Estimating the Value of Higher Education Financial Aid: Evidence from a Field Experiment*

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Abstract

Using data from a Canadian field experiment designed to elicit risk and time preferences and quantify financial barriers to higher education, we estimate the value of financial aid for prospective students and relate it to parental socio-economic background, individual skills, risk and time preferences. Consistent with credit constraints affecting a sizable share of prospective students, the median agent would trade a one period increase in current consumption corresponding to 6% of the principal for the option to take up a $1,000 loan at the market interest rate.

Keywords: Higher Education Financing, Time and Risk Preferences, Field experiment.

JEL codes: I22, I23, J24

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Introduction

Despite inconclusive evidence on the relationship between credit constraints and the decision to attend higher education, many education policies are based on the premise that borrowing constraints preclude students from a modest background to access higher education.[1] The lack of consensus on this topic, which is largely explained by the difficulty to measure key economic variables driving credit constraints, leads us to propose an alternative strategy based on the willingness-to-pay for various financial aid packages.

Specifically, we specify and estimate an educational financing decisions model using data from a field experiment that was conducted in several Canadian high schools between 2008 and 2009.[2] The experiment consists of a sequence of choices between a cash payment and various types of financial aid: single loan, single grant and hybrid package composed of a loan and a grant.[3] Loans conditions were similar to the Federal Canadian Student Loan Program. Financial aid packages varied from $500 - $4,000 and represented a high fraction of yearly tuition at any of the Canadian universities.[4] Therefore, these financial packages remove, or reduce any potential liquidity constraints by providing education financing ahead of high-school graduation. As a consequence, potential students facing liquidity constraints are likely to attach a significant value to the opportunity of receiving a loan at the market rate, while those who do not perceive financial constraints will regard those opportunities as redundant.

We formulate the decision to accept a financial aid package as an intertemporal problem. The structure of our model is simple and may be described as follows.

[1] See our next section for a review of literature on this topic.

[2] Montmarquette and Johnson (2015) who have designed the experiment used in the present paper, estimated a reduced-form model of the decision to take-up loans. They focus primarily on the notion of loan aversion and conclude in favor of the absence of any sizeable loan aversion.

[3] This experiment uses tools from standard lab experiments and applies them to a sample of individuals drawn from the population of interest. As such, it qualifies as an "artefactual field experiment" as defined in Harrison and List (2004).

[4] Amounts are in Canadian dollars. The average tuition were equal to $2,180 for Quebec, $5,667 for Ontario, $3,228 for Saskatchewan, and $5,064 for Manitoba, over the period covered by the experiment. Similarly, the average US in-state tuition fees charged by public 4-year institutions for 2007-2008 was US $6,200 according to the Bureau of Labor Statistics (Spotlight on Statistics: Back to College, 2010).

Young individuals, endowed with Constant Relative Risk Aversion (CRRA) preferences, must weigh the increase in utility generated by acceptance of a cash payment against the expected future gain generated by a specific financial aid package. Although we do not observe the post high-school graduation decisions of agents, we can use information on their revealed preferences to infer the utility gains of accepting different financial aid packages. We derive the willingness-to-pay for financial aid opportunities, and use those estimates to uncover the distribution of the individual specific additional rate of interest that each individual would pay to secure financial aid.

Since the experiment was also designed to infer fundamental preference parameters for risk and time, we estimate non-parametrically the joint distribution of risk aversion and discount factors which are obtained using standard elicitation techniques in the experimental literature, and examine how those preference parameters affect education financing decisions. To our knowledge, most experimental economists use monetary incentives to design tasks aimed at identifying fundamental preference parameters but they do not examine the explanatory power of those parameters within a separate task. In our setting, since we allow higher education financing decisions observed in the experiment to depend on time and risk preference parameters, it is possible to evaluate the explanatory power of our preference parameter estimates within a context that is characterized by much higher stakes. In addition, we are able to separate the effects of preferences from other components such as skills, and parental background on the probability to accept a financial aid. Since these choices are exerted prior to actual college enrollment, the decision to accept a financial aid packages depends not only on the perceived magnitude of borrowing constraints in the economy but also on the probability of applying for higher education. Understanding financial aid acceptance therefore requires to take into account both heterogeneity in risk aversion and discount factors, as well as financial resources provided by the family. The experimental data and surveys used in this paper provides a unique opportunity to address this important question.

The majority of our sample attaches a significant value to the option of accessing higher education loans. Specifically, our estimates indicate that the median student

would be willing to trade an increase in current consumption corresponding to 6% of the principal in return for the option to take up a $1,000 loan at the market interest rate in the near future. When expressed in terms of interest rate, this result implies that individuals would be willing to accept a loan at a rate of approximately 6.7% per year, which corresponds to a 1 percentage point increase with respect to the market rate. Furthermore, we find that as much as 39% of the population would be willing to forego an increase in immediate consumption corresponding to half of their baseline consumption level to secure a $1,000 loan. Overall, these results are consistent with the existence of credit constraints affecting a sizable share of high school students.

In terms of public policy, our estimates can be more generally interpreted as uncovering the willingness-to-pay for a counterfactual expansion in higher education financial aid offers. Since the set of financial aid offers also include grants, our estimates also speak to the value of a significant reduction in university tuition fees. As expected, students attach higher values to grants. For instance, our estimation results imply that the median agent would be willing to trade a $400 increase in current consumption against a $1,000 reduction in tuition in the future.

Our results also indicate that students in our sample have a median discount factor of 0.83 and a median degree of relative risk aversion equal to 0.64. Individual-specific discount factors as well as risk aversion parameters, which are highly heterogeneous across students, play an important role in explaining the willingness-to-pay for higher education financial aid. A variance decomposition analysis shows that these individual preference parameters are more important than all other determinants taken together. For instance, they are about 6 times more important than parental education, parental income and numeracy test score in explaining the willingness-to-pay for a $1,000 loan. We also find that the future value of accepting financial aid is dominated by differences in risk aversion, with more risk averse individuals attaching a higher value to financial aid. However, the overall willingness-to-pay is mostly explained by discount factors as the more risk averse are also those who gain the most from an increase in immediate consumption. On the other hand, parental background variables play a much smaller role than discount factors and risk aversion parameters. As such, our results point to the

importance of collecting data on individual time and risk preferences to improve our understanding of educational financing decisions and, more generally, of higher education demand.

The rest of the paper is organized as follows. In Section 2, we provide an overview of the related literature and detail our contributions. The design of the field experiment and a summary of the data are discussed in Section 3. Section 4 describes the model and Section 5 presents our estimation strategy. The estimation results are discussed in Section 6. Finally, Section 7 concludes.

1 Background literature and contributions

The existence and the intensity of credit constraints are among the most important issues guiding public policies aimed at stimulating human capital formation such as loans, grants and work study programs (see Lochner and Monge-Naranjo, 2012, 2016, and Heckman and Mosso, 2014 for recent surveys). At a purely theoretical level, the notion of credit constraints in the education context denominates any barrier hindering potential students to finance tuition fees or consumption. However, at an empirical level, it is difficult to perform direct tests for the presence of credit constraints because borrowing restrictions are not observed in standard data sets. As a consequence, most of the papers have used indirect approaches.

One can distinguish four main strands in this literature. A first set of papers argue that one reason why the estimated returns to schooling using standard instrumental variable techniques may be larger than the OLS estimates is that the subpopulation of compliers tend to be more credit constrained, and thus face larger returns to schooling at the equilibrium (see, e.g., Lang, 1993, and Card, 1995). A second strand of papers test for the importance of credit constraints by estimating short-term effects of parental income on the probability of entering higher education, controlling for long-run factors such as ability (see, e.g., Cameron and Heckman, 1998, Carneiro and Heckman, 2002, and Belley and Lochner, 2007). The third one estimates or calibrates structural models in which credit constraints are explicitly represented, as in Keane and Wolpin (2001), Cameron and Taber (2004), Lochner and Monge-Naranjo (2011) and Johnson (2013). Finally,

Cameron and Taber (2004) and Brown, Scholz, and Seshadri (2012) analyze various other testable implications of the existence of credit constraints. With the notable exceptions of Belley and Lochner (2007), Lochner and Monge-Naranjo (2011) and Brown et al. (2012), most of the studies relying on indirect measures conclude against the existence of a significant role played by credit constraints. [5]

Recently, alternative approaches based on direct measures of credit constraints have been proposed. Although access to these measures provides a clear advantage to researchers, they are typically obtained at the expense of a reduced external validity. In addition and importantly, while quantifying the overall importance of education financing barriers in the economy requires to evaluate its impact prior to actual college enrollments, direct measures are generally obtained from a sub-population of individuals who have already enrolled in higher education. Notably, Stinebrickner and Stinebrickner (2008) designed a survey of college students enrolled at Berea College (Kentucky) in order to identify those who are credit constrained and to analyze differences in college-drop-out decisions. The authors conclude that the majority of college attrition is explained by factors other than access to credit.[6]

In this paper, we follow another route and use rich data from a college education financing field experiment conducted among Canadian high school students to address this question. Importantly, this experiment provides us with direct measures of the opportunity cost of refusing various types of higher education financial aid packages. This unique feature of the data allows us to estimate the distribution of the monetary values associated with the option to take-up a college loan at the prevailing market interest rate. In the absence of credit constraints, one would expect these values to be small or negligible. On the other hand, large

[5] The intuition of Belley and Lochner (2007) is that changes across the 1979 and 1997 cohorts of the NLSY in the effect of income quantiles on college enrollment provides evidence in favor of credit constraints. Their argument is primarily based on the observation that college attendance rate among the low ability individuals has increased more over time for students coming from high income families.

[6] Recent work by Delavande and Zafar (2014) investigates the role played by credit constraints in the context of university choice in Pakistan. The authors address the identification issue by directly eliciting from the individuals the university they would have chosen in the (counterfactual) absence of financial constraints, and find that those constraints play an important role.

values associated with the option to take-up college loans are indicative of credit constraints.

Our study also contributes to the experimental literature dealing with the estimation of risk and time preferences, including Coller and Williams (1999), Holt and Laury (2002) and Andersen, Harrison, Lau, and Rutstrom (2008) (see also Frederick, Loewenstein, and O'Donoghue, 2002, for a survey). To our knowledge, this paper is the first to elicit the joint distribution of fundamental preferences (risk aversion and discount factor) non-parametrically while allowing for measurement errors. This is possible thanks to the large number of choices that are recorded for each individual, which allows us to treat both risk aversion parameters and discount factors as individual fixed-effects. It is worth noting that, in this respect, our approach comes in sharp contrast with most of the dynamic discrete choice literature, where one generally imposes the restriction that all agents share the same discount factor and the same degree of risk aversion.[7] The results obtained in this paper provide evidence that discount factors and risk aversion parameters are in fact highly heterogeneous across individuals.

2 Data

The data used in the paper comes from "The Millenium Foundation Field Experiment on Education Financing". The field experiment was conducted from October 2008 to March 2009. The sample, which consists of 1,248 Canadian full time senior high school students (or students enrolled in CEGEP, the equivalent of senior year of high school in Quebec), was drawn from both urban and rural sites across Canada. The students were aged between 16 and 18 years at the time of the experiment. The experiment was funded by the Canada Millennium Foundation (a public enterprise created by the Canadian federal government) and was carried jointly by The Social Research and Demonstration Corporation (SRDC, Ottawa, Canada) and the Centre Interuniversitaire de Recherche en Analyse des

[7] Notable exceptions include Arcidiacono, Sieg, and Sloan (2007) and Brodaty, Gary-Bobo, and Prieto (2014), who allow for heterogeneous discount factors and relative risk aversion, respectively.

Organisations (CIRANO, Montreal, Canada).

The experiment was conducted using pen and paper choice booklets as well as simple random sampling devices like bingo balls and dice. Project cost considerations suggested that participants be drawn from locations with convenient travel connections from the SRDC Ottawa and CIRANO Montreal offices. Manitoba, Saskatchewan, Ontario and Quebec were the selected provinces. Urban and rural school districts were selected in each of the four provinces and the implementation team was able to carry out work in urban and rural schools in each of the four provinces.[8]

The experiment consists of three parts. First, young individuals must answer a set of questions aimed at measuring their rate of time preference. In those questions, individuals are offered a choice between two payments of different values to be made at different points in time. In our analysis we use the 24 questions that provide cash payment within a week or a day. A second set of questions relate to the measurement of risk attitudes. Specifically, students are presented with a sequence of 55 binary choices between two lotteries in which risk is objectively stated. Finally, the third group of questions is a sequence of choices between a cash payment to be paid within one week from the day the experiment was carried, and the option to use a specific financial aid package covering future educational expenses. Should the student decide to exercise this option, the financial aid package is to be paid conditional on enrolling in a full-time program at any higher education institution in the country (within two years).[9] Students were paid for one, randomly selected decision, at the end of the session.

[8]Experiment staff were granted access to the high schools and cooperated with student services staff to recruit and schedule senior students. Sessions took place during school hours (over two days). Participation to a Web survey and parental consent were required to participate in the experimental session. The experimental sessions were held in controlled environments including classrooms, libraries, career counseling rooms, activity rooms and auditoriums. All rooms were held on the campus where the student attended classes. The planned optimal number of participants per session was between 20 and 25 allowing the entire urban subject pool to be contained in 50 sessions. A total of 75 sessions were conducted with 50 as the maximum number of participants in any session. For showing up on time, each participant received a $20 fee. Supplementary information regarding aspects of the experiment that we do not model may be found in Montmarquette and Johnson (2015).

[9]Over this period in Canada, the transition rate from high school to higher education was around 85% (see Belley, Frenette, and Lochner, 2014).

Overall, three types of financial aid packages were offered, namely grants, loans and hybrid loans which combines a loan and grant. In the paper we use a total of 17 financial aid decisions, with 5 choices with a single loan offer, 7 choices with a single grant offer, and 5 hybrid loan offers. These decisions are summarized in Table A3.[10]

Cash alternatives varied from $25 to $700, while grants and loans varied from $500 to $4,000. The variations in cash amounts and in the nature and the size of financial aid packages play a crucial role in our analysis. At the outset, it should be clear that these amounts are quite sizable. For instance, over the period considered, a grant of $2,000 in 2008 would have covered 65% of yearly fee at University of Western Ontario and Queen's University, and almost 100% at McGill University and Université de Montréal.[11]

2.1 Describing the take-up rates

To describe the sensitivity of individual take-up to financial aid structure and cash payments, we plot below the take-up rates associated to various combinations of grants and loans, against specific cash payments. In Figure 1, the take-up rates are those obtained when the alternative cash payment was $25 and $700, respectively.[12] As expected, the take-up rates are inversely related to the amount of cash payment. For instance, 90% of individuals opted for a $1,000 grant when offered a $25 cash payment, while only 40% opted for a $1,000 grant when offered a cash payment of $700. Those differences in take-up rates are very similar for the three financial aid packages considered in this figure ($1,000 grant, hybrid $1,000 loan combined with $1,000 grant, and $1,000 loan). Figure 2 reports the take-up rates for various sizes and types of financial aid packages and for a $300 cash payment. This figure shows that, for all three types of packages, take-up rates increase with the size of the financial aid. For instance, the take-up rate of $500 is approximately 39% to be compared with a take-up rate of 69% for a $1,000. However, the increase in take-up rates is modest after $1,000. Figure 2 shows that the marginal increase

[10] See Appendix A for a more extensive description of the data.
[11] Put in 2015 Canadian dollars, the total cost of the experiment is around $1,000,000.
[12] L stands for Loan and G for grant.

in take-up rates for additional financing is relatively small, with take-up rates respectively equal to 76% for a $2,000 grant and 84% for a $4,000 grant, against 68% for a $1,000 grant and 39% for a $500 grant. A potential explanation for those take-up rates being significantly below 1 even for a $4,000 grant is that not all individuals in our sample intend to enroll in higher education, and as a consequence, some individuals will always value more current consumption over financing opportunities. A similar pattern can be observed for single loan offers, as the take-up rate for $1,000 loan is 11%, to be compared to respectively 17% and 24% for $2,000 and $4,000 loans. Second, Figures 1 and 2 show that take-up rates for a grant of value x are very similar, and in fact always slightly higher, than for a hybrid financial package offering an additional loan of value x. This pattern likely reflects the fact that taking-up a hybrid financial aid package in practice entails taking-up both the loan and the grant associated with it, and thus paying the interests on the loan component. Depending on the expected future consumption profile as well as the existence and intensity of credit constraints, individuals may rationally attach a higher value to a grant offer than to an hybrid package adding a loan to the grant.

Figure 1: Take-up rates

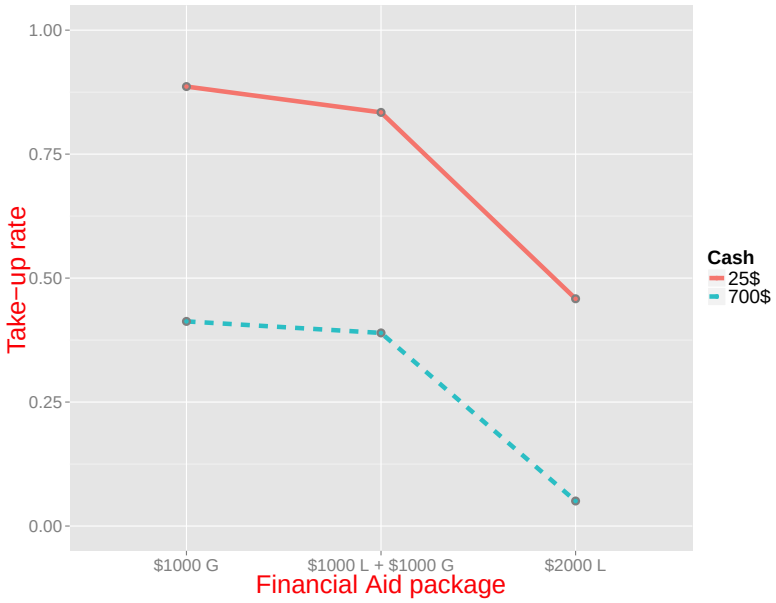
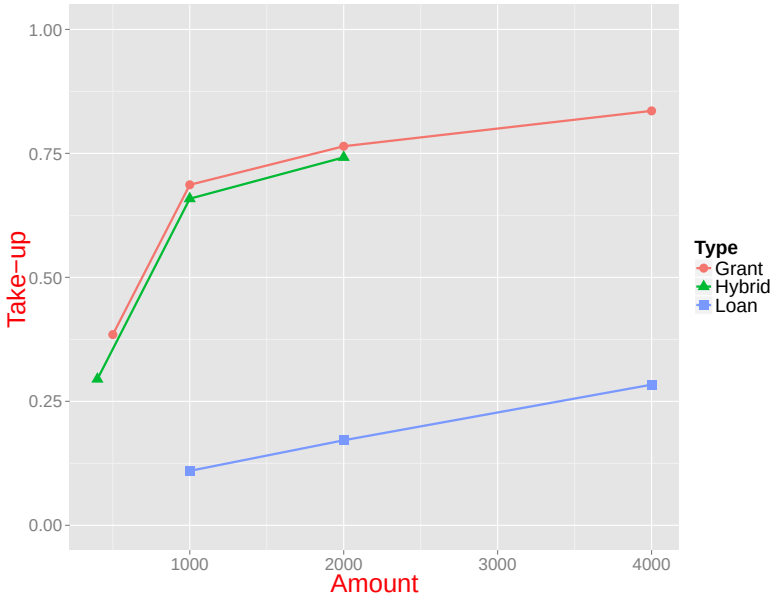


Figure 2: Take-up rates against $300



3 The model

We assume that preferences over consumption are represented by a CRRA utility function. Namely, for each student i, the utility of consumption c is given by:

$$u(c, \theta_i) = \begin{cases} \dfrac{c^{1-\theta_i}}{1-\theta_i} & \text{if } \theta_i \neq 1 \\ \log(c), & \text{if } \theta_i = 1 \end{cases} \tag{1}$$

where θ_i denotes the individual-specific risk aversion parameter.

The large number of questions available from the experiment allows us to treat relative risk aversion rate as well as the annual discount factors (denoted by β_i in the following) as individual-specific parameters. Because individuals presumably differ not only in their preferences, but also in their financial resources, we further allow for individual specific consumption endowments.[13] In the rest of the section we follow the structure of the experiment and discuss the choice equations separately for each group of questions.

3.1 Time preference

A first set of questions (indexed by $q = 1, \ldots 24$) is devoted to measuring the subjective discount rate and consists of a sequence of choices between two alternatives: an early cash payment denoted by a_{0q} to be paid t_{0q} months from now, and another cash payment denoted by a_{1q}, and to be paid t_{1q} months from now. We denote by Y_{iq} a dummy variable which is equal to 1 if individual i chooses the early cash payment. Questions differ with respect to the amount of the cash payment, and the periods at which the earlier or later cash payments would be paid.

We express individual i's probability to choose consumption at period t_{0q}

[13] In practice, we allow for different levels of individual consumption endowment across the three different groups of questions in an effort to capture contextual differences across those questions (see Section 4.1).

versus period t_{1q} using a simple two-period consumption model:

$$\Pr(Y_{iq}=1)=\Pr\Big\{\beta_i(t_{0q})[u(c_i+a_{0q},\theta_i)-u(c_i,\theta_i)] \\ +\beta_i(t_{1q})[u(c_i,\theta_i)-u(c_i+a_{1q},\theta_i)]+\varepsilon_{iq}>0\Big\} \tag{2}$$

where ε_{iq} is an idiosyncratic preference shock and c_i the individual background consumption. The distributional assumptions and specification of the background consumption are discussed in Section 4. Finally, the individual discount rate applied for a payment to be received t_q months from now is assumed to be given by:

$$\beta_i(t_q)=\frac{1}{1+\frac{t_q}{12}\cdot r_i}$$

where r_i denotes the individual annual subjective interest rate.

3.2 Risk aversion

A second set of questions relate to the measurement of the degree of relative risk aversion. In each of these questions, individuals are offered to choose between two alternatives, namely a lottery offering a^1_{0q} with probability p_q and a^2_{0q} with probability $1-p_q$, and another lottery offering a^1_{1q} with probability p_q and a^2_{1q} with probability $1-p_q$. Questions differ according to the state contingent cash payments $(a^1_{0q}, a^2_{0q}, a^1_{1q}, a^2_{1q})$ and probabilities $(p_q,\, 1-p_q)$.[14] The generic choice probability for

[14] As is standard in the experimental literature, we assume that individuals consume the windfall gain immediately upon reception.

the first alternative is given by:

$$\Pr(Y_{iq}=1)=\Pr\left\{p_q\cdot\left(u(c_i+a^1_{0q},\theta_i)-u(c_i+a^1_{1q},\theta_i)\right)\right. \tag{3}$$
$$\left.+(1-p_q)\cdot\left(u(c_i+a^2_{0q},\theta_i)-u(c_i+a^2_{1q},\theta_i)\right)+\varepsilon_{iq}>0\right\}$$

where ε_{iq} is an idiosyncratic preference shock and $q=25,\ldots 79$.

3.3 Choices between consumption and education financing

The third group of questions is a sequence of choices between a cash payment to be paid within one week, and a specific financial aid package covering educational expenses.

In order to interpret individual choices between cash payments and educational financial aid, we specify a stylized two-period model. Period 0 refers to the time when high school students are asked to choose between consumption and an education financing package, while period 1 refers to the residual life-cycle starting from high school graduation. For each choice, individuals must decide between a cash payment and a financial aid package which is to be paid conditional on higher education enrollment in period 1.

This structure of the model is as follows. Let a_{0q} and a_{1q} be the cash payment and financial aid transfer in question q. The potential financial aid offer (a_{1q}) offered in period 0 and to be paid at the beginning of period 1 is characterized by a two-element vector, denoted by $(g_q,\ell_q)'$ where g_q is the amount of the grant and ℓ_q the amount of the loan.[15] The choice variable Y_{iq} is equal to 1 when an individual chooses financial aid a_{1q} and 0 if she accepts consumption a_{0q}. As a consequence, the initial period consumption c_{0iq} is given by

$$c_{0iq}=c_i+a_{0q}\cdot(1-Y_{iq})$$

[15]For instance, an offer consisting of a grant has an entry equal to 0 for ℓ, while a loan has an entry equal to 0 for g. An hybrid offer that includes both a grant and a loan has a positive entry for both.

The period 0 utility of accepting or rejecting the financial aid are then given by:

$$W(Y_{iq} = 1) = u(c_i, \theta_i) + \varepsilon_{1iq} \quad (4)$$

$$W(Y_{iq} = 0) = u(c_i + a_{0q}, \theta_i) + \varepsilon_{0iq} \quad (5)$$

where ε_{0iq} and ε_{1iq} represent choice specific preference shocks.

Because we do not have data on actual choices exercised in subsequent periods, we focus on the estimation of the difference between future component of the utilities of accepting and rejecting financial aid. The intertemporal utilities of accepting and rejecting financial aid are given by $u(c_i, \theta_i) + \varepsilon_{1iq} + \beta_i EV_{iq}(Y_{iq} = 1)$ and $u(c_i + a_{0q}, \theta_i) + \varepsilon_{0iq} + \beta_i EV_{iq}(Y_{iq} = 0)$, respectively, where the future components $EV_{iq}(Y_{iq} = 1)$ and $EV_{iq}(Y_{iq} = 0)$ are the expected lifetime utilities associated with each choice.

In practice, expected future value terms associated with each alternative $Y_{iq} \in \{0, 1\}$ depend on individual beliefs about a range of future outcomes, some of them being alternative specific. Notably, those beliefs include the subjective probabilities of enrolling in higher education conditional on receiving the financial aid offer a_{1q}, and conditional on not receiving the financial aid offer, for the alternatives $Y_{iq} = 1$ and $Y_{iq} = 0$ respectively. The expected future value terms in principle also depend on the perceived availability of higher education financing opportunities outside of the experiment. As those outcomes are not observed in the data, we treat those future components as unknown functions of parental socio-economic background, individual skills as well as risk and time preferences. A key advantage of this approach relative to a more standard dynamic discrete choice model is that it avoids strong and untestable restrictions regarding the beliefs of the individuals and their evolution over the life cycle.[16]

Under these assumptions, agent i's probability to accept the financial aid package proposed at question q is given by

[16] An alternative approach would have been to elicit beliefs about counterfactual future schooling choices and consumption paths. In the higher education context, notable references include Arcidiacono, Hotz, and Kang (2012), Stinebrickner and Stinebrickner (2014) and Wiswall and Zafar (2015) who use subjective expectations data to examine the determinants of college major choice.

$$\Pr(Y_{iq} = 1) = \Pr\left\{ u(c_i, \theta_i) - u(c_i + a_{0q}, \theta_i) + \beta_i \cdot \psi_{iq} + \varepsilon_{iq} > 0 \right\} \tag{6}$$

where $\psi_{iq} = EV_{iq}(Y_{iq} = 1) - EV_{iq}(Y_{iq} = 0)$ denotes the expected future utility gain associated to accepting financial aid, and $\varepsilon_{iq} = \varepsilon_{1iq} - \varepsilon_{0iq}$.

4 Specification

In the following, we assume that the idiosyncratic shocks are independent across individuals and across questions, and identically distributed within each group of equations following a normal distribution with mean zero. We summarize in the rest of the section the specification of the background consumption and the expected future utility gain of accepting financial aid.

4.1 Background consumption

Until now, we have simplified the exposition by considering for each individual a unique background consumption variable c_i. However, in practice we allow the background consumption levels to vary with the group of questions in order to capture contextual differences across questions. Specifically, for each group of questions, we denote the individual background consumption by c_i^k (where $k \in \{1, 2, 3\}$ indexes the questions related to time preference, risk aversion and education financing, respectively), which is assumed to depend on a vector of individual and family background characteristics denoted by Z_i:

$$c_i^k = \exp(\gamma_k Z_i) \tag{7}$$

The vector Z_i includes an intercept and a set of individual characteristics, namely gender, parental income (20-40K, 40-60K, 60-80K, 80-100K and more than 100K Canadian dollars per year), parental education (high school, vocational college and college) of the respondent of the parental survey, Canadian citizenship, place of residence (Quebec, Ontario, Saskatchewan, and a dummy for rural location)

and family composition (existence of siblings younger or older than 18).[17] This flexible specification allows each of these characteristics to have different weights within each group of questions.

4.2 Approximation of the future component

The expected future utility gain of accepting financial aid (ψ_{iq}) is a key component of the model. Standard structural dynamic estimation would require to posit a parametric form of the utility of potential future schooling choices as well as all the probability distributions that characterize the subjective beliefs of agents about future returns to education and experience. In this paper, we take another route and assume instead that the future component may be approximated by a parametric function that depends on time and risk preference parameters, skills, geographical location, parental income and education. We estimate it using a flexible polynomial incorporating those variables in level and square as well as various interactions.[18]

5 Identification and Estimation

In this section we first discuss the sources of identification of the key parameters of the model, before turning to the estimation procedure.

[17] There are 269 individuals with missing income data, and 146 individuals with missing education data. We use a Gibbs sampling algorithm to impute those missing information using age, gender, location, income, education, citizenship variables in the full sample.

[18] The exact specification is given in Appendix B. Interaction between risk aversion and discount factor, squared terms in those preference parameters, and dummies for the existence of siblings younger or older than 18 are excluded from this specification as they did not show up significantly when we allowed them to enter the future component. Our approach is in line with Geweke and Keane (2000), who advocate the estimation of the future component of the value function using a polynomial which records the movement of state variables implied by the law of motion. However, in contrast with Geweke and Keane (2000), we account for heterogeneity in individuals preferences and incorporate time and risk preferences parameters in the polynomial.

5.1 Identification

We start by informally discussing the sources of identification of the individual time preference and risk aversion parameters, before turning to the expected future utility gain of accepting financial aid.

First, the risk aversion parameters are primarily identified from the sequence of choices described in Section 3.2 between two lotteries that differ in the cash payments and the probabilities associated with each payment. Importantly, variation across individuals in time preferences does not confound the identification of the risk aversion parameters here since all of the state-contingent cash payments are immediate.

The key sources of identification of the individual discount rates are the choices between earlier and later cash payments that are described in Section 3.1. However, given that in our model individuals are endowed with non-linear CRRA preferences over consumption, part of this variation may also reflect heterogeneity across individuals in risk aversion. This highlights the importance here of having access to choices that only depend on risk aversion, but not on discount factors.

Finally, having identified the time and risk preference parameters from the choices described above, the expected future utility gains of accepting financial aid are identified from the choices between immediate cash payment and education financial aid that are modeled in Section 3.3. Specifically, under our parametric assumptions, the expected future utility gains associated with the various types of financial aid are identified using the variation in take-up rates across discount rates. Individual-specific discount rates effectively play the role of an exclusion restriction in this context, in that they only affect the choices through the future component of the utility. As such, aside from being of interest in its own right, the distribution of discount rates plays a crucial role in the identification of the willingness-to-pay for different financial aid packages.

5.2 Estimation

The model is estimated by maximum likelihood under the assumption that the error terms are independent across individuals and across questions, and identically

distributed within each group of equations following a normal distribution with mean zero. Under these assumptions and keeping the conditioning on background characteristics Z and numeracy score implicit, the log-likelihood is given by:[19]

$$\sum_{i=1}^{1,248} \sum_{q=1}^{96} Y_{iq} \log(Pr(Y_{iq} = 1)) + (1 - Y_{iq}) \log(1 - Pr(Y_{iq} = 1))$$

where for each group of questions the choice probabilities $Pr(Y_{iq} = 1)$, which are given in Equations (2), (3) and (6) above, take a probit form. Standard errors are estimated using bootstrap with 500 replications.[20]

6 Results

We present the estimation results as follows. The first part is devoted to the distributions of risk aversion and discount factors, and of the background consumption levels. The second part discusses the estimates of the expected future utility gain of accepting financial aid, for various types of financial packages. In the third part, we present the model fit. We introduce and discuss the willingness-to-pay for financial aid in Part 4, and then examine the implications of these results in terms of credit constraints. Finally, we investigate the relative importance of family background characteristics, individual skills as well as time and risk preferences as determinants of the willingness-to-pay for financial aid.

[19] In practice, the log-likelihood exhibits several local extrema. To overcome this difficulty, we use a multi-step procedure to derive starting values in the region of the global optimum. The first step consists of estimating risk aversion and background consumption parameters using the subset of questions designed to elicit risk preferences. Holding fixed those parameters, we then estimate individual discount rates using the time preferences questions. Finally, we estimate in a final step the future component of accepting the different types of financial aid using the school financing decisions. We use the outcomes of these three steps as starting values to estimate the full model via a single step maximum likelihood.

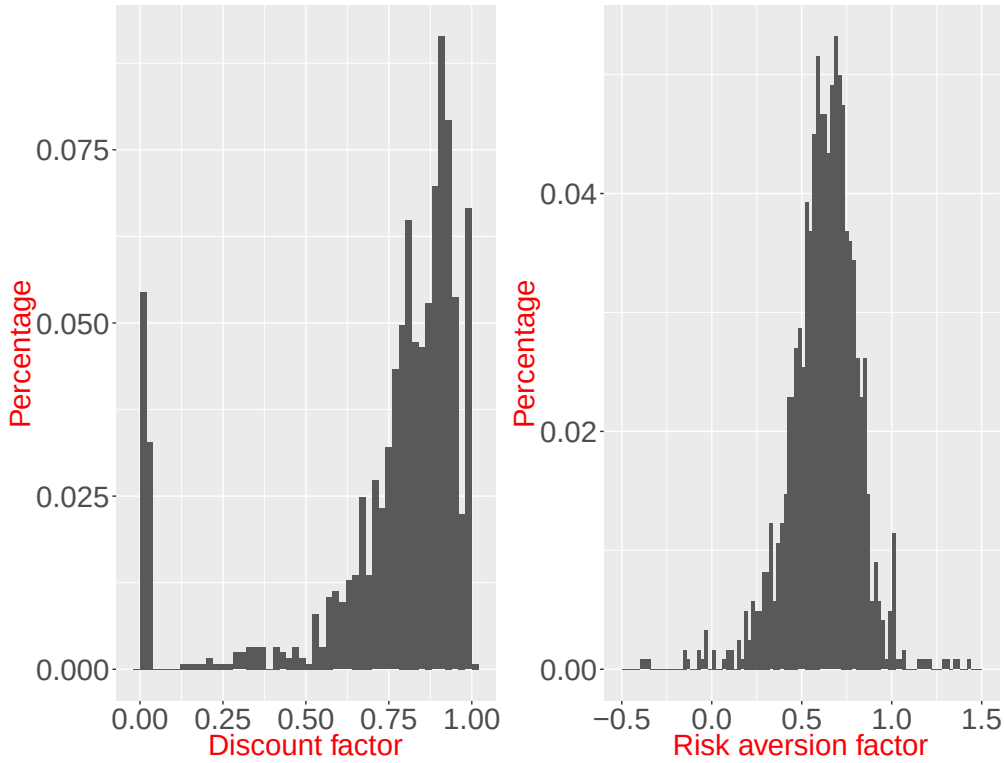
[20] Our framework corresponds to a binary choice panel data model with fixed effects, where the longitudinal dimension is given by the various questions q. Our MLE estimator is therefore in principle subject to the incidental parameter problem (Neyman and Scott, 1948). However, in practice we expect the incidental parameter bias to be small here given the large number of questions that we use in the estimation (96 overall for each individual).

6.1 The Distributions of risk aversion, discount factors and reference consumption

The empirical distributions of the estimated degrees of relative risk aversion, θ_i, and discount factors, β_i, are reported in Figure 3, while Table 1 describes the joint distribution of the estimated relative risk aversion parameters and discount factors. Starting with risk aversion, it is worth stressing that 97.2% of the estimated risk aversion parameters are significant at 5%, thus leading to the rejection of risk neutrality ($\theta = 0$) for the vast majority of the individuals in the sample. The distribution of risk aversion is skewed to the right and is characterized by a substantial degree of dispersion, as indicated by the inter-decile range (0.40 for the first decile and 0.85 for the last decile). Risk loving behavior ($\theta < 0$), however, is limited to 16 individuals out of 1248. The median of the estimated risk aversion parameters (0.64) fits in the range of the relative risk aversion parameters that have been estimated in the related literature on dynamic schooling choices. For instance, Keane and Wolpin (2001) estimate a smaller risk aversion coefficient (0.49), while Belzil and Hansen (2004) and Sauer (2004) find larger degrees of risk aversion (0.93 and 0.77, respectively). Particularly relevant for us is the paper by Brodaty et al. (2014), who, unlike the previous studies, estimate a dynamic model of schooling decisions allowing for heterogeneous degrees of relative risk aversion across individuals. In their paper, the estimated risk aversion coefficients range between 0.6 and 0.9. Our estimates exhibit a larger degree of heterogeneity across individuals, which may be partly due to the fact that we estimate the risk aversion parameters more flexibly than Brodaty et al. (2014) who assume the existence of a small number of heterogeneity types.

Turning to the time preferences, the discount factors are also found to be highly heterogeneous across individuals. The distribution is skewed to the left with its median (0.83) being larger than its mean (0.75). The empirical distribution of discount factor is essentially bimodal, with around 10% of our sample having an estimated discount rate lower than 0.33, while another 40% of the sample has discount rate higher than 0.87. This points to the co-existence of a myopic subpopulation and a set of forward-looking individuals endowed with large discount

Figure 3: Histogram of the risk aversion and discount factors



Notes: (i) The range of the risk factor has been restricted from -0.5 to 1.5 to improve display, excluding a total of 24 individuals. (ii) The binwidth has been set to 0.02.

Table 1: Discount factor and risk aversion

	Discount Factor	Risk Aversion
Min	0.00	-1.60
1st De.	0.33	0.40
1st Qu.	0.72	0.52
40th Cent.	0.80	0.60
Median	0.83	0.64
Mean	0.75	0.73
Sd	0.27	1.00
60th Cent.	0.87	0.68
3rd Qu.	0.91	0.75
9th De.	0.96	0.85
Max	1.00	16.82
Correlation	-0.14	

Table 2: Background consumption

	Discount Questions	Risk Questions	Financial Questions
Mean	3.21	0.58	237.30
Sd	36.37	1.02	274.75

factors of about 0.9.

The distribution of discount rates is difficult to compare to the rest of the literature for two main reasons. First and foremost, most of the relevant literature has focused on estimating a unique discount factor for a given population (see e.g. Frederick et al., 2002). Second, most estimates in the literature such as Andersen et al. (2008) have been obtained for different population, typically university undergraduates or older. Nonetheless, it is interesting to note that our mean value matches that of Andersen et al. (2008) who report, using data from a field experiment conducted in Denmark, an estimate of 0.75 (under a risk neutrality assumption), while being lower than the value estimated under risk aversion (0.9).[21]

Our data also allows us to examine the joint distribution of risk aversion and discount factors. Table 1 reports a negative correlation (-0.14, significant at 1%) between the discount rate and relative risk aversion. In the experimental economics literature, risk and time preferences are generally not elicited jointly and for this reason there exists to our knowledge very few estimates of the correlation between risk aversion and discount factors. A notable exception is Andersen et al. (2008), who discuss the bias affecting discount factor estimates when individuals are erroneously assumed to be risk neutral, and show that the joint elicitation of risk and time preferences result in lower discount rates estimates. Andersen et al. (2008) consider the joint distribution of risk aversion and discount rates using a parametric model in which both risk aversion and discount rates depend on observed heterogeneity and an orthogonal unobserved heterogeneity term. Consistent with our results, they report a weak positive correlation between risk aversion and impatience.

Finally, in our model, the level of background consumption allows us to capture differences in consumption levels due to heterogeneity in family background. As discussed earlier, background consumptions are allowed to differ across groups of questions as well. Our estimates indicate that the consumption levels that are

[21] Some of the papers estimating dynamic models of schooling decisions also attempt to estimate the discount factor. Notably, Keane and Wolpin (1997) estimate a discount factor (0.85) that is very close to the median of our estimated distribution (0.83).

used to evaluate cash payments differ markedly across questions. For example, the mean reference consumption is around $3 for discount rate questions, 50 cents for relative risk aversion choices, and $237 for financial aid questions. The background consumption levels for the financial aid questions are also highly dispersed across individuals.

Having estimated the time and risk preferences for each individual in the sample, it is interesting to examine whether these parameters could be predicted by standard background characteristics. Table 3 below reports the results from a linear regression of the (estimated) individual specific degrees of relative risk aversion and discount factors on a set of socio-economic background and demographic characteristics. The main takeaway from this table is that those characteristics only account for a small fraction of the variation in risk aversion parameters and discount factors, the R^2's for both regressions being low (0.016 and 0.085, respectively). Nonetheless, it is worth noting that females are significantly more risk averse and less forward looking than males. Immigrants also tend to be less forward looking, while children of college educated parents have a lower degree of risk aversion, although the coefficient is only significant at the 10% level. Finally, residents of Saskatchewan, which is the poorest region in the sample, have significantly lower discount rates.

At any rate, these results show that discount rates and risk aversion parameters are economic primitives which are mostly left unexplained by standard background and demographic characteristics. To the extent that, as discussed in Section 6.3.4, discount rates and risk aversion play a dominant role in explaining the willingness-to-pay for financial aid, this highlights the importance of eliciting those preference parameters.

6.2 The expected future gain of financial aid

To consider the relevant decision variable between cash payment and financial aid, Table 4 compares the distribution of the expected discounted future utility gain against the period 0 utility of accepting a cash payment, for various types of financial aid packages and three different cash payments. Period 0 utility gains of accepting a cash payment (denoted by $\Delta(.)$) are evaluated as the difference in the initial period utility of consumption evaluated at the reference consumption level (c_i) plus a cash payment, and the initial period utility evaluated at the reference consumption level.

First, as expected, for a given amount of financial aid, the median value of a grant exceeds the value of a loan. The median future utility gain of a $1,000 grant is more than 5 times as high as the expected utility gain of a $1,000 loan, while the median gain associated with a $2,000 grant is 6 times as large as the expected gain of a $2,000 loan. More generally, the distribution of the discounted expected future utility gains for a grant first-order stochastically dominates that of the expected future gains for a loan. Second, the utility gain associated with a grant increases with its size, with the the distribution of the utility gains of a $2,000 grant dominating that of a $1,000 grant. A similar pattern holds for loans. This result shows that, in most parts of the distribution, the interest costs are not high enough to make a $2,000 loan less attractive than a $1,000 loan. Finally, the discounted expected future utility gains of the financial aid packages are highly heterogeneous across individuals, with the ratio of interdecile range over the median ranging from 1.1 (for a $2,000 grant) to as much as 2.9 (for a $1,000 loan).

We now turn to the utility gains of accepting a cash payment. The distributions of the utility gains associated with a $300 and $700 cash payments dominate that of both types of loans. This is also true throughout most of the distribution of the utility gains associated with a smaller $100 cash payment. The sign of the value of immediate cash versus grant varies across the distribution, with the median utility gain of accepting a $700 cash payment ranging between the median gain of a $1,000 grant and that of a $2,000 grant.

Taken together, these results already provide suggestive evidence that the

Table 3: Understanding individual preferences

		Regression	
		β	θ
	Const	0.685^{***}	0.857^{***}
		(0.042)	(0.162)
Parental	Drop-out	Ref.	Ref.
Education	High-school	0.018	-0.157
		(0.030)	(0.116)
	Vocational College	0.009	-0.080
		(0.038)	(0.149)
	College	0.034	-0.189^{*}
		(0.028)	(0.110)
Parental	0-20K	Ref.	Ref.
Income	20-40K	0.023	0.202
		(0.037)	(0.144)
	40-60K	0.034	0.074
		(0.035)	(0.135)
	60-80K	-0.030	0.104
		(0.036)	(0.142)
	80-100K	0.020	0.142
		(0.037)	(0.144)
	+100K	0.030	0.157
		(0.036)	(0.139)
	Rural	0.043^{**}	-0.101
		(0.021)	(0.081)
	Female	-0.076^{***}	0.118^{**}
		(0.015)	(0.057)
	Immigrant	-0.141^{***}	0.191
		(0.031)	(0.121)
Province	Ontario	Ref.	Ref.
	Quebec	0.002	-0.047
		(0.019)	(0.075)
	Manitoba	-0.005	-0.060
		(0.021)	(0.082)
	Saskatchewan	-0.123^{***}	0.107
		(0.026)	(0.103)
	R^2	0.085	0.016
	Num. obs.	1,248	1,248

Notes: (i) Least Squares Weighted by the inverse of the standard deviation of the estimated parameters. ii) $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table 4: Utilities of consumption and expected discounted future gain of financial aid

	$\Delta(c_{100})$	$\Delta(c_{300})$	$\Delta(c_{700})$	$\beta\psi(\ell_{1000})$	$\beta\psi(\ell_{2000})$	$\beta\psi(g_{1000})$	$\beta\psi(g_{2000})$
Min	0	0	0	0	0	0	0
1st De.	32	83	157	2.8	2.8	47	96
1st Qu.	48	122	223	15	19	148	237
40th Cent.	58	144	260	29	36	186	282
Median	66	156	280	40	50	206	305
Mean	74	167	303	62	68	210	301
Sd	144	152	282	144	142	167	190
60th Cent.	73	173	305	55	64	227	330
3rd Qu.	84	198	345	77	86	263	370
9th De.	103	229	407	117	122	321	438
Max	4281	4282	7599	3048	3014	3214	3448

Notes: (i) $\Delta(c_x) = u(c_i + x) - u(c_i)$, (ii) $\beta\psi(\ell_{1000})$ (resp. $\beta\psi(\ell_{2000})$) denotes the expected discounted future utility gain associated with a \$1,000 (resp. \$2,000) loan, (iii) $\beta\psi(g_{1000})$ (resp. $\beta\psi(g_{2000})$) denotes the expected discounted future utility gain associated with a \$1,000 (resp. \$2,000) grant.

willingness-to-pay for financial aid packages is heterogeneous across high school students. However, our estimates allow us to go beyond the marginal distributions of utility gains associated with cash payments and financial aid, and directly compute individual-specific willingnesses-to-pay for the different types of financial aid packages that are proposed in the experiment. We report and discuss the estimated distributions of the willingness-to-pay for various types of financial aid packages in Section 6.3.

6.3 Borrowing constraints and the value of financial aid

6.3.1 Measurement

In the paper we combine the observed choices between cash transfers and financial aid packages with our model to evaluate the monetary values associated with the option to take-up the various types of financial aid. Before doing so, it is important to examine the ability of our model to fit the financial aid decisions from the experiment. Table A5 in Appendix C reports the empirical frequencies of financial aid acceptance and the predicted probabilities, for each of the 17 financial choices to exercise. Our model generally fits the data reasonably well, with a couple of

exceptions. Most notably, we overestimate the take-up rates of \$1,000 grant and of the hybrid package (\$1,000 loan and \$1,000 grant) against \$700 cash payment, while we underestimate the relatively high take-up rates for \$2,000 loans against \$25 cash payment.

In the following, we estimate individual-specific values of each type of grant, loan and hybrid loan that are proposed in the context of the experiment. Put into a public policy perspective, these estimates can be interpreted as uncovering the willingness-to-pay for a counterfactual expansion in higher education financial aid offers. In the following we pay specific attention to the willingness-to-pay for loans, which are a natural measure of the tightness of individual borrowing constraints. While constrained students may attach a significant value to the opportunity of taking-up a loan at the market rate, unconstrained students should only attach small or negligible values to those redundant opportunities.

Let c_{iq}^m be the incremental level of consumption that makes individuals indifferent between current consumption $(c_i + c_{iq}^m)$ and the financial aid package at question q. For such a value, we have

$$u(c_i, \theta_i) + \beta_i \psi_{iq} = u(c_i + c_{iq}^m, \theta_i) \tag{8}$$

After a few steps of algebra, we obtain:

$$c_{iq}^m = \begin{cases} \exp\left(\frac{1}{1-\theta_i} \log\left((1-\theta_i)\beta_i \psi_{iq} + c_i^{1-\theta_i}\right)\right) - c_i & \text{if } \theta_i \neq 1 \\ \exp\left(\beta_i \psi_{iq} + \log(c_i)\right) - c_i & \text{if } \theta_i = 1 \end{cases} \tag{9}$$

c_{iq}^m is the maximum consumption increase that one would be willing to trade in order to secure the financial aid package. In the following we use c_{iq}^m as our individual-specific measure of the willingness-to-pay for the financial aid package offered in question q.

6.3.2 Willingness-to-pay for financial aid

In Table 5, we report various quantiles of the distributions of the willingness-to-pay for the three types of financial aid packages (loan, grants and hybrid loans) of sizes

$1,000 and $2,000, respectively. Our results indicate that the median high school student would be willing to forego a $58.6 increase in current consumption to secure a $1,000 loan at the market interest rate in the near future. This corresponds to a non-trivial 6% of the principal of the loan. The willingness-to-pay for a $1,000 loan is highly heterogeneous across students, with an interdecile range equal to $180. While a quarter of the students are willing to sacrifice more than $116 for the option to take-up a $1,000 loan, students in the bottom quartile are only willing to sacrifice less than $20. In the next subsection we will examine how much of this heterogeneity is attributable to risk and time preference parameters, skills, as well as family background, socio-economic and geographical characteristics.

Table 5: The distribution of willingness-to-pay

Quantiles	$1000			$2000		
	Loan	Grant	Hybrid	Loan	Grant	Hybrid
1st Decile	4.257	50.81	55.43	5.948	128.4	118
1st Quart.	20.29	245.4	239.7	33.55	458.6	359.1
Median	58.58	396.1	372.2	82.26	678.4	504.7
3rd Quart.	116	556.1	509.1	141.7	923.1	664.2
9th Decile	183.9	721.8	649.8	207.9	1199	828.1

Note: Amounts are in Canadian dollars.

Put into a public policy perspective, the value of a grant is equivalent to a tuition reduction, or a higher education subsidy. Not surprisingly, the value of a grant is typically much larger. The median student would be willing to trade in $396 increase of their current consumption for the option to take-up a $1,000 grant. Contrary to loans, only a small proportion of the population attaches low values to grant availability. For instance, less than 10% of the students would sacrifice less than $50 for a $1,000 grant, while around half of them would do so for a $1,000 loan. More generally, for both amounts of financial aid ($1,000 and $2,000), the distribution of the willingness-to-pay for a grant stochastically dominates that of a loan.

Turning to the hybrid packages, adding a loan to a grant generally has a small

negative impact on the value of the package. This pattern holds true in most parts of the distributions of the willingness-to-pay. In practice, taking-up a hybrid loan involves taking-up both the grant and the loan components of the package. As a result, how much students are willing to trade for a hybrid package versus a single grant depends on the incremental value of a loan, as well as on the interest cost associated with it. Our results suggest that, in this context, the latter effect dominates. At any rate, this provides additional evidence that our model fits the descriptive patterns previously reported in Section 2, Figure 2.

Finally, for loans, grants as well as hybrid loans, the value of the package generally increases with the size of the financial aid. Specifically, the distribution of the willingness-to-pay for a $2,000 loan (grant) stochastically dominates that of a $1,000 loan (grant), while a ($2,000 loan, $2,000 grant) hybrid loan also dominates that of a ($1,000 loan, $1,000 grant) hybrid loan. In particular, the results for loans provide suggestive evidence that, at least for a subset of the students in the sample, getting access to a $1,000 loan is not enough to remove higher education credit constraints.

In the following we re-express the current consumption increases that individuals are willing to trade to secure a $1,000 loan, as a fraction of their background consumption endowment. We report in Table 6 the shares of students who are willing to forego consumption increases ranging from 10% to 100% of their background consumption. We find that about 76% (39%) of the population would be willing to forego an increase in immediate consumption corresponding to 10% (50%) of their background consumption to secure a $1000 loan. Besides, our estimates indicate that as much as 18.7% of the population are willing to trade in an amount higher than their background consumption over a period of time in order to secure a $1,000 loan.

Overall, these results indicate that most of the students in our sample attach a non-trivial value to the option of taking-up higher education loans at the prevailing market interest rate. As such, they are consistent with the existence of credit constraints affecting a substantial share of high school students in Canada. Our estimates further show that a non-negligible fraction of high school students

Table 6: $1,000 loan valuation as a fraction of background consumption endowment

	Proportion of Background Consumption						
	0.1	0.2	0.5	0.6	0.8	0.9	1
Population Share	0.755	0.636	0.39	0.338	0.245	0.209	0.187

Reading: 0.755 is the share of the sample with a willingness-to-pay higher than 10% of their background consumption.

attach large values to the option to take up a college loan.[22] From a public policy standpoint, our findings indicate that expanding higher education financial aid may in fact be socially desirable in this context, in spite of the Canadian higher education system being already heavily subsidized.

Spatial heterogeneity Since the previous results hide substantial heterogeneity across locations, we also report them separately for different provinces. In Table 7 below, we report the distribution of the willingness-to-pay for a $1,000 loan, a $1,000 grant and a hybrid financial aid package containing a $1,000 loan and a $1,000 grant, separately for Ontario and Québec.[23] These two provinces, which are the most populated in Canada, are characterized by markedly different levels of tuition fees. Specifically, Québec has low average annual tuition ($2,180 over the period of interest), while Ontario has significantly higher tuition rates ($5,667 on average over the period of interest). Québec and Ontario do not only differ in terms of higher education tuition fees, but also in terms of financial aid generosity. The average amount of financial aid offers per student, as well as the fraction of the total financial aid that takes the form of grants is significantly higher in

[22] To the extent that some individuals in the sample are likely to have low, or even zero subjective probabilities of enrolling in college, our results effectively provide a lower bound on the value attached to financial aid expansion among those students who anticipate enrolling in higher education. In practice 9.6% of the individuals in the sample have refused all financial offers that included a grant, presumably indicating a very small subjective probability of attending higher education for those students.

[23] The willingness-to-pay for the hybrid financial aid package should naturally be compared with the valuation of a grant of $1,000 since the valuation of a single $1,000 loan is based on a higher effective tuition cost.

Québec than in Ontario.[24] For a Québec resident, the median value of securing a $1,000 loan is estimated to be $54. On the other hand, the median young Ontarians, who are faced with higher tuition rates, would pay a higher amount ($71). More generally, the distribution of the willingness-to-pay in Ontario dominates almost everywhere the distribution in Québec. For instance, at the third quartile, the values indicating the willingness-to-pay are equal to $137 for Ontario and $100 for Québec.

Students from Ontario also attach higher values to grants as well as hybrid loans than students from Québec. The median Ontarian high school student in our sample is willing to forego $458 to secure a $1,000 grant (45.8 cents per dollar), while the median student from Québec is willing to trade $360 against a $1,000 grant (36 cents per dollar). Differences for hybrid loans are of similar magnitude, with the median willingness-to-pay for a hybrid ($1,000 loan, $1,000 grant) package in Ontario being equal to $432, against $334 in Québec. These findings are consistent with the existence of significantly higher levels of (net) tuition fees in Ontario than in Québec.

Table 7: The distribution of the willingness-to-pay by province

	$c_i^m(\ell_{1000})$		$c_i^m(g_{1000})$		$c_i^m(\ell_{1000}+g_{1000})$	
	ON	QC	ON	QC	ON	QC
1st Qu.	28	22	310	226	300	214
Median	71	54	458	360	432	334
3rd Qu.	137	100	618	487	569	448

Notes: (i) QC: Quebec, ON: Ontario. ii) Amounts are in Canadian dollars.

6.3.3 Statistical decomposition

We now examine the determinants of the value attached to financial aid. Before estimating marginal effects, we evaluate the relative importance of the main

[24] For more details regarding financial aid parameters in Canada, see Belley et al. (2014).

components of the willingness-to-pay for financial aid, namely (i) preference parameters (risk aversion and discount factors), (ii) skills (numeracy test score), (iii) family background characteristics (parental income and education) and (iv) other socio-economic and geographical variables such as gender, province, an indicator for living in a rural area, and family composition.

Understanding the determinants of the willingness-to-pay for financial aid is important from a policy standpoint. Notably, if skills or family background characteristics play an important role in this decomposition then these results may provide some guidance regarding the optimal targeting of higher education financial aid opportunities. On the other hand, if most of the variation in willingness-to-pay is attributable to risk and time preferences, which are typically unobserved by the policy maker, then identifying who would benefit more from an expansion in higher education financial aid offers would prove much more challenging.

Our model being highly non-linear, there are multiple possible ways to decompose the willingness-to-pay. In the following we simply regress linearly the willingness-to-pay on various sets of characteristics. We then compute the adjusted coefficient of determination (Adjusted R^2) associated with each specification, and divide it by the Adjusted R^2 obtained when all four groups of determinants (i)-(iv) are included. The corresponding ratio can be interpreted as a measure of the relative importance of each group of variables.

As we did before, we focus our analysis on the willingness-to-pay for a \$1,000 loan and a \$1,000 grant. The decomposition results are reported in Table 8. We highlight two main takeaways. First, and as indicated by the ratios of adjusted R^2 (0.52 for loans and 0.61 for grants), time and risk preference parameters are more important than all other determinants taken together. As such, those are key factors underlying the value of higher education financial aid. This is true for both loans and grants. A second noteworthy finding is the low incremental explanatory power of numeracy test scores and parental background variables taken together.[25] For the case of a \$1,000 loan, the relative explanatory power

[25]Note that this holds true even though, as discussed earlier, background and demographic characteristics accounts for very little of the variation in time and risk preferences.

(computed as the ratio of adjusted R^2) increases by about 15% (from 0.52 to 0.60), while it increases by less than 7% only (from 0.61 to 0.65) for a \$1,000 grant. Overall, those results provide clear evidence that time and risk preference parameters play a key role in accounting for the variation across individuals in willingness-to-pay for financial aid. We report and discuss next the marginal effects associated with those preference parameters, as well as with the numeracy scores and background characteristics.

Table 8: Statistical decomposition

	$c^m(\ell_{1000})$				$c^m(g_{1000})$			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Ratio Adjusted R^2	0.52	0.52	0.60	1	0.61	0.61	0.65	1
Risk and Discounting	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual Skills		Yes	Yes	Yes		Yes	Yes	Yes
Parental education and income			Yes	Yes			Yes	Yes
Geography and Family structure				Yes				Yes

6.3.4 Explaining the willingness-to-pay

We now turn to the marginal effects of parental background variables and other observed attributes and preferences on the willingness-to-pay for financial aid. Those marginal effects are reported in Table 9 below for two types of financial aid packages, namely a \$1,000 loan and a \$1,000 grant.[26]

We first examine the effects of parental income. There is a large literature in economics on the relationship between parental income and schooling attainment (Heckman and Mosso, 2014). Economists have long been debating on the magnitude of the causal effects of parental income on educational outcomes, in particular

[26] All marginal effects are evaluated at the mean risk and time preference parameters.

Table 9: Explaining the willingness-to-pay

	$c_m(\ell_{1000})$	$c_m(g_{1000})$
θ	3.7^{***} (0.89)	6.03^{***} (0.13)
β	33.57^{***}(9.7)	49.6^{***} (10.3)
Numeracy	$-0.073^{**}(0.042)$	$0.75^{***}(0.14)$
0-20K	Ref.	Ref.
20-40K	$-1.1^{***}(0.23)$	$-0.38^{**}(0.19)$
40-60K	$2.4(0.3)^{***}$	$-0.69^{***}(0.13)$
60-80K	$-0.42^{**}(0.23)$	$2.5^{***}(0.41)$
80-100K	$-0.78^{***}(0.13)$	0.092(0.077)
+100K	0.13(0.072)	$-0.54^{***}(0.13)$
Drop-out	Ref.	Ref.
High-school	-0.64(0.14)	1.7(0.28)
Vocational College	0.59(0.59)	2.1(0.65)
College	-0.26(0.25)	0.7(0.32)
Ontario	Ref.	Ref.
Quebec	-0.58(0.12)	-0.2(0.054)
Manitoba	1.1(0.2)	1.7(0.26)
Saskatchewan	2.1(0.34)	-0.97(0.17)

college enrollment. Identifying those effects is a complicated task as family income is also likely correlated with individual abilities, as well as preferences for schooling. The experiment used in this paper allows us to go beyond evaluating the impact of parental income on schooling attainment as we can directly quantify how the willingness-to-pay for education financial aid, a measure that increases with the intensity of credit constraints, vary with family income. Doing so is also an important step towards evaluating the effectiveness of publicly provided financial aid policies that are meant to equalize opportunities across income groups. The results reported in Table 9 disclose the differences in willingness-to-pay across income classes, using as a reference those who earn $20,000 or less. The results indicate that the willingness-to-pay for a $1,000 loan is non-linear and non-monotonic as the highest willingness-to-pay is found for the $40,000-$60,000 income group. However, the marginal effects across income groups are very small. For instance, on average, young individuals raised in families earning $40,000-$60,000 would only be willing to pay $2.4 more for the option to take-up a $1,000 loan, relative the lowest income reference group. This is coherent with the very low explanatory power associated with parental education and income that has been documented earlier in Table 8. A similar pattern holds for grants. The highest willingness-to-pay for a $1,000 grant is found for students from the $60,000-$80,000 income group, who would pay only $2.5 more than those from the reference group. Consistent with the low explanatory power of those characteristics, the marginal effects of parental education on the willingness-to-pay for a $1,000 loan and a $1,000 grant are also generally very small.

The co-existence of positive and sizable values attached to loans and grants, documented in Section 6.3.2 (Table 5), with the quasi-independence of the willingness-to-pay with respect to parental income indicates two important features of the Canadian higher education financing system. First, the median Canadian high school student is not satiated with financial aid opportunities, and the marginal utility of financial aid is non-negligible. Second, it does appear that the higher education public policies in place in Canada are successful in equalizing the marginal utility of financial aid opportunities across various income groups, as differences in family income have pretty much no impact on the value that young individu-

als would attach to a counterfactual expansion in higher education financial aid opportunities.

Finally, as was already noted in the previous section, there is clear evidence that individual differences in the willingness-to-pay for financial aid are mostly explained by deep (time and risk) preference parameters. We now discuss their marginal effects.

The effect of the discount factor is easily predictable as the structure of the experiment implies that the benefit of financial aid can only be experienced in the future while the cash payment is practically immediate. Indeed, as shown in Table 9, the marginal effect of the discount factor on the willingness-to-pay for grants and loans is positive and significant, both statistically and economically. All else equal, increasing the discount factor by one standard deviation leads to a \$34 (\$50) increase in the willingness-to-pay for a \$1,000 loan (\$1,000 grant). This marginal effect is in particular much larger than any of the effects associated with a \$20,000 income differential.

However, the marginal effect of risk aversion on the willingness-to-pay for grants or loans is more intricate because risk aversion affects not only the value of accepting a cash payment but also the value of financial aid, with the effect of risk aversion on the value of financial aid being ambiguous.[27] Indeed, while high-school students who are more risk averse are also those who would benefit more from the consumption smoothing opportunity provided by financial aid, individuals who accept financial aid can only exercise the option to take-up a loan or a grant it if they end up enrolling in higher education. Those who are more risk averse and who are also not certain of entering higher education, or are not sure when they are likely to do so, will be particularly sensitive to the latter feature. As a consequence, it is in theory not possible to sign unambiguously the effect of risk aversion on the willingness-to-pay for financial aid. Because both individual-specific enrollment uncertainty and future parental transfers are unobserved in our context, our model is not capable of separating those two channels, and, while

[27] Although with CRRA preferences the effect of risk aversion on the marginal utility of immediate consumption is in theory ambiguous too, and depends on the level of background consumption, it is always negative in our case since the background consumption happens to be larger than 1 for all the individuals in the sample.

interesting, any discussion about their relative importance would lie beyond the scope of the paper. At this stage, we only note that the marginal effect of a one standard deviation increase in risk aversion on the willingness-to-pay for a $1,000 grant and a $1,000 loan are both positive (equal to around $4 for loans and $6 for grants), but are 8 to 10 times smaller than the marginal effects of discount factors.

7 Conclusion

In this paper, we estimate the distribution of the willingness-to-pay for higher education financial aid using data from a field experiment conducted in Canada where high school students had to choose between immediate cash payments and various types of higher education financing packages. Our simple model of financial aid acceptance decisions is based on an explicit trade-off between the increase in current utility following an immediate cash payment and the expected future gain associated with a specific financial aid package. As the experiment also allows us to estimate the distributions of individual risk aversion and discount factors, we are able to uncover how preference parameters for time and risk affect the willingness-to-pay for the various types of financial aids.

We find that the majority of students attach a sizable value to accessing student loans. The median student is willing to pay a 6% premium to secure a $1,000 loan set at the market rate of interest. Furthermore, our results indicate that close to 40% of the students would be willing to forego an increase in immediate consumption corresponding to half of their background consumption to get access to a $1,000 loan. Overall, these findings are coherent with the existence of credit constraints affecting a sizable share of the population of high school students.

Our results also disclose a large degree of heterogeneity in both risk aversion and discount rates. The majority of the students exhibit a mild degree of risk aversion, while the distribution of discount factors is bimodal with individuals with low discount factors coexisting with forward-looking individuals. These results are of interest in their own right, especially since the vast majority of the schooling choice literature abstracts from these sources of heterogeneity in individual choices. Interestingly, we find that the willingness-to-pay for financial

aid is dominated by individual preferences. The value of financial aid is found to increase strongly with individual discount factors. Risk aversion also has a positive but much smaller effect on willingness-to-pay. After conditioning on individual preferences, family background characteristics only play a relatively modest role in the decision to accept a financial aid offer.

Our findings suggest a number of avenues for future research. First, we believe that more effort should be devoted at eliciting time and risk preferences, and investigating the role of those preferences in educational financing decisions and schooling choices more broadly. Indeed, our results show that those preference parameters play a crucial role in financial aid acceptance decisions. Second, data availability has confined us to the analysis of financing decisions prior to actual college enrollment. It would be interesting to combine our educational financing experiment with observational data on actual educational outcomes to gain additional insights into the effects of improving higher education financing opportunities as well as about the economic interpretation of the positive correlation between parental income and higher education participation.

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A The Millenium Foundation Field Experiment on Education Financing

In this section, we provide additional details on the structure of the field experiment.

A.1 A Description of the experiment

All subjects were presented with the full set of decisions and are paid for one, randomly selected, at the end of the session. The subjects were informed that they would be paid for one decision, but they did not know which one at the beginning of the session. The questions can be split into three groups. First, young individuals must answer a set of questions aimed at measuring their rate of time preference. Table A1 illustrates the experiment where individuals are offered a choice between two payments of different values to be made at different points in time. This approach originally developed by Coller and Williams (1999), allows to evaluate each subject's willingness to forgo present consumption for future consumption, and provides a measure of discount rate.

A second set of questions relate to the measurement of risk attitudes. Students are presented with a sequence of binary choices between two lotteries in which risk is objectively stated. Table A2 presents the two strategies used for eliciting risk aversion. Both strategies consists of choosing between a lottery with average payoff and another one with extreme payoff, and identify the cutoff point where an agent switch from the average to the extreme lottery. The major difference between the two strategies lies in the fact that while the first one pins down a cut-off probability, the second identifies a cut-off payoff. These approaches pioneered by Holt and Laury (2002) are standard in the experimental literature to measure the degree of risk aversion.

The third group of questions, which constitutes the most original aspect of the field experiment, is a sequence of choices between a cash payment to be paid within one week from the day the experiment was carried, and the option to use a specific financial aid package covering educational expenses. The financial aid

Table A1: Payoff Table for Measuring Discount Rates

Choice 1		Choice 2		
Payment 1 day	Payment 1 month	Payment 1 day	Payment 1 year	Annual Interest(%)
$ 75	$ 75.31	$ 75	$ 78.75	5
$ 75	$ 75.63	$ 75	$ 82.5	10
$ 75	$ 76.25	$ 75	$ 90.00	20
$ 75	$ 78.13	$ 75	$ 112.5	50
$ 75	$ 81.25	$ 75	$ 150.0	100
$ 75	$ 87.5	$ 75	$ 225.0	200
Choice 3		Choice 4		
Payment 1 week	Payment 1 month + 1 week	Payment 1 week	Payment 1 year + 1 week	Annual Interest(%)
$ 75	$ 75.31	$ 75	$ 78.75	5
$ 75	$ 75.63	$ 75	$ 82.5	10
$ 75	$ 76.25	$ 75	$ 90.00	20
$ 75	$ 78.13	$ 75	$ 112.5	50
$ 75	$ 81.25	$ 75	$ 150.0	100
$ 75	$ 87.5	$ 75	$ 225.0	200

Table A2: Risk aversion lotteries

Panel 1: Moving probability Lotteries

			Choice 1		Choice 2		Choice 3	
			L= 32	L=2	L=24	L=1.5	L=40	L=2.5
			H=40	H=77	H=30	H=57.75	H=50	H=96.25
	Prob L	Prob H	$\mathbb{E}V$	$\mathbb{E}V$	$\mathbb{E}V$	$\mathbb{E}V$	$\mathbb{E}V$	$\mathbb{E}V$
1	0.90	0.10	32.80	9.50	24.60	7.12	41.00	11.87
2	0.80	0.20	33.60	17.00	25.20	12.75	42.00	21.25
3	0.70	0.30	34.40	24.50	25.80	18.38	43.00	30.63
4	0.60	0.40	35.20	32.00	26.40	24.00	44.00	40.00
5	0.50	0.50	36.00	39.50	27.00	29.62	45.00	49.38
6	0.40	0.60	36.80	47.00	27.60	35.25	46.00	58.75
7	0.30	0.70	37.60	54.50	28.20	40.88	47.00	68.12
8	0.20	0.80	38.40	62.00	28.80	46.50	48.00	77.50
9	0.10	0.90	39.20	69.50	29.40	52.12	49.00	86.88
10	0.00	1.00	40.00	77.00	30.00	57.75	50.00	96.25

Panel 2: Fixed probability Lotteries

L	H	$\mathbb{E}V$	L	H	$\mathbb{E}V$	L	H	$\mathbb{E}V$	L	H	$\mathbb{E}V$
Choice 1			Choice 2			Choice 1			Choice 2		
48	48	48	40	64	52	18	90	54	8	104	56
40	64	52	32	80	56	8	104	56	0	112	56
32	80	56	24	96	60	42	42	42	36	60	48
24	96	60	16	112	64	36	60	48	30	78	54
16	112	64	8	120	64	30	78	54	24	96	60
48	48	48	42	66	54	24	96	60	18	114	66
42	66	54	36	84	60	18	114	66	10	122	66
36	84	60	30	102	66	54	54	54	44	68	56
30	102	66	24	120	72	44	68	56	34	82	58
24	120	72	16	128	72	34	82	58	24	96	60
48	48	48	38	62	50	24	96	60	14	110	62
38	62	50	28	76	52	14	110	62	6	118	62
28	76	52	18	90	54						

Notes: (i) $\mathbb{E}V$ for expected value, L for Low payoff, H for High payoff. ii) Payoffs are in Canadian $. iii) Source: SRDC-CIRANO Field Experiment on Education Financing.

package is to be paid conditional on enrolling in a full-time program at any higher education institution in the country (within 2 years). Grants and loans are formally defined as follows.

- Grant: Educational grants will be disbursed if a participant enrolls in an institution for learning or training full time within two years from the date of experiment participation. The grant will cover direct and indirect costs related to the learning activity. For tuition fees, payments will be made directly to the education institution. Receipts will be required for the reimbursement of other costs.

- Loan: Educational loans will be disbursed if a participant enrolls in an institution for learning or training full time. These loans will be available up to two years from the date of the experiment. The loans are repayable upon the completion of the study or if the participant drops out of the program of study. The interest rate, which is the same as the one offered by the Canadian Federal Student Assistance program, is floating and is set at the prime rate (3.2% on average over the period of interest) plus 2.5%.

In total, we consider three different types of subsidies: Grants, Loans, and Hybrid Loans which incorporate both a loan and grant component. We use a total of 17 financial decisions, with 5 choices with a single Loan offer, 7 choices with a single Grant offer, and 5 Hybrid offers. These decisions are summarized in Table A3.

In monetary terms, cash alternatives varied from \$25 to \$700, while grants and loans varied from \$500 to \$4,000. The variations in cash, and in the nature and the size of financial aid packages have many advantages. For instance, for a given cash payment offered and manipulating the financial parameters, we can uncover the relative values of a grant and a loan. Suppose instead that the financial aid package is fixed, we can also reveal the willingness to pay for a specific package by manipulating the cash payment. At the outset, it should be clear that these amounts are quite sizeable. Over the period considered, a grant of \$2,000 in 2008 would have covered 65% of yearly fee at University of Western Ontario and Queen's

Table A3: Financial aid Lotteries

Type of package	Choices	Cash	Grant	Loan	Aid Take-up
	1	25	0	2,000	0.458
	2	300	0	2,000	0.171
Single Loans	3	700	0	2,000	0.051
	4	300	0	1,000	0.109
	5	300	0	4,000	0.283
	6	25	1,000	1,000	0.834
	7	300	1,000	1,000	0.637
Standard Hybrid	8	700	1,000	1,000	0.389
	9	300	400	400	0.287
	10	300	2,000	2,000	0.727
	11	25	1,000	0	0.886
	12	100	1,000	0	0.826
	13	300	1,000	0	0.686
Single Grants	14	700	1,000	0	0.412
	15	300	500	0	0.384
	16	300	2,000	0	0.764
	17	300	4,000	0	0.835

Notes: i) Amounts are in Canadian dollars, ii) Source: SRDC-CIRANO Field Experiment on Education Financing.

University, and almost 100% at McGill University and Université de Montréal.[28] In addition, although tuition fees at vocational college are more dispersed, they are also subject to the same regulation and are therefore comparable to those of universities.[29] Put in 2015 Canadian dollars, the total cost of the experiment is around $1,000,000.

The sample was recruited to generate meaningful comparisons by population group, gender, and low-, medium- or high-income status. The original project design called for a minimum sample size of 1,000 urban respondents with the goal of 200 participants per group of interest, with a total sample of 1,248 individuals. Table A4 briefly summarizes the number of participants in several groups of interest.

Over the day of the experiment, a numeracy test provided by the Center for Education Statistics was administered to all students. The test was based on the numerical component of the International Adult Literacy and Skills Survey project undertaken by numerous OECD countries between 1995 and 2005. The questions are meant to capture the capacity to perform numerical calculations.[30] Students received a score between 0 and 500, which we use in the following as a cognitive ability measure. In our empirical application, individual numeracy test score has been scaled to have variance one, and the mean is 5.1.

While there exist no official published statistics on the fraction of the population of high school seniors who attend post-secondary education, descriptive statistics for older cohorts (those born around 1980) indicate that around 75% and 85% of those who graduate from high school (depending on the province) participate in post-secondary education. As this fraction is likely to have increased between 1998-1999 and 2008-2009, our fraction of young individuals who never take up any loan or any grant, which is equal to 9.6%, points toward the overall representativity of our sample of participants.

[28] Those universities are representative of the Canadian Elite schools.
[29] See Council of ministers of education of Canada.
[30] More details can be found in Murray, Clermont, and Binkley (2005).

Table A4: Descriptive statistics of the sample

Parent's	Drop-out	0.08
Education	High-school	0.25
	Vocational College	0.07
	College	0.61
Parent's	0-20k	0.05
Income	20-40k	0.13
	40-60k	0.23
	60-80k	0.19
	80-100k	0.15
	+100K	0.24
Location	Urban	0.80
	Rural	0.20
Province	Quebec	0.30
	Ontario	0.29
	Manitoba	0.28
	Saskatchewan	0.13
Citizen	Native	0.94
	Immigrant	0.06
Gender	Male	0.46
	Female	0.54

Source: SRDC-CIRANO Field Experiment on Education Financing.

B Parametrization

$$
\begin{aligned}
c_i^a &= c_0 + c_1 \mathbb{1}^p_{\text{High-school}} + c_2 \mathbb{1}^p_{\text{Voc college}} + c_3 \mathbb{1}^p_{\text{College}} \\
&+ c_4 \mathbb{1}^p_{\text{20-40K}} + c_5 \mathbb{1}^p_{\text{40-60K}} + c_6 \mathbb{1}^p_{\text{60-80K}} + c_7 \mathbb{1}^p_{\text{80-100K}} + c_8 \mathbb{1}^p_{\text{+100K}} \\
&+ c_9 \mathbb{1}_{\text{Quebec}} + c_{10} \mathbb{1}_{\text{Ontario}} + c_{11} \mathbb{1}_{\text{Saskatchewan}} + c_{12} \mathbb{1}^p_{\text{Rural}} \\
&+ c_{13} \mathbb{1}^a_{\text{Female}} + c_{14} \mathbb{1}^a_{\text{Citizenship}} + c_{15} \mathbb{1}^a_{\text{Siblings -18 years}} + c_{16} \mathbb{1}^a_{\text{Siblings +18 years}}
\end{aligned} \tag{10}
$$

$$
\begin{aligned}
\psi_{iq}(g_q, \ell_q) &= \psi_0 + \psi_1 g + \psi_2 g^2 + \psi_3 \ell + \psi_4 \ell^2 + \psi_5 \ell \times g \\
&+ \psi_6 \beta + \psi_7 \theta + \psi_8 \beta \times g + \psi_9 \theta \times g + \psi_{10} \beta \times \ell + \psi_{11} \theta \times \ell \\
&+ \psi_{12} \text{NU} + \psi_{13} \text{NU}^2 + \psi_{14} \text{NU} \times \beta + \psi_{15} \text{NU} \times \theta, \text{NU} \times g + \psi_{16} \text{NU} \times \ell \\
&+ \psi_{17} \mathbb{1}^p_{\text{20-40K}} + \psi_{18} \mathbb{1}^p_{\text{40-60K}} + \psi_{19} \mathbb{1}^p_{\text{60-80K}} + \psi_{20} \mathbb{1}^p_{\text{80-100K}} + \psi_{21} \mathbb{1}^p_{\text{+100K}} \\
&+ \psi_{22} \mathbb{1}^p_{\text{High-school}} + \psi_{23} \mathbb{1}^p_{\text{Voc college}} + \psi_{24} \mathbb{1}^p_{\text{College}} + \psi_{25} \mathbb{1}_{\text{Quebec}} + \psi_{26} \mathbb{1}_{\text{Ontario}} + \psi_{27} \mathbb{1}_{\text{Saskatchewan}} \\
&+ \psi_{28} \mathbb{1}_{\text{QC}} \frac{g}{2180} + \psi_{29} \mathbb{1}_{\text{ON}} \frac{g}{5667} + \psi_{30} \mathbb{1}_{\text{SK}} \frac{g}{5064} + \psi_{31} \mathbb{1}_{\text{QC}} \frac{\ell}{2180} + \psi_{32} \mathbb{1}_{\text{ON}} \frac{\ell}{5667} + \psi_{33} \mathbb{1}_{\text{SK}} \frac{\ell}{5064} \\
&+ \psi_{34} \mathbb{1}^p_{\text{20-40K}} \times g + \psi_{35} \mathbb{1}^p_{\text{40-60K}} \times g + \psi_{36} \mathbb{1}^p_{\text{60-80K}} \times g + \psi_{37} \mathbb{1}^p_{\text{80-100K}} \times g + \psi_{38} \mathbb{1}^p_{\text{+100K}} \times g \\
&+ \psi_{39} \mathbb{1}^p_{\text{20-40K}} \times \ell + \psi_{40} \mathbb{1}^p_{\text{40-60K}} \times \ell + \psi_{41} \mathbb{1}^p_{\text{60-80K}} \times \ell + \psi_{42} \mathbb{1}^p_{\text{80-100K}} \times \ell + \psi_{43} \mathbb{1}^p_{\text{+100K}} \times \ell \\
&+ \psi_{44} \mathbb{1}^p_{\text{20-40K}} \times \theta + \psi_{45} \mathbb{1}^p_{\text{40-60K}} \times \theta + \psi_{46} \mathbb{1}^p_{\text{60-80K}} \times \theta + \psi_{47} \mathbb{1}^p_{\text{80-100K}} \times \theta + \psi_{48} \mathbb{1}^p_{\text{+100K}} \times \theta \\
&+ \psi_{49} \mathbb{1}^p_{\text{20-40K}} \times \beta + \psi_{50} \mathbb{1}^p_{\text{40-60K}} \times \beta + \psi_{51} \mathbb{1}^p_{\text{60-80K}} \times \beta + \psi_{52} \mathbb{1}^p_{\text{80-100K}} \times \beta + \psi_{53} \mathbb{1}^p_{\text{+100K}} \times \beta \\
&+ \psi_{54} \mathbb{1}^p_{\text{HS}} \times g + \psi_{55} \mathbb{1}^p_{\text{VC}} \times g + \psi_{56} \mathbb{1}^p_{\text{CO}} \times g + \psi_{57} \mathbb{1}^p_{\text{HS}} \times \ell + \psi_{58} \mathbb{1}^p_{\text{VC}} \times \ell + \psi_{59} \mathbb{1}^p_{\text{CO}} \times \ell \\
&+ \psi_{60} \mathbb{1}^p_{\text{HS}} \times \beta + \psi_{61} \mathbb{1}^p_{\text{VC}} \times \beta + \psi_{62} \mathbb{1}^p_{\text{CO}} \times \beta + \psi_{63} \mathbb{1}^p_{\text{HS}} \times \theta + \psi_{64} \mathbb{1}^p_{\text{VC}} \times \theta + \psi_{65} \mathbb{1}^p_{\text{CO}} \times \theta
\end{aligned} \tag{11}
$$

C Model fit

Table A5: Model Fit

Choices	Empirical Frequencies	Predicted Probabilities
c_{25} VS g_{1000}	0.899	0.886
c_{100} VS g_{1000}	0.837	0.827
c_{300} VS g_{1000}	0.64	0.687
c_{700} VS g_{1000}	0.28	0.413
c_{300} VS g_{500}	0.412	0.385
c_{300} VS g_{2000}	0.823	0.764
c_{300} VS g_{4000}	0.776	0.836
c_{25} VS ℓ_{2000}	0.632	0.458
c_{300} VS ℓ_{2000}	0.187	0.171
c_{700} VS ℓ_{2000}	0.042	0.05
c_{300} VS ℓ_{1000}	0.177	0.11
c_{300} VS ℓ_{4000}	0.28	0.284
c_{25} VS $\ell_{1000} + g_{1000}$	0.891	0.834
c_{300} VS $\ell_{1000} + g_{1000}$	0.603	0.637
c_{700} VS $\ell_{1000} + g_{1000}$	0.237	0.389
c_{300} VS $\ell_{400} + g_{400}$	0.35	0.288
c_{300} VS $\ell_{2000} + g_{2000}$	0.739	0.728

Note: c, g and ℓ stand for cash, grant and loan, respectively. For example c_{25} VS g_{1000} refers to the choice between \$25 cash and \$1,000 grant, while c_{25} VS $\ell_{1000} + g_{1000}$ refers to the choice between \$25 cash and the hybrid package (\$1,000 loan and \$1,000 grant).