheet	Sooner payment (t)	Later payment	Delay (k)
(1)	Today	In 3 weeks	3 weeks
(2)	Today	In 6 weeks	6 weeks
(3)	In 3 weeks	In 6 weeks	3 weeks

Note: Within each decision sheet seven decisions were elicited with the following gross interest rates $(1 + r)$: 1.00, 1.025, 1.05, 1.08, 1.18, 1.33 and 2.00, on the budget constraint $(1 + r)x_t + x_{t+k} = m$.

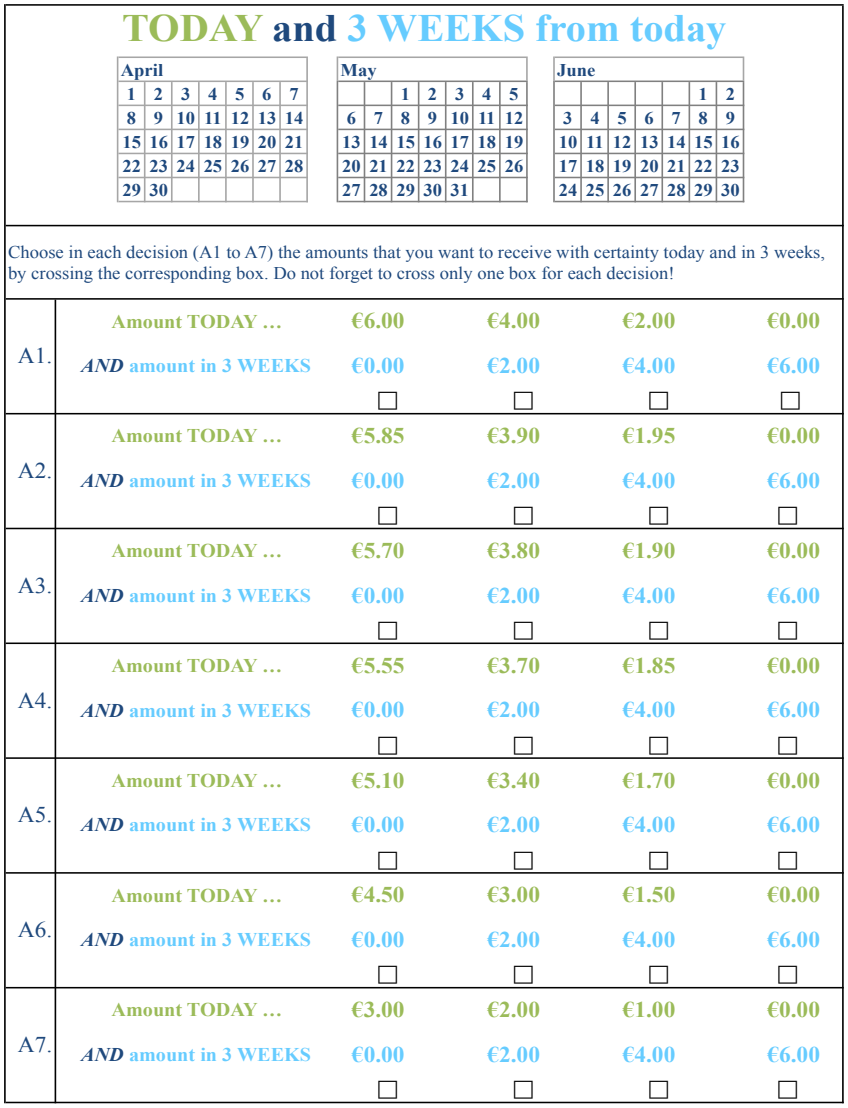
We adapt the elicitation task, which was originally designed for college students, to students aged 13 to 15. Specifically, Andreoni and Sprenger (2012) offered a choice set with 100 choices within each budget and, in a follow-up study, Andreoni, Kuhn and Sprenger (2015) limited the choice set to seven choices. Since they find qualitatively similar results, we simplify the presentation, reducing complexity further, to offer four combinations of sooner and later payments. In each choice situation, participants can either allocate 100%, 66.6%, 33.3% or 0% of the budget to the sooner point in time. To make the variation in the time horizons salient, color-coding is used for each point in time. Additionally, students see a calendar at the top of each sheet on which the relevant payment dates were marked in the corresponding color. An example of a decision sheet is provided in Figure 1. We randomize the ordering of the three decision sheets across classes to balance any potential order effects.

3.3 Conceptual Framework

The classic model of savings and consumption (e.g., Modigliani and Brumberg, 1954) assumes that fully rational consumers make optimal savings choices, smoothing marginal utility of consumption over their lifetime, given their time preferences.

While time preferences are assumed to be fixed in the classic model, Becker and

27128% for gross rate 2.00. We chose to allow for high interest rates to capture variation in choice.



TODAY and 3 WEEKS from today

April						
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

May						
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

June						
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

Choose in each decision (A1 to A7) the amounts that you want to receive with certainty today and in 3 weeks, by crossing the corresponding box. Do not forget to cross only one box for each decision!

A1.	Amount TODAY …	€6.00	€4.00	€2.00	€0.00
	AND amount in 3 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
A2.	Amount TODAY …	€5.85	€3.90	€1.95	€0.00
	AND amount in 3 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
A3.	Amount TODAY …	€5.70	€3.80	€1.90	€0.00
	AND amount in 3 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
A4.	Amount TODAY …	€5.55	€3.70	€1.85	€0.00
	AND amount in 3 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
A5.	Amount TODAY …	€5.10	€3.40	€1.70	€0.00
	AND amount in 3 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
A6.	Amount TODAY …	€4.50	€3.00	€1.50	€0.00
	AND amount in 3 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
A7.	Amount TODAY …	€3.00	€2.00	€1.00	€0.00
	AND amount in 3 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐

Figure 1: Example of a decision sheet (translated from German)

Mulligan (1997) propose that time preferences may change with education. Specifically, they argue that education may decrease the costs of imagining the future and, in turn, decrease impatience. Based on this work, a first hypothesis is that financial education could change students' intertemporal choices, by changing their time preferences. Specifically, the discussion of savings and the potential uses of money saved for the fu-

ture, extensive in the Planning and Savings module of the financial education program, could increase a student's preference for waiting to earn the interest from saving. A direct test of this hypothesis can be conducted by eliciting incentivized intertemporal choices, using the CTB task with monetary rewards. We chose monetary rewards since they are closest to real-world financial choices, which were the object of interest in the program.

However, the identification of time preferences using monetary rewards faces three important challenges. First, it relies on the assumption that individuals display a perfect understanding of the trade-offs involved when making decisions among time-dated payments, and choose the allocation that maximizes their utility given their preferences. Second, it assumes that individuals are extremely liquidity constrained, and hence do not have the option to arbitrage rewards within the task with other resources outside the task. Third, if individuals have such options to arbitrage, identification of time preferences is possible only under the assumption that individuals bracket narrowly, and thus do not consider these options when making choices within the CTB task.

If such assumptions are satisfied, we would expect students to display present bias and impatience and to smooth payments across time, i.e. choose interior allocations that provide positive payments on the two time periods involved. Fitting a $\beta - \delta$ model (e.g., Laibson, 1997) to such choices would imply a present-bias parameter $\beta < 1$, a discount factor $\delta \leq 1$ and utility curvature of $\alpha < 1$. We will show in Sections 4 and 5 that the choices of students in the control group, who did not receive financial education, are largely consistent with such patterns, suggesting that the task was able to identify the time preferences of this group.[11]

If treated students display significant changes in their intertemporal allocations, this

[11]Several studies have found that experimental choices in time preference elicitation tasks that use monetary rewards correlate with field behaviors related to impatience and present-bias (Chabris et al., 2008; Meier and Sprenger, 2010 and 2012; Castillo et al., 2011; Sutter et al., 2013).

could be due to two reasons. First, the financial education program may have changed students' time preferences, as suggested by Becker and Mulligan (1997). Second, the program may have affected the validity of the assumptions required for the identification of such preferences. In what follows, we discuss these assumptions in detail.

3.3.1 Choice Consistency

A standard assumption in models of intertemporal choice is that individuals display a perfect understanding of the trade-offs in the CTB task. Hence, they never make mistakes. Several studies have shown that individuals often exhibit violations of rationality, even in simple choice environments (see, e.g., Giné et al., 2016). One such kind of violation is the violation of the law of demand, which requires that individuals exhibit weakly more patience as the interest rate increases.[12]

Financial education programs aim to raise awareness about the implications of consumption and savings choices in the short- and long-run. In the program we examine, adolescents i) discuss impulsive shopping within the Shopping module, ii) plan savings for the purchase of a durable, such as a motorcycle, in the Planning module, and iii) learn about the properties of different savings vehicles in the Savings module. These discussions can improve their understanding of intertemporal trade-offs. Thus, financial education may decrease violations of the law of demand. If so, controlling for such violations will be necessary to assess the impact of the program on patience, present bias and the share of interior choices, i.e. choices that smooth payments over time.

[12]Precisely, within each of the three decision sheets, students made seven choices. A choice is consistent with the law of demand if the allocation to the sooner payment date decreases or stays unchanged as the interest rate increases. By definition, the first choice in each sheet is excluded. Thus, the fraction of choices consistent with the law of demand is the sum of consistent choices divided by 18.

3.3.2 Arbitrage and Bracketing

Students' choices only reflect their time preferences if they are extremely liquidity constrained or if they bracket their choices so narrowly in the CTB task that available borrowing and savings vehicles are ignored (e.g., Frederick, Loewenstein and O'Donoghue, 2002; Harrison, Lau and Williams, 2002, Cubitt and Read, 2007; Chabris, Laibson and Schuldt, 2008; Sprenger, 2015).

Students in our sample, both in the control and treatment groups, do not appear to be extremely liquidity constrained. They receive money from their parents (about 35 Euro each month), and often have savings (about 50% have savings, and those who save have 71 Euro in savings, on average). Their financial situation, as measured by their income, consumption and savings in the month preceding the experiment, does not change with the program, suggesting that background consumption was the same for both groups. Given the age of the students (13 to 15), they lack access to financial markets. However, both treatment and control students could potentially borrow from friends and family. Despite this possibility, students in the control group display present bias and choose interior allocations of the budget, consistent with significant smoothing. This suggests that the assumption of narrow bracketing is valid for students in the control group.

Financial education could change the validity of the assumption of narrow bracketing for treated students. Specifically, the degree of narrow bracketing could decrease for treated students, since the program increases students' budgeting and financial planning skills. For example, the Planning module of the program raises awareness about where students' money comes from, how it is spent and how it can be saved to achieve students' goals. By discussing their sources of income and savings, financially educated students may become more "financially sophisticated", i.e., more aware of alternative saving and borrowing opportunities.

If financial education decreases narrow bracketing, we would expect treated students to be more likely to consider the possibility of arbitraging against their alternative saving and borrowing sources. This would imply that their choices are more reflective of such sources, rather than of their time preferences. While control students exhibit present bias, treated students would be more likely to consider alternative sources for immediate consumption and hence would exhibit less present bias. At the same time, since money in the task is compared to outside sources they would exhibit less consumption smoothing within the CTB task. Since they cannot borrow from financial markets, we would not expect their choices to reflect market interest rates. However, their choices could exhibit more patience if the transaction costs involved in borrowing from friends and family were sufficiently low.

To sum up, if students bracket narrowly throughout, and the effect of the financial education treatment is to make students more patient, we would expect students to exhibit less present bias and more patience in their intertemporal choices, while equally choosing interior allocations of the budget. By contrast, if treated students are less likely to bracket narrowly, due to the financial education program, we would expect such students to exhibit less present bias but also fewer interior choices. The effect of the treatment on patience would depend on the transaction costs of borrowing from informal sources, i.e., from family and friends, which are ex-ante unknown.

To examine the effects of financial education, and the interpretation of such effects, our analysis proceeds as follows. We first investigate whether financial education changes intertemporal choice. Specifically, we test the effects of financial education on time inconsistency and impatience within the CTB task. We then examine whether changes in intertemporal choices are consistent with an increase in understanding and sophistication, or a change in deep time preferences.

3.4 Procedures

3.4.1 Implementation of Payments

We follow a number of procedures to ensure trust and address issues of risk and transaction costs that typically arise when implementing delayed payments. All procedures are explained in the instructions before any decisions are taken by the students.

Transaction costs. Students are given a "participation" fee of 2 Euro to thank them for their participation. They are informed that the participation fee will be split equally across both payment dates. Hence, independent of the specific choice of each student, she will always receive at least one Euro at each point in time.

Record of payments. After students make their 21 (7×3) choices, one decision is drawn for payment to be actually implemented. The random draw is performed by one volunteer student for the entire class and this draw is noted on the classroom board. Subsequently, based on the student's choice and the decision drawn for payment, each student receives a payment card that records her exact payments and payment dates. Hence, students do not need to remember when the future payment would occur and how much they would receive. The payment card also serves as a written confirmation of each student's payment entitlement. The card format is designed to fit into students' wallets, and students are requested to keep it there. At the same time, each student writes her name on a payment list containing the payments chosen for the decision drawn for payment. This list is given to the teacher in the presence of the class. Both act as records for delayed payments and the payment list ensures that payments can be made even if individual payment cards are lost.

Delivery of payments. Payments are made in cash to each student individually in class. Payments are made at the end of the session if today is the sooner payment date. Delayed payments are made exactly three or six weeks later in class at the

dates noted on the payment cards. The exact appointment for the future payment is discussed with the teacher and then announced in class. Our instructions clearly indicate that we will return to the class once (or twice, depending on the draw) to make the delayed payments at the date(s) indicated on the calendars on the decision sheets and on payment cards. The teachers are present in class when we make this commitment.[13] The same procedures are followed in the control and treatment groups, so trust concerns should be the same across the groups. In line with this, we do not observe a treatment effect on the average allocation to the sooner payment date, as reported below.

Consent. Only students whose parents consent to participate are included in the study. The parental consent forms include the researchers' contact information, which the teacher also obtains. Our study is conducted independently from the educational program, and students, parents and teachers are advised to contact the researchers in case of any doubts with respect to future payments. These procedures are followed in both the treatment and control groups, so as to maximize trust in both. Almost all students (97%) provide a signed consent form to participate in the study.

3.4.2 Other Experimental Procedures

In each session, the instructions for the CTB task are first read aloud in front of the class.[14] The CTB task is conducted using pen and paper, and after the task is completed, students fill out a survey. All class visits are conducted by the same two experimenters. Students complete four basic control questions about the task before starting to provide their choices. Each student's answers are checked by the experimenters before she starts making her 21 choices.

[13] Teachers are, however, kept uninformed about student choices, except for the one choice that was drawn for payment and recorded on the payment list.

[14] A copy of the instructions can be found in Online Appendix A.

The presentation of the instructions takes 25 minutes, on average. Students make their decisions in 5 to 10 minutes. After they finish the CTB task, students complete a questionnaire on their gender, age, math grade, and three questions regarding their background. We elicit their household composition (i.e., who they live with), the language they speak at home, and the number of books at home. These are standard questions in the PISA survey (Frey et al., 2009) that are used to capture important family inputs into a student's education (Hanuschek and Woessmann, 2011). Our survey also includes four of Raven's progressive matrices (Raven, 1989), selected to measure heterogeneity in cognitive skills, based on a previous study in Germany by Heller et al. (1998). The survey also includes several questions on financial knowledge and financial behavior. The impact of the training on standard financial literacy questions is similar to the findings in Lührmann, Serra-Garcia and Winter (2015) who study the effect of the program using survey questions in a non-experimental design. We show that financial knowledge increases among treated students in Online Appendix B.We also surveyed students regarding their allowance, spending, and saving behavior. In total, the sessions last between 45 and 60 minutes.[15]

3.5 Sample

Our sample consists of 914 students (492 in control, and 422 in treatment) from 55 classes in 25 schools (12 treatment, 13 control).[16] The average age is 14.3 years and

[15] As mentioned above, in each city, all sessions were scheduled to take place during the same week, for both treatment and control groups. This was possible for 46 out of 55 classes. For a small group of nine classes the class was scheduled to be at a practical training out of school for the week, and hence we conducted the experiment 3 weeks later in eight classes and 6 weeks later for one class. We control for any potential time effects by adding a month dummy for April (as 46 out of 55 were scheduled in April) in our regression analysis.

[16] While coding the answers, we found that 80 students provided multiple answers or left unanswered one or more questions. Results remain qualitatively the same if these students are included. These students are equally distributed across treatment and control (χ^2-test, p-value=0.43) and present no difference in observable characteristics, including gender, school grade, family situation, math grade and cognitive ability (t-tests, p-value>0.1 in all cases).

39.8% of the students are female. Regarding the student's family situation, we find that a substantial share, 46.4%, speak a language other than German at home. Also 24% live with a single parent and 60.2% report having fewer than 25 books at home. Individual characteristics are balanced across treatment and control, as shown by the t-tests presented in Table 2, supporting that randomization worked.[17,18]

Table 2: Individual characteristics in the treatment and control groups

	Control	Treatment	Treatment vs. Control t-test (p-value)
Girl	42.0%	37.2%	0.12
Grade 8	50.6%	52.1%	0.92
Cognition score	0.756	0.718	0.67
Math grade (relative)	0.012	0.010	0.91
Migrant background	47.1%	45.7%	0.87
Single parent	23.4%	25.1%	0.67
$<$ 25 books at home	60.4%	60.1%	0.95

Note: This table presents the mean of the individual characteristics by treatment and control. The third column reports the p-value of a t-test that the coefficient of the treatment dummy is equal to zero in a linear regression on each individual characteristic, using robust standard errors. Girl takes value 1 for female students, and grade 8 takes value 1 for students in that grade 8, 0 if in grade 7. Cognition score is the number of correct answers in 4 of Raven's progressive matrices. Math grade is defined relative to the average math grade in the class. A positive value indicates that the student performs better than the class average. Migrant background and single parent are dummy variables that take value 1 when the student speaks a language other than German at home and lives with a single parent, respectively. $<$ 25 books at home is a dummy that takes value one if the subject indicated the number of books at home was either 0-10 or 11-25 (below median), and zero if she indicated 26-100, 101-200, or more than 200 books at home (above median).

4 Results: Intertemporal Choices

We first examine the impact of the financial education program on measures of impatience and present bias within the CTB task. We do not observe a significant impact of

[17]Overall, nonresponse is very low, less than 2.4% of the sample. The difference in nonresponse across treatment and control is not significant for any variables, except for books at home (t-test, p-value=0.04). Our results are robust to the inclusion of a dummy for nonresponse to this question.

[18]Throughout, we cluster standard errors at the individual level, as each individual made multiple choices in the experiment. Results remain the same if we cluster standard errors at the level of the treatment randomization, i.e. the school level.

the educational program on the average allocation to the sooner payment, a measure of impatience. The average share allocated to the sooner payment date is 55.04 percent in the control group and 54.70 in the treatment group (Mann-Whitney test, p=0.4795). Table 3 shows the results of a regression explaining the budget share allocated to the sooner payment date. We use an interval regression model to account for the fact that students had four choices.[19] The coefficient of the treatment dummy is not significantly different from zero.[20]

The treatment group displays less present bias in its allocations than the control group. The extent of present bias within the task is measured by comparing allocation choices when the sooner payment is immediate, versus when it lies in the future. Controlling for interest rates and interaction effects, students in the control group increase their allocation by 7.73 percentage points when the sooner payment is immediate (p=0.008), as shown in Table 3. The effect of immediacy is reduced by 7.06 percentage points in the treatment group (p=0.095). A similar result is obtained by comparing the proportion of present-biased choices, as shown in Table 4. Choices are defined as present-biased if students allocate a larger share of the budget to the sooner payment date when this date is immediate than when it is delayed. In the control group, on average, individuals make present-biased choices in 22.2% of the cases. In the treatment group, this percentage is 19.9% (Mann-Whitney test, p=0.029). The frequency of time consistent choices, i.e., choices that are the same when the sooner payment date is immediate and when it is delayed three weeks, increases from 58.2% to 61.5%. In addition, there is a small decrease, from 19.7% to 18.6%, in the percentage of choices in which the students allocate less money when payments are immediate. In all, the

[19]Results are robust to using an OLS or ordered probit regression model, as shown in Online Appendix B.

[20]The estimated coefficient for the treatment dummy corresponds to the treatment effect for the baseline decision sheet, which elicited allocations between 3 and 6 weeks. For this baseline decision sheet we obtain a positive and non-significant coefficient, which can be explained by the change in the distribution of choices in the treatment group, as detailed below.

Table 3: Determinants of allocation to sooner payment

	Allocation to sooner payment	
	Coefficient	Std. Error
Treatment	5.449	[4.407]
Immediate Payment	7.726***	[2.932]
Immediate Payment × Treatment	-7.057*	[4.225]
Delay is 6 w.	-4.844	[3.031]
Delay is 6 w. × Treatment	8.470*	[4.358]
Gross Interest	-24.671***	[2.284]
Gross Interest × Treatment	-3.147	[3.187]
Female	-2.989	[2.014]
Grade 8	-3.317	[2.232]
Cognition score	-3.637***	[1.215]
Math grade	-3.733***	[1.023]
Migrant background	-0.878	[2.140]
Single parent	0.073	[2.395]
<25 books at home	4.642**	[2.132]
Constant	78.010***	[5.783]
Observations	17,724	
Nr of left-censored observations	4579	
Nr. of right-censored observations	3547	
Nr. of interval observations	9598	
Pseudo-loglikelihood	-23720	

Note: Interval regression results. The dependent variable is the budget share allocated to the sooner payment date, ranging from 0 to 100. Immediate payment is a dummy variable that takes the value 1 if the sooner payment occurred immediately after the students completed the task and survey. Delay is 6 weeks is a dummy variable that takes the value 1 if the delay between the sooner and later payment was 6 weeks and not 3 weeks. Individual characteristics are defined as in Table 2. Month and location fixed effects are included. Interaction terms of the gross interest rate with delay as well as immediacy, and their interaction with treatment, are included in the regression. Robust standard errors are shown, clustered at the individual level. ***, **, * indicate significance at the 1, 5 and 10 percent level, respectively.

distribution of present-biased, time-consistent and future-biased choices is significantly different between treatment and control (χ^2-test, p-value=0.02).

The CTB task also allows the examination of sensitivity to delay, i.e. how much more impatient individuals are when the delay between the sooner and the earlier payment increases. In the control group, we do not find evidence of increased impatience as the

Table 4: Time consistency and delay sensitivity in students' intertemporal choices

	Proportion of choices	
	Control	Treatment
Time consistency		
Present-biased	22.2%	19.9%
Time-consistent	58.2%	61.5%
Future-biased	19.7%	18.6%
χ^2*-test, p-value*	*0.020*	
Delay sensitivity		
Positive discounting	19.2%	19.6%
No discounting	61.0%	62.7%
Negative discounting	19.9%	17.7%
χ^2*-test, p-value*	*0.096*	

Note: Time consistent choices are choices that are the same when the sooner payment date is immediate and when it is delayed three weeks. Present biased choices are choices that allocate a larger share of the budget to the sooner payment date when this date is immediate than when it is delayed, while future biased choices are those that allocate a smaller share to the sooner payment date when it is immediate. No discounting refers to choices that are the same when the delay is three or six weeks. Positive discounting choices are choices that allocate a larger share of the budget to the sooner payment date when the delay increases, while negative discounting choices are those that allocate a smaller share.

delay between the sooner and later payment date increases from 3 to 6 weeks. In fact, there is a decrease, of 4.84 percentage points, in the allocation to the sooner payment date when the delay is six weeks instead of three.[21] This is somewhat surprising, as standard models of intertemporal choice assume that individuals either do not discount the future or they discount the future positively, i.e. their discount factor is weakly smaller than one. Delay sensitivity increases significantly, by 8.47 percentage points (p=0.052), in the treatment group, as shown in Table 3.

In Table 4 we classify decisions into three types of discounting, which allows us to assess whether it reflects a change in preferences (increased impatience) or enhanced

[21]Positive discounting is tested by comparing two different pairs of decision sheets. First, fixing the sooner payment date at today, we compare the allocation to the sooner payment date when the later date is in six weeks to when it is in three weeks. Second, fixing the later payment date at six weeks, we compare the allocation to the sooner payment date when the sooner payment date is today to that when it is in three weeks. Positive discounting requires a weakly positive increase in the allocation for the sooner payment date when delay is longer.

understanding of the task. Choices are classified as consistent with positive discounting if the individual allocates a larger share of the budget to the sooner payment date when the delay is six weeks, rather than three. No discounting refers to equal allocations for both delays. A choice is classified as consistent with negative discounting if the student allocates a smaller share to the sooner payment date as delay increases. Treated students are somewhat less likely to exhibit such choices, and more likely to exhibit no discounting (χ^2-test, p-value=0.096). Thus, the increase in delay sensitivity among treated students does not appear to be driven by a potential change in preferences, but rather increased understanding. We further analyze understanding in the next section, by examining violations of the law of demand.

The chosen allocations vary similarly with student characteristics as found in previous studies of adolescents' intertemporal choices. For example, we find that students with better math grades and cognition scores display more patience in their choices, in line with Castillo et al. (2011) and Sutter et al. (2013).

To sum up, we obtain two main results. First, the financial education program decreases time inconsistency in intertemporal choice. Second, it does not significantly affect the average allocation to the sooner date, a measure of patience within the CTB task. As discussed earlier, changes in intertemporal choices only reflect a change in deep preferences if individuals exhibit a complete understanding of the task and bracket narrowly, treating experimental payments as consumption. We turn to these two assumptions in the next section.[22]

[22]An alternative explanation for changes in intertemporal choices is that financial education changes adolescents' financial situation (see, e.g., Carvalho, Meier and Wang, 2016; Dean and Sautmann, 2014; Janssens, Kramer and Swart, 2017). The survey administered after the CTB task measured the monthly allowance of each student and the amount of spending in a typical month, as well as the amount of savings in the last month. We find no significant effects of the treatment on these measures (t-test from a regression with a treatment dummy and robust standard errors, $p > 0.1$ for all three variables, as shown in Online Appendix B). Thus, we do not find differences in students' financial resources between the treatment and control groups that could give rise to the decrease in present bias.

5 Understanding the Treatment Effects

5.1 Consistency of Choices and Present Bias

The educational program leads to an increase in consistency with the law of demand, as shown in Table 5, column (1). A choice is defined as consistent with the law of demand if share of the budget allocated to the sooner payment date weakly decreases as the interest rate increases.[23] The increase by 8 percentage points is significant at the 5% level. On average, pooling across all decisions, 80.8% of choices in the control and 82.9% in the treatment group are consistent with the law of demand. These rates are very similar to those found by Giné et al. (2016) in individual interviews with farmers in Malawi (81%) and by Carvalho, Meier and Wang (2016) in the American Life Panel, an internet sample representative of the US adult population (between 82% and 84%).[24]

The increase in consistency with the law of demand among treated students raises the question of whether it can explain the decrease in time inconsistency observed in choices. To answer this question, we proceed in two steps. First, we drop choices that are inconsistent with the law of demand from the data and re-estimate the treatment effects on intertemporal allocations. As shown in Table 5, column (2), we obtain qualitatively the same results. This indicates that the decrease in present bias is not driven by inconsistent choices.[25]

Second, the descriptive analysis suggests that, if narrow bracketing is assumed and individual preference parameters are structurally estimated, the control group exhibits

[23]Precisely, within each of the three decision sheets, students made seven choices. A choice is consistent with the law of demand if the allocation to the sooner payment date decreases or stays unchanged as the interest rate increases. By definition, the first choice in each sheet is excluded. Thus, the fraction of choices consistent with the law of demand is the sum of consistent choices divided by 18.

[24]In line with the idea that inconsistencies may reflect indifference between allocations, we observe higher rates of consistency with the law of demand as the offered interest rate increases.

[25]If we drop choices that are consistent with a negative discount rate, we obtain qualitatively similar results.

Table 5: Consistency with the law of demand

Dependent variable:	(1) Consistent choice		(2) Allocation to sooner payment	
Sample:	All choices		Consistent choices	
	Coefficient	Std. Error	Coefficient	Std. Error
Treatment	0.081**	[0.036]	7.315	[4.945]
Immediate Payment	0.042	[0.031]	10.116***	[3.492]
Immediate Payment × Treatment	-0.068	[0.047]	-9.917**	[4.910]
Delay is 6 w.	-0.017	[0.031]	-5.677*	[3.261]
Delay is 6 w. × Treatment	0.041	[0.047]	9.773**	[4.711]
Gross Interest	0.062***	[0.018]	-28.267***	[2.542]
Gross Interest × Treatment	-0.044	[0.028]	-3.995	[3.587]
Female	-0.050***	[0.010]	-4.426*	[2.334]
Grade 8	0.009	[0.012]	-3.097	[2.592]
Cognition score	0.008	[0.006]	-4.034***	[1.352]
Math grade	0.017***	[0.005]	-3.750***	[1.196]
Migrant background	-0.008	[0.011]	-1.249	[2.467]
Single parent	-0.000	[0.012]	-0.341	[2.757]
<25 books at home	-0.022**	[0.011]	4.294*	[2.453]
Constant			78.971***	[6.598]
Observations	15,192		14,967	

Note: Probit regression results for consistency with the law of demand are shown column (1), marginal effects shown. Consistent choice takes value 1 if the choice is consistent with the law of demand, 0 otherwise. Interval regression results are shown in column (2), where the dependent variable is the budget share allocated to the sooner payment date, ranging from 0 to 100. The sample is restricted to those choices that are consistent with the law of demand. It also includes choices at a gross interest rate of 1, which is the lowest interest rate presented to subjects, and thus for which consistency with the law of demand cannot be tested. Individual characteristics are defined as in Table 2. Month and location fixed effects included. Interaction terms of the gross interest rate with delay as well as immediacy, and their interaction with treatment, are included in all regressions. Robust standard errors are shown, clustered at the individual level. ***, **, * indicate significance at the 1, 5 and 10 percent level, respectively.

time inconsistent preferences while the treatment group does not. We examine in a structural model whether this prediction holds when we allow for errors in decision-making. If allowing for errors eliminated the change in time consistency between treatment and control, this would suggest that the change in time consistency within the CTB task is the result of errors in decision-making. Specifically, we follow Andreoni and Sprenger (2012) in assuming that individuals exhibit CRRA utility within the quasi-

hyperbolic discounting model (Laibson, 1997). In this model, individuals discount the future with a daily discount factor, δ, and a present-bias coefficient, β, that measures the degree of time inconsistency. The curvature of the period utility is determined by the parameter α.[26]

We then extend this framework to flexibly allow for errors in decision-making. We estimate multiple error models to reduce concerns about specification error, i.e. that our results are driven by specific assumptions about the nature of stochastic choice. In the first model we allow students to make Fechner errors, i.e., a stochastic evaluation of the distance between the optimal ratio of consumption and the available one. A larger Fechner error parameter, τ, implies that this distance is given less weight and hence that errors are more likely (von Gaudecker, van Soest, and Wengstrom, 2011).[27] In the second model we follow the approach of Andersen et al. (2008), among others, and estimate a probability choice model based on Luce (1959). In this model, there is a stochastic decision error σ. As $\sigma \to 0$ choices collapse to the deterministic choice model, while as σ increases choices become random.

Table 6 displays the estimated parameters for each model, separately for the control and treatment groups. We first present the results for a model without errors in decision making in columns (1)-(2). We then present the results including specific models of stochastic choice in columns (3)-(6). We start by discussing the parameter estimates for the control group and then turn to the treatment group in what follows.

In the control group, the estimated β is between 0.943 and 0.975. Throughout it is

[26]We impose no restrictions on β throughout our analysis. See Online Appendix C for a formal statement of the model.

[27]We also considered models that include a trembling-hand error in addition to Fechner or Luce errors. In these models, there is a probability ω that an individual makes a random choice among the four available allocations of sooner and later payments (Harless and Camerer, 1994). However, since such errors arise at the individual level, they would be difficult to interpret when the model is used to estimate aggregate parameters. Our preferred specification thus excludes trembling-hand errors. This being said, results remain qualitatively unchanged when we include them, as shown in Online Appendix C.

Table 6: Estimated Aggregate Time Preference Parameters, by Control and Treatment

	(1)	(2)	(3)	(4)	(5)	(6)
Model:	Interval-censored tobit		Interval-censored tobit with Fechner errors		Luce model	
Group:	Control	Treatment	Control	Treatment	Control	Treatment
$\hat{\beta}$	0.975	1.003	0.967	1.005	0.943	0.989
	[0.013]	[0.016]	[0.017]	[0.021]	[0.017]	[0.021]
$\hat{\delta}$	1.002	1.001	1.003	1.001	0.991	0.990
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]
$\hat{\alpha}$	0.765	0.778	0.802	0.818	0.821	0.876
	[0.021]	[0.022]	[0.013]	[0.012]	[0.026]	[0.027]
$\hat{\tau}$			2.499	2.754		
			[0.112]	[0.140]		
$\hat{\mu}$					0.050	0.059
					[0.004]	[0.007]
Observations	10,332	8,862	10,332	8,862	10,332	8,862
$H_0 : \hat{\beta} = 1$	0.0554	0.8447	0.0537	0.8129	0.0012	0.5956

Note: Columns (1) and (2) report the estimated preference parameters from the interval-censored tobit model. Columns (3) and (4) add Fechner errors to this model. Columns (5) and (6) report the estimated preference parameters from the probability choice model, based on Luce (1959) and used in Andersen et al. (2008). All parameters are computed as nonlinear combinations, using the Delta method, of parameters estimated using maximum likelihood. Robust standard errors are presented, clustered at the individual level.

significantly smaller than one (χ^2-test, p=0.055 or smaller), consistent with significant present bias in students' intertemporal choices. In contrast to recent studies, we hence find present bias in the monetary domain, with slightly larger estimates than those for effort choices in Augenblick, Niederle and Sprenger (2015). The estimated daily discount factor among control students is between 0.991 and 1.003. In two out of three specifications, students do not display significant discounting. This result reinforces our finding in the descriptive analysis that a large share (61%) of choices is consistent with no discounting (Table 4). The estimated CRRA parameter α lies between 0.765 and 0.821 in the control group.[28] The value of α is significantly smaller than 1 throughout,

[28]The CRRA parameter α and the Fechner error τ are only jointly identified in the interval-censored tobit model with Fechner errors, and hence should be interpreted carefully.

indicating that students exhibit a very high elasticity of substitution relative to previous studies (e.g., Andreoni and Sprenger, 2012). These estimates imply that a \$20 split in two periods would be preferred to about \$46.5 in one period by control students (with $\alpha = 0.821$). This is consistent with the high rate of interior choices in the raw data (e.g., over 48% of choices in the control group), which is higher than that found in other studies (e.g., 88% of choices are corner choices in Andreoni, Kuhn and Sprenger (2015)).

In the treatment group, the parameter estimate $\hat{\beta}$ is between 0.989 and 1.005 and not significantly different from one (χ^2-test, $p>0.1$ throughout). Hence, we do not find evidence of present bias in the choices of students in treatment group. Relative to the control group, the estimated value of β increases in the treatment group (t-test, $p=0.089$ in the Luce model), in line with the results obtained in Table 3. This result is consistent with the interpretation that students in the control group may have perceived monetary payments more as consumption (closer to effort) than treated students.

In comparison to the control group, there is a small decrease in the discount factor among treated students. It is in line with the increased delay sensitivity found at the descriptive level, since the discount factor is identified by changes in delay sensitivity. Finally, we find that the CRRA parameter α increases with program participation, though not significantly. This result is also consistent with a change in students' bracketing in the task. If control students bracket more narrowly than treated students, they should exhibit a higher elasticity of substitution. The magnitude of this change is however small, consistent with the significant but moderate decrease in the share of interior choices (8 percentage points) in the treatment group, as we discuss in the next subsection.

In summary, we find that the educational program increases the consistency of choices in the CTB task. Together with the finding that the program significantly increases consistency with zero or positive discounting, this suggests that the program

increased understanding of intertemporal tradeoffs. However, when we account for choice inconsistency, our results do not explain the decrease in time consistency found among treated students.

5.2 Narrow Bracketing and Present Bias

As described earlier, a decrease in narrow bracketing would have two implications for choices within the CTB task. A first implication of a decrease in narrow bracketing would be a decrease in time inconsistency, as the one we have documented in Section 4.

A second implication of a decrease in narrow bracketing is that it should reduce the degree of smoothing exhibited within the task. We refer to allocations of the entire budget to a single payment date as corner choices and examine their prevalence. In Andreoni and Sprenger (2012), around 70% of the choices were corner choices, suggesting that a majority of individuals may not have treated time-dated monetary payments as consumption. Corner choices are less frequent in our sample, and occur more frequently in the treatment group than in the control group (48% vs. 44%, respectively). Controlling for the characteristics of the budget available and individual characteristics, we find that the rate at which treated students choose corner solutions increases by close to 8 percentage points, as shown in Table 7. The fact that the rate of corner choices observed in the treatment group is almost 20% higher than in the control group suggests a decrease in narrow bracketing among treated students.

A further implication of a decrease in narrow bracketing is that treated students should exhibit the following pattern of choices more frequently: at low interest rates, they allocate 100% of the budget to the sooner payment date. As the interest rate in the CTB task increases, they switch to allocating 100% of the budget to the later payment date, when receiving sooner payments through the CTB becomes more costly.

Table 7: Corner choices

	Corner choices	
	Coefficient	Std. Error
Treatment	0.078*	[0.043]
Immediate Payment	0.051*	[0.029]
Immediate Payment × Treatment	-0.025	[0.042]
Delay is 6 w.	-0.032	[0.031]
Delay is 6 w. × Treatment	0.030	[0.043]
Gross Interest	0.015	[0.019]
Gross Interest × Treatment	-0.026	[0.027]
Female	-0.175***	[0.024]
Grade 8	0.017	[0.029]
Cognition score	0.011	[0.015]
Math grade	0.005	[0.013]
Migrant background	-0.007	[0.026]
Single parent	0.041	[0.029]
<25 books at home	-0.031	[0.026]
Observations	17,724	

Note: Probit regression, marginal effects shown, with robust standard errors clustered at the individual level. Corner choice takes value 1 if the choice was to allocate 0 or 100% of the budget to the sooner payment date. Individual characteristics are defined as in Table 2. Month and location fixed effects included. Interaction terms of the gross interest rate with delay as well as immediacy, and their interaction with treatment, are included in the regression. ***, **, * indicate significance at the 1, 5 and 10 percent level, respectively.

We find a significant increase of 6 percentage points in the share of students displaying this choice pattern (p=0.035), as shown in Online Appendix B.

Furthermore, if treated students are less likely to bracket narrowly, their choices in the task would be less informative about their deep intertemporal preferences. This would imply a weaker correlation between estimated preference parameters and intertemporal behaviors in the field, such as self-reported savings or impulsivity, among treated students. As shown in Online Appendix C, we find that the correlation between estimated time preference parameters and field savings behaviors weakly decreases with the treatment, which is consistent with the conclusion that the financial education pro-

gram decreased narrow bracketing. For example, we find that in the control group, the estimated present bias parameter ($\hat{\beta}_i$) and discount factor ($\hat{\delta}_i$) are correlated with the savings amount of savers. This result is consistent with the time preference elicitation task being informative about deep intertemporal preferences among control group students. By contrast, in the treatment group, the correlation between the present bias parameter and savings decreases significantly ($p = 0.06$). It also decreases for the discount factor, though not significantly ($p = 0.17$). This provides suggestive evidence that the task is less able to identify time preference parameters among treated students.

6 Discussion and Conclusion

This paper examines the effect of a financial education program on intertemporal choice in adolescence. Intertemporal choice is a central determinant of many important economic decisions, ranging from education to savings and investment behavior. Financial education may change such behaviors by increasing an individual's preference for the future or by improving her understanding of intertemporal trade-offs and sophistication in financial decision-making.

We document four main effects of financial education on intertemporal choice. Primarily, financial education increases time consistency in experimental choices among teenagers. At the same time, financial education decreases the extent of smoothing among experimental time-dated payments. It also increases consistency of choice with the law of demand and, finally, it leads to an increase in consistency with zero or positive discounting.

Taken together, these four effects suggest that financial education increases adolescents' understanding of, and sophistication in, intertemporal choice. One may ask whether there is an alternative explanation for the four effects we document. One that is common to experiments with delayed monetary payments is trust. Individuals who

trust the experimenter more are typically more patient within the experimental task. We take careful precautions in the experimental design to establish trust in equal measure in both groups. Additionally, we do not observe differences in patience in our data, suggesting that the treatment effects are not due to trust.

Our findings provide new perspectives on the impact of financial education. From a methodological viewpoint, they indicate that financial education may compromise the identification of time preference parameters using standard experimental methods. We thus contribute to the recent debate on how to measure time preferences (e.g., Sprenger, 2015; Cohen et al., 2016) by pinpointing a factor, financial education, that might be a crucial determinant of whether the restrictive assumptions needed to identify time preferences using tasks with time-dated monetary rewards are satisfied.

At the same time, our results suggest that short financial education programs may change *how* youth make intertemporal choices, enhancing their understanding and broadening the set of alternatives they consider when making such choices. Individuals who receive financial education may be more likely to behave in line with the assumptions of standard economic models, such as rationality and broad bracketing. These changes could have implications for wealth accumulation in the long run, in light of the well-established relationship between quality of decision making and wealth accumulation.

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ONLINE APPENDIX

Appendix A: Detailed Program Description and Experimental Instructions

A.1. Detailed Program Description

Table A.1. provides a summary of the contents of the financial education program.

A.1. Summary of the financial education program

Module	Topic	Activity
Shopping	Introduction	Brainstorming: words associated with "shopping"
	Discussion of shopping criteria	(a) Discussion: what did students buy last? Was it something they "needed" or "wanted"? (b) Comic strip: an adolescent receives money from his mother and spends it on unplanned expenses (chips and chocolate).
	Advertising	(a) Discussion: where do you see ads? Which instruments are used in advertising (emotions, logos, etc.)? (b) Typical messages in ads
	Buying a smartphone	(a) Discussion: what shopping criteria do you use? (b) Roleplay: adolescent wants to buy a smartphone, discussion with parents and friends.
Tips for students		*(1) Prioritise when making spending choices* *(2) Be critical about advertising* *(3) Think about which criteria are important for you before buying* *(4) Compare different options before buying*
Planning	Introduction	Brainstorming: words associated with "planning"
	Different kinds of plans	Exercise: linking different types of plans (e.g. school schedule) to their purposes
	Financial planning	(a) Discussion: why plan your expenses and income? (b) Discussion: where does your money come from and what do you spend it on? (c) Case study: Felix wants to buy a motorcycle; help him planning expenses, and discuss why Felix should not take on debt
Tips for students		*(1) Just as with other plans, you can plan your finances* *(2) Have an overview of your income and expenses* *(3) A plan can help you reach your goals* *(4) Do not spend more money than you have* *(5) Purchases of durables can have running costs*
Saving	Introduction	Brainstorming: words associated with "saving"
	Saving money	(a) Discussion: what do you do with money? (b) Discussion: how can you save money to reach your savings goal? (c) Discussion: why there are different savings products (d) Comic strip: savings product choice by an adolescent
	Risk, return, liquidity	(a) Discussion: trade-off between risk, return and liquidity (b) Case study: Paul (14 years old) receives money for his driving license (to be spent at 18), help him choose how to save it
	Definition of savings products	Find the product that matches the definition
Tips for students		*(1) Decide which is more important for you: return, risk or liquidity* *(2) Do not choose the first offer made to you* *(3) Do not believe that one savings product can achieve everything (high return, low risk and high liquidity)* *(4) Decide which savings product fits best your objective*

A.2. Instructions

The instructions below were read aloud by the same experimenter at the beginning of each class visit. They are translated from German into English. Text in parenthesis and italics was not read aloud.

Description of the experiment

Welcome to our experiment. Our experiment today will consist of 2 parts. We will now go through the first part of the experiment. Please do not talk to your classmates and listen carefully. There will be breaks during the description of the experiment so that you can ask questions. Just raise your hand and someone will come to you.

In part 1 of the experiment you can earn money. We will ask you to choose between different payments, which you will receive at two different points in time. You will make several decisions on how to split money between an earlier point in time (e.g. today) and a later point in time (e.g. in 3 weeks). One of your decisions will be paid out in cash to you. You will only know which decision is paid out, once you have made all your decisions. We will determine it by drawing one decision at random in this classroom with your help. Each decision can be drawn for payment. Therefore, you should make each decision, as if it were the decision that is paid out.

Any questions so far?

We have brought an example to show you how it works. This example shows how your decisions could look like (*put sheet on projector, show only the upper part including decision A1 only*).

You have to decide between payments today and in 3 weeks from today. As you can see, there is a small calendar at the top of the sheet, in which we marked the exact corresponding dates. Today is colored in green, and in 3 weeks is colored in blue. Just below the calendar you can see the decisions you will be asked to make. The payments today and in 3 weeks are, respectively, colored in green and blue.

Let us look at the decision A1. For example, if I check the first box on the left, then I decide to get 12 Euro today and 0 Euro in 3 weeks. If I check the second box, then I decide to get 8 Euro today and 1 Euro in 3 weeks. If I check the third box, then I decide to get 4 Euro today and 2 Euro in 3 weeks. If I check the fourth box, then I decide to get 0 Euro today and 3 Euro in 3 weeks.

I have to check one of these four boxes. Suppose I would like to get 4 Euro today and 2 Euro in 3 weeks. Then, I will check the third box.

Any questions so far?

Please remember that we will pay out one of your decisions to you in cash. Therefore, choose each time what you really want. You indicate that by checking your preferred box. You may only check one of the four boxes in each row.

(*Uncover sheet completely*) As you can see, there are 7 rows on this sheet. The green payments, which you get today, become somewhat smaller in each row. The payments which you get in 3 weeks stay the same. As you can see, the last decision of this example (A7) would give you 30 cents today and 0 in 3 weeks if you check the first box. If you check the second box, how much will you get today and in 3 weeks? If you check the third box, how much will you get today and in 3 weeks? What about checking the fourth box?

In each row you make one decision, that is, you check one box. There is no right or wrong. You can decide differently in each row.

In this example most people choose the first option on the left in the beginning (in decision A1) and further down in the decision sheet they choose an option more to the right, for example the second, third, or fourth box. One possible way of making your decisions is thus to decide which option you prefer in the first row and then decide from which row onwards you would prefer a combination of payments to the right of the option you chose previously.

We will give you 3 sheets with different decisions. On each sheet the timing will be different. There are in total 3 different points in time: today, in 3 weeks, and in 6 weeks. The relevant points in time are indicated at the top of each sheet. Additionally, the exact dates are marked in the calendar.

Let us look at another example in which the points in time change. Here, it is (*show sheet with decisions between 3 and 6 weeks*). Here, you have to decide how much money you would like to get in 3 weeks and in 6 weeks. "In 3 weeks" is still coloured in blue, while "in 6 weeks" is coloured in pink. Note that each point in time has its own colour. Apart from that, the rules stay the same. In each row you have to make one decision which determines how much money you will get. Any questions so far?

How does the payment work?
After you have made all decisions on the 3 sheets, you will return your decision sheets

for part 1 of the experiment to us. In total, you will have made 7 decisions per sheet, A1-A7, B1-B7, and C1-C7. We will then choose the decision relevant for your earnings. You will help us to choose one decision at random. For that purpose, there are small cards, one for each decision (*show cards*). One of you will blindly draw one card out of this bag. This card will determine the decision, which is relevant for your payment.

Let us turn to the most important point: Suppose, we draw decision C4. As you can see on the sheet, the relevant points in time for your payment are in 3 weeks and in 6 weeks (*point to header*). No matter which decisions you made, you will get an extra Euro for both points in time in order to thank you for your participation (*use overhead marker to indicate extra euro above both points in time*).

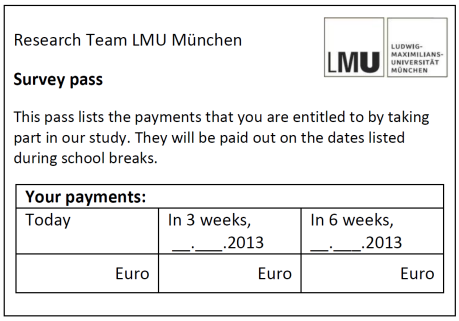
Suppose you chose the third box in C4. Then, in 3 weeks, you will get 1 Euro and 1.75 Euro, in total 2.75 Euro. In 6 weeks, you will get 1 Euro and 4 Euro, in total 5 Euro. Suppose you chose something else, for example the first box. Then, in 3 weeks you will get 5.25 Euro and 1 Euro, in total 6.25 Euro, and in 6 weeks 1 Euro.

Each of your 21 decisions can be drawn out of the bag. Thus, you should think about each decision very carefully.

How do you exactly receive your money?
Payments for today you will get at the end of this session. Payments at a later date, for example in 3 weeks, you will get in three weeks. We will come back and give you the money in class before the break starts or during the break. And in six weeks, the same will happen.

In order for us to know who gets how much money, we will give you a small card (*show card*). That is your receipt for your earnings. It is very important that you keep this card safe until we meet again. It helps us to know which decision you made. If you lose the card, your teacher will help us. He/She will safeguard a list with information on how much money you get at which point in time. At the end of this session, we will come to each of you and give you the card with your payments from part 1. We will also ask you to put your name on the list next to the payments you will get at each point in time.

Now, please turn around the front page of part 1. There you can see another example. Please answer the questions on this sheet now and wait when you are done. We will go around and check your answers to make sure you understand everything.



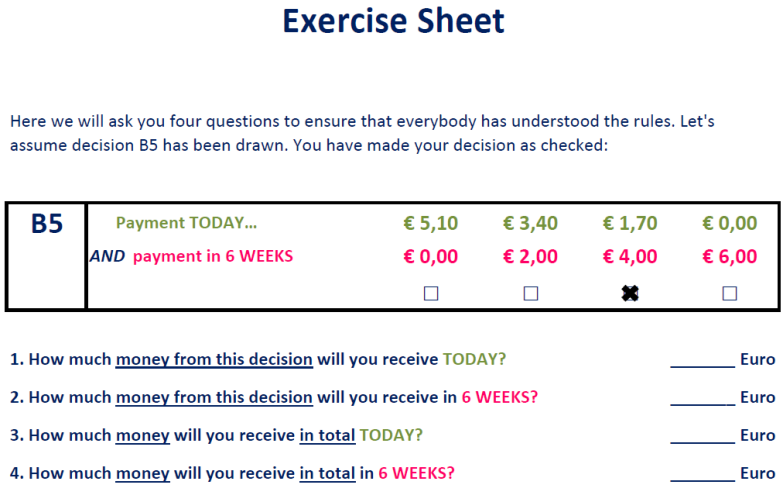
Research Team LMU München

Survey pass

This pass lists the payments that you are entitled to by taking part in our study. They will be paid out on the dates listed during school breaks.

Your payments:		
Today	In 3 weeks, __.___.2013	In 6 weeks, __.___.2013
Euro	Euro	Euro

Figure A.1. Payment card (translated from German)



Exercise Sheet

Here we will ask you four questions to ensure that everybody has understood the rules. Let's assume decision B5 has been drawn. You have made your decision as checked:

B5					
	Payment TODAY...	€ 5,10	€ 3,40	€ 1,70	€ 0,00
	AND payment in 6 WEEKS	€ 0,00	€ 2,00	€ 4,00	€ 6,00
		☐	☐	✖	☐

1. How much money from this decision will you receive TODAY? _____ Euro
2. How much money from this decision will you receive in 6 WEEKS? _____ Euro
3. How much money will you receive in total TODAY? _____ Euro
4. How much money will you receive in total in 6 WEEKS? _____ Euro

Figure A.2. Example to test comprehension of CTB task (translated from German)

TODAY and 3 WEEKS from today

April						
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

May						
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

June						
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

Choose in each decision (A1 to A7) the amounts that you want to receive with certainty today and in 3 weeks, by crossing the corresponding box. Do not forget to cross only one box for each decision!

A1.	Amount TODAY …	€6.00	€4.00	€2.00	€0.00
	AND amount in 3 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
A2.	Amount TODAY …	€5.85	€3.90	€1.95	€0.00
	AND amount in 3 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
A3.	Amount TODAY …	€5.70	€3.80	€1.90	€0.00
	AND amount in 3 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
A4.	Amount TODAY …	€5.55	€3.70	€1.85	€0.00
	AND amount in 3 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
A5.	Amount TODAY …	€5.10	€3.40	€1.70	€0.00
	AND amount in 3 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
A6.	Amount TODAY …	€4.50	€3.00	€1.50	€0.00
	AND amount in 3 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
A7.	Amount TODAY …	€3.00	€2.00	€1.00	€0.00
	AND amount in 3 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐

Figure A.3. Decisions sheet for payment choices between today and in 3 weeks (translated from German)

TODAY and in 6 WEEKS from today

April						
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

May						
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

June						
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

Choose in each decision (B1 to B7) the amounts that you want to receive with certainty today and in 6 weeks, by crossing the corresponding box. Do not forget to cross only one box for each decision!

B1.	Amount TODAY …	€6.00	€4.00	€2.00	€0.00
	AND amount in 6 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
B2.	Amount TODAY …	€5.85	€3.90	€1.95	€0.00
	AND amount in 6 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
B3.	Amount TODAY …	€5.70	€3.80	€1.90	€0.00
	AND amount in 6 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
B4.	Amount TODAY …	€5.55	€3.70	€1.85	€0.00
	AND amount in 6 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
B5.	Amount TODAY …	€5.10	€3.40	€1.70	€0.00
	AND amount in 6 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
B6.	Amount TODAY …	€4.50	€3.00	€1.50	€0.00
	AND amount in 6 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
B7.	Amount TODAY …	€3.00	€2.00	€1.00	€0.00
	AND amount in 6 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐

Figure A.4. Decisions sheet for payment choices between today and in 3 weeks (translated from German)

In 3 WEEKS and in 6 WEEKS from today

April						
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

Mai						
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Juni						
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

Choose in each decision (C1 to C7) the amounts that you want to receive with certainty in 3 weeks and in 6 weeks, by crossing the corresponding box. Do not forget to cross only one box for each decision!

C1.	Amount in 3 WEEKS...	€6.00	€4.00	€2.00	€0.00
	AND amount in 6 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
C2.	Amount in 3 WEEKS...	€5.85	€3.90	€1.95	€0.00
	AND amount in 6 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
C3.	Amount in 3 WEEKS...	€5.70	€3.80	€1.90	€0.00
	AND amount in 6 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
C4.	Amount in 3 WEEKS...	€5.55	€3.70	€1.85	€0.00
	AND amount in 6 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
C5.	Amount in 3 WEEKS...	€5.10	€3.40	€1.70	€0.00
	AND amount in 6 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
C6.	Amount in 3 WEEKS...	€4.50	€3.00	€1.50	€0.00
	AND amount in 6 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐
C7.	Amount in 3 WEEKS...	€3.00	€2.00	€1.00	€0.00
	AND amount in 6 WEEKS	€0.00	€2.00	€4.00	€6.00
		☐	☐	☐	☐

Figure A.5. Decisions sheet for payment choices between today and in 3 weeks (translated from German)

Appendix B: Additional Results

B.1. Effects of the financial education program on students' knowledge

After all students had completed the CTB task, we administered a survey. The survey instrument contained several questions on financial knowledge. These are a combination of standard financial literacy questions and questions that that are closely tailored to the contents of the program.

Table B.1. presents the effects of the program on the share of incorrect answers provided by students. Column (1) below presents the results for all questions. Column (2) focuses on the program-specific questions. Column (3) present the results for two PISA financial literacy questions on the value of money (PISA 2012 Financial Literacy Assessment Framework Report, 2012). Column (4) presents the results for four basic financial literacy questions designed by Lusardi and Mitchell (2014). They elicit numeracy regarding interest compounding, inflation, diversification and the definition of a share.

Table B.1. Treatment effect on financial knowledge

	(1)	(2)	(3)	(4)
	Share of incorrect questions			
	All questions	Program-specific questions	PISA financial literacy questions	Basic financial literacy (Lusardi and Mitchell, 2014)
Treatment	-0.028***	-0.034**	0.001	-0.033*
	[0.011]	[0.014]	[0.019]	[0.017]
Constant	0.435***	0.403***	0.212***	0.594***
	[0.007]	[0.010]	[0.013]	[0.012]
Observations	914	914	914	914
R-squared	0.008	0.006	0.000	0.004

Note: The dependent variable is the share of questions answered incorrectly. Column (1) presents the results including all questions. Column (2) focuses on the questions tailored to the program contents. Column (3) focuses on PISA financial literacy questions (on the value of money). Column (4) focuses on basic financial literacy questions developed by Lusardi and Mitchell (2014). Standard errors are shown in brackets. ***, **, * indicate significance at the 1, 5 and 10 percent level, respectively.

The treatment reduced the number of incorrect answers significantly. This effect stems both from questions that were tightly linked to the program as well as basic financial literacy questions. If we examine each basic financial literacy question in detail, we find increases in the knowledge of what a share is (a concept that was discussed in the

program), but no increase in correct answers for the remaining questions (on inflation, numeracy regarding compounding, and diversification).

B.2. Adolescents' financial situation

If adolescents' financial circumstances differ systematically between the treatment and control group, this may affect their choices in the CTB task. Table B.2 provides statistical tests regarding four descriptives of teenagers' financial situation, namely monthly income (pocket money plus family transfers and income from small jobs) and expenditures, and savings, measured as the existence of any savings and the log of total savings in the last month. We find no systematic differences in either of these financial outcomes between treatment and control.

Table B.2. Treatment effect on adolescents' financial situation

	(1) Monthly income	(2) Monthly spending	(3) Save	(4) Ln(savings)
Treatment	2.854	3.792	-0.107	-0.395
	[2.988]	[3.056]	[0.084]	[0.267]
Constant	32.957***	39.746***	0.052	0.609***
	[1.835]	[1.845]	[0.057]	[0.207]
Observations	769	827	894	881

Note: OLS regressions in columns (1) and (2), probit regression in column (3), tobit in column (4). All with robust standard errors clustered at the individual level. Monthly income is measured as the money available to adolescents each month; spending is measured using a one-shot total expenditure question; Save takes the value one if the teenager saved during the last month; ln(savings) is the log of the amount saved in the last month. Standard errors are shown in brackets. ***, **, * indicate significance at the 1, 5 and 10 percent level, respectively.

B.3. Allocation to sooner payment: Robustness tests

Table B.3 displays the regression results on the determinants of the allocation to the sooner payment, using an OLS regression model and an ordered probit model, instead of the interval regression used in Table 4 of the paper. All results are qualitatively similar.

Table B.3. Treatment effect on adolescents' financial situation

	Allocation to sooner payment date			
	(1)		(2)	
	OLS regression		Ordered probit	
	Coefficient	Std. Error	Coefficient	Std. Error
Treatment	3.731	[3.237]	0.135	[0.104]
Immediate Payment	5.696***	[2.189]	0.185***	[0.068]
Immediate Payment X Treatment	-5.256*	[3.158]	-0.167*	[0.099]
Delay is 6 w.	-3.599	[2.257]	-0.115	[0.071]
Delay is 6 w. X Treatment	6.218*	[3.235]	0.200**	[0.102]
Gross Interest	-18.913***	[1.604]	-0.577***	[0.049]
Gross Interest X Treatment	-2.043	[2.333]	-0.076	[0.075]
Female	-1.862	[1.512]	-0.083	[0.047]
Grade 8	-2.461	[1.662]	-0.077	[0.052]
Cognition score	-2.718***	[0.897]	-0.085***	[0.028]
Math grade	-2.760***	[0.757]	-0.087***	[0.024]
Migrant background	-0.580	[1.597]	-0.021	[0.050]
Single parent	-0.105	[1.776]	0.005	[0.056]
<25 books at home	3.528**	[1.590]	0.107**	[0.050]
Constant	84.573***	[4.185]		
Observations	17,724		17,724	

Note: OLS regressions in columns (1) and (2), order probit regressions in columns (3) and (4). The dependent variable is the budget share allocated to the sooner payment date, which is either 0, 33.3, 66.6 or 100. Immediate payment is a dummy variable that takes the value 1 if the sooner payment occurred immediately after the students completed the task and survey. Delay is 6 weeks is a dummy variable that takes the value 1 if the delay between the sooner and later payment was 6 weeks and not 3 weeks. Individual characteristics are defined as in Table 3. Month and location fixed effects are included. Interaction terms of the gross interest rate with delay as well as immediacy, and their interaction with treatment, are included in the regression. Robust standard errors are shown, clustered at the individual level. ***, **, * indicate significance at the 1, 5 and 10 percent level, respectively.

B.3. Corner choice patterns

Table B.4 presents the estimated marginal effects for the likelihood that an individual chooses to allocate 100% of the budget to the sooner payment date at a low interest rate (r), starting at $r = 0$, and then switches to allocating 100% of the budget to the later payment date at a higher interest rate. The dependent variable, labeled "corner choice pattern", is a dummy variable that takes value one if the individual behaves as described, zero otherwise.

Table B.4. Patterns of corner choices

	Corner choice pattern	
	Coefficient	Std. Error
Treatment	0.062**	[0.028]
Female	-0.068**	[0.029]
Grade 8	0.071**	[0.032]
Cognition score	0.023	[0.016]
Math grade	0.021	[0.014]
Migrant background	-0.004	[0.029]
Single parent	0.015	[0.033]
<25 books at home	-0.040	[0.028]
Observations	844	

Note: Probit regression, marginal effects shown, with robust standard errors clustered at the school level (25 clusters). Corner choice pattern takes value 1 if the individual always chooses to allocate 100% of the budget to the sooner payment date at $r = 0$ and as r increases he switches to allocating 100% of the budget to the later payment date immediately, and zero otherwise. Individual characteristics (gender, grade, cognition score, relative math grade, migrant background, single parent and books at home) are defined as in Table 3. The regression includes month and location fixed effects. Standard errors are shown in brackets. ***, **, * indicate significance at the 1, 5 and 10 percent level, respectively.

Appendix C: Estimation of time preferences

C.1. Econometric model

Following Andreoni and Sprenger (2012), we assume a time separable CRRA utility function within the $\beta - \delta$ model of quasi–hyperbolic discounting (e.g., Laibson, 1997),

$$U(x_t, x_{t+k}) = x_t^{\alpha} + \beta^{I_{t=0}} \delta^k x_{t+k}^{\alpha} \tag{1}$$

where the individual receives monetary amounts x_t and x_{t+k} at time t and $t+k$, and $I_{t=0}$ is an indicator variable that takes value one if payments are immediate. The preference parameters of interest are the discount rate δ, present bias β and utility curvature α. Individuals maximise utility subject to the budget constraint, $(1+r)x_t + x_{t+k} = m$. This yields the standard Euler equation, which can be written in logs as:

$$ln(\frac{x_t}{x_{t+k}}) = \frac{ln(\beta)}{\alpha - 1} I_{t=0} + \frac{ln(\delta)}{\alpha - 1} k + \frac{1}{\alpha - 1} ln(1+r), \tag{2}$$

The Euler equation establishes the optimal log ratio of payments across t and $t+k$, $x_j^* = ln(\frac{x_{t,j}}{x_{t+k,j}})$, in decision j, given the vector of preference parameters $\mu = (\frac{ln(\beta)}{\alpha-1}, \frac{ln(\delta)}{\alpha-1}, \frac{1}{\alpha-1})$ and the vector of decision characteristics $X = (I_{t=0}, k, (1+r))$. An individual i is offered four possible log ratios s_m in each decision problem j, where $m \in \{1, \ldots, M\}$ and $M = 4$. Hence, we estimate an interval data model (Wooldridge, 2001, p. 509).

More specifically, let us denote the vector of possible ratios as $s = (s_1, s_2, s_3, s_4)$. To simplify notation we drop the subscripts for each individual i and choice j. For each decision problem, an individual chooses

$$s = \begin{cases} s_1 & \text{if } x^* > s_2. \\ s_2 & \text{if } s_2 > x^* > s_3. \\ s_3 & \text{if } s_3 > x^* > s_4. \\ s_4 & \text{if } s_4 > x^*. \end{cases} \tag{3}$$

The probability that $s = s_m$, where $m \in \{1, 2, 3, 4\}$, depends on $X'\mu$. Additionally, as in von Gaudecker, van Soest and Wengström (2011) and Loomes, Moffatt and Sugden (2002), we model stochastic choice by allowing Fechner errors. These errors enter as weight τ on ε, which is assumed to be i.i.d across choices and individuals, and follow a

standard logistic distribution. Hence, we have that,

$$\begin{cases} P(s = s_1|X, \mu, \tau, s) & = 1 - \Lambda(\frac{1}{\tau}(s_2 - X'\mu)), \\ P(s = s_2|X, \mu, \tau, s) & = \Lambda(\frac{1}{\tau}(s_3 - X'\mu)) - \Lambda(\frac{1}{\tau}(s_2 - X'\mu)), \\ P(s = s_3|X, \mu, \tau, s) & = \Lambda(\frac{1}{\tau}(s_4 - X'\mu)) - \Lambda(\frac{1}{\tau}(s_3 - X'\mu)), \\ P(s = s_4|X, \mu, \tau, s) & = \Lambda(\frac{1}{\tau}(s_4 - X'\mu)), \end{cases}$$

where $\Lambda(t) = (1 + e^{-t})^{-1}$. Thus, the conditional log-likelihood is

$$ln\ L(\mu, \tau; X, s_m) = \sum_i \sum_j ln(P_{ij}(s = s_m|\mu, \tau; X, s) I_{(s=s_m)})$$

where $I_{(s=s_m)}$ is an indicator variable that takes value one if $s = s_m$.

At the individual level and in additional specifications, shown as robustness tests below, we add a trembling-hand error (e.g., Harless and Camerer, 1994), which allows for a probability ω that a student makes a random choice in a given decision. The results remain qualitatively similar with or without this additional type of stochastic choice.

An alternative stochastic choice model, which is frequently used in related studies, is the Luce model (e.g., Andersen et al., 2008). According to this model (Luce, 1959), the utility "index" of option m is the ratio of its utility, weighted by an "error" parameter σ, over the sum of the utilities of all other options. In particular,

$$u_m = \frac{U(x_{m,t}, x_{m,t+k})^{\frac{1}{\sigma}}}{\sum_{n=1}^{M} U(x_{n,t}, x_{n,t+k})^{\frac{1}{\sigma}}} \tag{4}$$

As $\sigma \to 0$ choice collapses to the deterministic choice model, while as σ increases choices become random. In this case, the likelihood that an individual chooses m is $P(s = s_m) = P(u_m + \varepsilon > 0) = \Phi(-u_m)$, where $\Phi(\cdot)$ is the cumulative standard normal distribution.

C.2. Estimated Aggregate Parameters: robustness tests

In this section, we show that the estimated aggregate parameters in Table 6 of the paper are robust to alternative models. The first alternative model, shown in columns (1) and (2) of Table C.1., is the non-linear least squares approach in Andreoni and Sprenger (2012). The second model, shown in columns (3) and (4), is the interval censored tobit (ICT) presented in section C.1. with an added trembling-hand error ω that is school-specific. The third model, shown in columns (5) and (6), adds a trembling-hand error that is homogeneous within the treatment and control group, respectively. The same result is obtained in all specifications, $\hat{\beta}$ is significantly smaller than 1 in the control group and not significantly different from 1 in the treatment group.

Table C.1: Estimated Aggregate Parameters: Alternative Specifications

	(1)	(2)	(3)	(4)	(5)	(6)
	NLS		ICT with Fechner error and school-specific trembling hand		ICT with Fechner error and homogeneous trembling hand	
	Treatment	Control	Treatment	Control	Treatment	Control
$\hat{\beta}$	0.971	1.001	0.928	0.994	0.915	0.996
	[0.013]	[0.012]	[0.026]	[0.029]	[0.025]	[0.009]
$\hat{\delta}$	0.995	0.994	0.997	0.993	0.997	0.996
	[0.001]	[0.001]	[0.001]	[0.002]	[0.001]	[0.001]
$\hat{\alpha}$	0.573	0.599	0.571	0.453	0.614	0.911
	[0.017]	[0.041]	[0.030]	[0.056]	[0.024]	[0.005]
$\hat{\tau}$			0.499	0.612	0.411	0.594
			[0.046]	[0.052]	[0.045]	[0.091]
Observations	10,332	8,862	10,332	8,862	10,332	8,862
H_0: $\hat{\beta} = 1$ (p-value)	0.0227	0.9649	0.0051	0.8420	0.0008	0.6977

Note: Columns (1) and (2) report the estimated preference parameters using the nonlinear least square specification in Andreoni and Sprenger (2012), setting the Stone-Geary consumption minima parameters equal to zero. Columns (3) and (4) report the estimated parameters by assuming ω is school-specific, in the interval regression model. Columns (5) and (6) report the estimated parameters by assuming ω is homogeneous within the treatment and control groups, respectively, in the interval regression model. All parameters are computed as nonlinear combinations, using the Delta method, of parameters estimated using maximum likelihood.

C.3. Estimated Individual Parameters

Next, we estimate individual parameters based on the model presented in Section C.1 with trembling-hand errors. Estimating alternative models that do not include Fechner

or trembling-hand errors yield similar results. Table C.2 presents the descriptive statistics for the estimated individual parameters $(\beta_i, \delta_i, \alpha_i, \tau_i, \omega_i)$. Please note that τ_i and α_i are only jointly identified in this model, so the individual estimates have no economic interpretation.

Table C.2: Descriptive statistics for the estimated individual parameters

	Median	5^{th} Percentile	25^{th} Percentile	75^{th} Percentile	95^{th} Percentile
Control					
Present bias parameter $(\hat{\beta}_i)$	1.000	0.440	0.751	1.155	2.627
Discount factor $(\hat{\delta}_i)$	1.002	0.962	0.997	1.018	1.056
Curvature $(\hat{\alpha}_i)$	0.473	-1.411	0.097	0.736	1.738
Fechner error $(\hat{\tau}_i)$	0.335	0.025	0.225	0.515	1.867
Trembling-hand error $(\hat{\omega}_i)$	0.149	0.000	0.000	0.358	0.585
Treatment					
Present bias parameter $(\hat{\beta}_i)$	0.998	0.464	0.782	1.140	2.075
Discount factor $(\hat{\delta}_i)$	1.003	0.961	0.995	1.014	1.108
CRRA Curvature $(\hat{\alpha}_i)$	0.334	-3.341	-0.007	0.697	1.332
Fechner error $(\hat{\tau}_i)$	0.350	0.042	0.278	0.457	0.903
Trembling-hand error $(\hat{\omega}_i)$	0.000	0.000	0.000	0.189	0.581

Note: The subscript i indicates individual i. N=815.

Table C.3 displays the treatment effects on individual parameters. We first examine whether the share of students classified as time consistent varies with the treatment. Time consistency, implying the absence of change in allocations when the earlier payment is immediate or delayed, is reflected in a present bias parameter close to 1, more specifically, between 0.99 and 1.01, following Augenblick, Niederle and Sprenger (2015). We find a significant increase of between 8 and 10 percentage points in the share of students who are classified as time-consistent. The magnitude of this increase is large, as it implies that the share of time-consistent students almost doubles, moving from 9% in the control group to 17% in the treatment group. This finding is consistent with a decrease in narrow bracketing: when time-dated monetary payments are treated less as consumption and integrated within the students' budgets, students should appear more time consistent.

We also estimate a multivariate multiple regression model to examine the treatment effect on the jointly estimated parameters. The results reveal no significant changes

Table C.3. Treatment effect on time consistency and individual time preference parameters

	(1) Time consistency	(2) Present bias ($\hat{\beta}_i$)	(3) Discount factor ($\hat{\delta}_i$)	(4) Trembling hand error ($\hat{\omega}_i$)	(5) CRRA curvature ($\hat{\alpha}_i$)	(6) Fechner error ($\hat{\tau}_i$)
Treatment	0.099**	-0.033	0.009	-0.073***	-0.266	-0.057
	[0.042]	[0.057]	[0.007]	[0.015]	[0.168]	[0.062]
Female	0.015	0.026	0.008	-0.015	-0.022	-0.036
	[0.031]	[0.056]	[0.007]	[0.015]	[0.166]	[0.061]
Grade 8	-0.066	0.032	0.013*	0.005	-0.111	-0.020
	[0.046]	[0.062]	[0.008]	[0.017]	[0.185]	[0.068]
Cognition score	0.01	0.002	-0.002	-0.013	0.087	0.011
	[0.015]	[0.031]	[0.004]	[0.008]	[0.093]	[0.034]
Math grade	0.017	0.015	0.001	0.005	0.051	0.023
	[0.012]	[0.028]	[0.003]	[0.008]	[0.084]	[0.031]
Migrant background	0.002	-0.081	0.008	-0.006	0.106	0.010
	[0.029]	[0.056]	[0.007]	[0.015]	[0.168]	[0.062]
Single parent	0.031	-0.087	-0.008	0.002	-0.069	0.056
	[0.029]	[0.064]	[0.008]	[0.017]	[0.191]	[0.070]
<25 books at home	0.018	-0.025	0.003	-0.021	0.070	0.113*
	[0.028]	[0.057]	[0.007]	[0.015]	[0.168]	[0.062]
Constant		1.017***	0.969***	0.258***	-0.103	0.182
		[0.139]	[0.017]	[0.037]	[0.414]	[0.152]
Observations	749	749	749	749	749	749
Adj. R-squared		0.037	0.013	0.047	0.018	0.039

Note: Column (1) reports the marginal effects of a probit model on the likelihood that an individual is time-consistent, i.e., $\hat{\beta}_i$ falls within $0.99 < \hat{\beta}_i < 1.01$. Columns (2)-(6) report multivariate regression results on all estimated parameters. Treatment is a dummy variable that takes value 1 if the student participated in the education program. Individual characteristics are defined as in Table 3. Additional controls are location and month fixed effects. Robust standard errors, clustered at the school level, are computed. ***, **, * indicate significance at the 1, 5 and 10 percent level, respectively.

in the present bias parameter, $\hat{\beta}_i$,[1] or in the estimated discount factor ($\hat{\delta}_i$), while the treatment strongly decreased the estimated trembling-hand error ($\hat{\omega}_i$).This result is in line with the increase in the share of choices consistent with the law of demand we

[1]This result, together with the increase in time consistency, suggests that both the estimated present bias and future bias may have decreased. The data indeed reveal a decrease in the share of individuals who appear as strongly present biased, with $\hat{\beta}_i \leq 0.6$ (χ^2-test, p=0.07), but no significant decrease in the share of individuals that are classified as weakly present biased, i.e. $0.6 < \hat{\beta}_i < 0.99$. At the same time, we find no evidence of a significant decrease in the share of students who look like strongly future biased individuals, with $\hat{\beta}_i \geq 1.4$, but we find a decrease in those who appear as weakly future biased individuals, with $1.4 > \hat{\beta}_i > 1.01$ (χ^2-test, p<0.01).

showed in the descriptive analysis, suggesting increased understanding of intertemporal choice.

C.4. Estimated individual parameters and field behaviours

The treatment decreases the share of students that appear as time inconsistent and the rate of errors in intertemporal choice. The absence of changes in student income or spending across treatment and control suggests that changes in external consumption opportunities cannot explain the observed changes in intertemporal choice. An explanation for these findings is, as mentioned above, that the treatment may have changed how students view time-dated experimental payments, leading to more broad bracketing. If so, students' choices in the CTB task should exhibit a weaker correlation with field behaviours such as saving in the treatment group.

We explore this hypothesis by relating the estimated parameters to several field behaviours reported in the survey conducted after the CTB task. We consider savings behaviour, whether the student saves and, if so, how much. We additionally study self-reported impulsivity measures when shopping, based on Rook and Fisher (1995) and Valence, d'Astous and Fortier (1988). The measure is the average answer to four statements: "I buy impulsively"; "before I buy something, I consider carefully whether I can afford it" (reverse coded); "before I buy something important, I compare prices in the Internet or several shops" (reverse coded); and, "sometimes I regret having bought something new". The answers were given on a 5-item Likert scale, 1-strongly disagree to 5-strongly agree. We also include a measure of efficacy at achieving savings goals. This measure is the average answer to two statements: "when I plan to buy something, I manage to save for it"; "I am good at reaching my saving goals". The answers were provided on the same 5-item Likert scale.

Table C.4 displays the relationship between the estimated present bias parameter, $\hat{\beta}_i$, and these field behaviours. A higher $\hat{\beta}_i$, implying lower present bias, is related to increased savings amounts, directionally lower impulsivity and a higher self-reported efficacy at achieving savings goals. Additionally, $\hat{\delta}_i$ is related to the savings amount as expected. Overall, these correlations suggest that the estimated time preference parameters are informative of students' behaviour in the control group.

The estimates in Table C.4 for the interaction between $\hat{\beta}_i$ and the treatment provide suggestive evidence that the relationship between estimated parameters and field behaviours weakens with the treatment. In particular, we observe a marginally significant weaker relationship between $\hat{\beta}_i$ and savings amount in the treatment group. The same

sign is obtained for $\hat{\delta}_i$, though it is not significant. We also observe a weaker relationship between $\hat{\delta}_i$ and efficacy at achieving savings goals in the treatment group, which is positive though not significant in the control group. Overall, this suggests that, while intertemporal choices in the control group capture underlying time preferences, in the treatment group choices may have become less informative about preferences.

Table C.4. Estimated parameters and field behaviours

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Save (0/1)		If save=1, ln(save)		Impulsivity		Saving goals	
Treatment	-0.039	0.114	-0.130	3.316	-0.028	0.685	0.016	2.833**
	[0.033]	[0.986]	[0.108]	[2.186]	[0.052]	[1.850]	[0.077]	[1.253]
$\hat{\beta}_i$		0.035		0.283***		-0.069		0.113**
		[0.037]		[0.064]		[0.052]		[0.052]
$\hat{\delta}_i$		-0.015		4.016**		0.938		1.964
		[0.964]		[1.767]		[1.743]		[1.150]
$\hat{\omega}_i$		0.056		-0.070		0.112		0.446
		[0.117]		[0.421]		[0.294]		[0.268]
$\hat{\beta}_i$ * treatment		0.009		-0.227*		0.109		-0.055
		[0.047]		[0.116]		[0.071]		[0.098]
$\hat{\delta}_i$ * treatment		-0.150		-3.098		-0.845		-2.649**
		[0.963]		[2.185]		[1.797]		[1.196]
$\hat{\omega}_i$ * treatment		-0.031		-0.594		0.206		-0.410
		[0.163]		[0.507]		[0.422]		[0.371]
Constant			3.778***	-0.583	0.003	-0.885	-0.146	-2.378*
			[0.214]	[1.856]	[0.091]	[1.775]	[0.165]	[1.214]
Observations	749	749	371	371	730	730	734	734
Adj. R-squared			0.055	0.079	0.025	0.030	0.065	0.080

Note: Columns (1)-(2) report estimated marginal effects of a probit model on the likelihood that an individual saves. Columns (3)-(8) report OLS regression results with the natural logarithm of savings, conditional on savings (columns 3 and 4), self-reported impulsivity (columns 5 and 6) and efficacy at achieving saving goals (columns 7 and 8) as dependent variables. The latter two measures are standardised. The table includes individual characteristics (gender, grade, cognition score, relative math grade, migrant background, single parent and books at home) as controls. All specifications include location and month fixed effects. Robust standard errors, clustered at the school level, are computed. ***, **, * indicate significance at the 1, 5 and 10 percent level, respectively.

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