Deciding under Doubt: A Theory of Risk Aversion, Time Discounting Preferences, and Educational Decision-making

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Abstract: We develop a rational choice model of educational decision-making in which the utility of educational choices depends on students' risk aversion and their time discounting preferences. We argue for the role of risk aversion and time discounting preferences in the choice of different tracks in secondary education and in mediating the impact of socioeconomic background on such choices. Enrolment decisions in Danish secondary education provide our empirical example, and the results are generally in line with the proposed theory in that (i) risk aversion deters students from choosing the academically challenging but economically rewarding academic track in secondary education, (ii) students with a low time discount rate are particularly likely to enter the academic track, and (iii) students from advantaged socioeconomic backgrounds are not affected by risk aversion when making educational decisions.

Introduction

In recent years, social stratification research has shown a renewed interest in the development of micro-level or behavioural models of educational decision-making, usually within a broadly defined rational choice framework (e.g. Gambetta, 1987; Breen and Goldthorpe, 1997; Goldthorpe, 1998; Morgan 2002, 2005; Hillmert and Jacob, 2003; Breen and Yaish, 2006). Although the phenomena to be explained continue to lie at the macro-level—notably the existence, extent, and persistence of inequalities in educational outcomes according to class, gender, ethnicity, and suchlike—this recent turn seeks to account for these inequalities by understanding educational decision-making among individuals and their families. Theoretically, this research sees individuals as forward-looking, attempting to make the best educational choices in the light of the expected costs and benefits of the available options. Empirically, this research treats educational decisions as a function of the expected costs and benefits of different educational options.

Although recent research that uses rational choice theory to explain educational inequality has yielded important new insights, much of it does not take into account several core aspects of rational choice theory. Notably, it frequently fails to consider students' risk aversion and time discounting preferences. In rational choice theory, the extent to which students are risk-averse and the weight they assign to future rather than immediate returns to educational decisions are key components in the utility they assign to different educational options and are assumed to be crucial for the decisions they make (Breen and Goldthorpe, 1997; Morgan, 2005). Yet, the theoretical and empirical implications of risk aversion and time discounting preferences for educational decision-making and inequality have been little explored. This article develops a theory of how risk aversion and time discounting preferences affect educational decision-making and applies it to the empirical case of track enrolment in secondary education in Denmark. The article uses Denmark as the empirical example because the Danish secondary education system is well suited to illustrate the

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ideas in our theory and because we have new data from this country, which include information on risk aversion, time discounting preferences, and choice of secondary education. However, our theoretical argument applies to most European educational systems that incorporate some form of tracking in secondary education.

We extend existing research in three ways. First, we propose a theory of educational decision-making that incorporates risk aversion and time discounting preferences. It builds on a rational choice framework in which individuals are assumed to be utility-maximizers who attempt to make the best educational decisions in light of the expected costs and benefits of different educational options. Compared with existing rational choice models, the novelty of our theory lies in its explicit incorporation of risk aversion and time discounting preferences as important aspects of the educational decision-making process.

Second, we extend our theory to the explanation of socioeconomic inequalities in educational decision-making by incorporating risk aversion and time discounting preferences as mediating factors underlying socioeconomic inequalities in educational decisions. We distinguish two mechanisms through which risk aversion and time discounting preferences may be linked to educational inequalities: socioeconomic mediation and socioeconomic heterogeneity. *Socioeconomic mediation* means that students with different socioeconomic backgrounds differ with regard to risk aversion and time discounting preferences, and furthermore, that these differences will partially account for baseline socioeconomic gradients in educational choices. *Socioeconomic heterogeneity* means that students with different socioeconomic backgrounds will differ in how much they are affected by risk aversion and time discounting preferences when making educational decisions. Students from privileged socioeconomic backgrounds, for example, may be less sensitive to risk aversion than students from non-privileged backgrounds because, irrespective of how risk averse they are, they almost always pursue academic education as a means of reproducing their privileged socioeconomic background (Breen and Goldthorpe, 1997; Breen and Yaish, 2006; Bernardi 2012). Descriptive results from Denmark are consistent with the socioeconomic heterogeneity mechanism because students from advantaged socioeconomic backgrounds are unaffected by risk aversion when choosing between different educational options, while those from less advantaged socioeconomic backgrounds are affected to a significant extent.

Third, as a first illustration of our theoretical model, we collected new data, which include direct measures of students' risk aversion and time discounting preferences.

Much previous research relies on revealed preference assumptions and hypothesizes that educational choices reflect utility-maximizing behaviour. Some empirical studies do include direct subjective measures of students' expected economic and other returns to education (Beattie, 2002; Stocké, 2007; van de Werfhorst and Hofstede, 2007; Gabay-Egozi, Shavit, and Yaish, 2010), or proxies for risk aversion such as the expected likelihood that an education can be successfully completed (Need and de Jong, 2001; Becker and Hecken, 2009; Tolsma, Need, and de Jong, 2010). Our measure of risk aversion, which is often used in experimental economics, uses respondents' answers to a hypothetical lottery to elicit information about their risk perceptions. Our measure of time discounting preferences refers to students' preferred earnings profiles when choosing between different jobs. Compared with those who are less risk-averse, we find that students who are more risk-averse are less likely to have chosen the academic track in upper secondary education over no education and vocational education. Similarly, students who assign more weight to higher economic returns in the future than to smaller returns in the present are more likely to have pursued the academic track rather than no education or vocational education. These findings are consistent with the basic ideas in our theoretical model.

Our article contributes to the growing body of work that seeks to develop rational choice models of educational decisions and which links these decisions to persisting socioeconomic inequalities in educational outcomes. We integrate elements of rational decision-making that have previously been neglected in the sociological literature on educational inequality, and we present descriptive evidence that they may indeed make a contribution to the generation of socioeconomic inequalities in educational decisions.

Theoretical Framework

Basic Model

Our model starts from the fact that at a certain branching point in the educational career students have to choose between several options. Focusing on educational decision-making beyond the elementary level of education (i.e., compulsory education), our model assumes that there are three options: choosing an academically oriented program (A), a vocationally oriented program (V), or leaving the educational system (L). We use the Danish secondary education system to develop our argument, but the distinction between academically and vocationally oriented programs exists in most European educational systems. Each alternative

A, V, and L yields a stream, over time, t, of potential future returns. We think of returns as principally economic, but other types of returns may also apply. However, returns depend on two things. First, they depend on the level of academic performance in academic, vocational, or elementary education, and we denote performance by a^j where j indicates academic, vocational, or elementary education. Thus, better academic performance in an educational track is expected to lead to higher future returns. Second, the returns will also vary according to what is usually termed 'the state of the world'. This means that returns will differ depending on factors such as the overall condition of the economy and on the fate of the jobs and occupations associated with a particular level of education. We denote these states by s_t, with the t subscript allowing the states to vary over time. We write the returns to a given level of education, j, in each time period, t, during the person's time in the labour market (which ends at $t = T$) as $S_j(t) = S_{j,t}(a^j, s_t, \varepsilon_j)$, where $S_{j,t}$ is a function that combines how well the student performs in a given level of education with the state of the world at time t and with a random component, ε, that captures variation in returns within an educational level among people with the same level of performance. We assume that ε has a zero mean and variance given by ω_j. The function, $S_{j,t}$, can itself differ according to the level of education and time period. The total return to education j, S_j, is the discounted sum of these single period returns minus the costs of completing that level of education:

$$S_j = \int_t e^{-rt} S_j(t) dt - c_j$$

The costs of education are denoted c_j, and the time discount rate, r. The time discount rate, which can differ between students, captures the extent to which students' value returns in the future compared with returns that are more immediate (Mischel, Shoda, and Rodriguez, 1989; Frederick, Loewenstein, and O'Donoughhue, 2002). For example, imagine that two types of educations have the same academic requirements and direct costs, but one program takes 3 years to complete and the other takes 4 years. Also, the 4-year program yields a slightly higher return than the 3-year program. Holding everything else constant (including the state of the world), a student with a high time discount rate (i.e. a student who prefers a lower return in the present compared with higher returns in the future) will assign higher utility to the 3-year program than to the 4-year program.

But students and their families do not know S_j: rather, we assume that they have a belief about it, $\bar{S}_j$, surrounded by uncertainty, σ_j^2. Students will differ among themselves in both $\bar{S}_j$ and σ_j^2, but the latter will always be driven by three basic sources of uncertainty: beliefs about ω_j (i.e. beliefs about the degree of within-educational level variation in returns among those with the same performance), uncertainty about future states of the world, s_t, and uncertainty about how the student will perform in education, a^j. But this latter source of uncertainty—performance uncertainty—applies only to academic or vocational education (i.e. a^A and a^V) because elementary education has already been completed and a^L is known. This means that choosing to remain in either academic or vocational education adds an element of uncertainty that is not present in the decision to leave school immediately (performance uncertainty is an important aspect of other rational choice models of educational decision-making, e.g. Breen and Goldthorpe, 1997; Stocké, 2007; Gabay-Egozi, Shavit and Yaish, 2010).

Individual students and their family choose whichever of A, V, and L they believe will yield the greatest utility, net of the costs of each alternative. The utility of the jth level of education can be written as following:

$$U_j = m\bar{S}_j - b\sigma_j^2, m > 0, b \geq 0 \qquad (1)$$

Utility from a given level of education is increasing in its expected real return and is either unaffected by or declining as the variance of beliefs about the returns gets larger.[1] The weights attached to the expected return and the variances are given by m and b, respectively, and we assume that m and b are such that utility is positive for all j. The more risk-averse a student is, the more the utility is affected by the variance relative to the mean and so the greater is b relative to m.

Our model expresses the student and their family's choices as a function of their beliefs, and there will, of course, be variation between families in their beliefs. For example, some students will have much higher expectations about their future academic performance than others, while some will expect to perform better in one kind of education than in the other. Similarly, they will also differ in their beliefs about what the future holds. We discuss below how we try to capture the sources of this variation. But our interest in this article is in the difference in choices that stem from individual differences in risk aversion and time discounting preferences rather than, for example, different expectations of educational success.

To summarize, our theoretical model incorporates *risk aversion* by allowing for the utility of an educational option to depend on the level of uncertainty in the expected return, and we incorporate *time discounting* by letting the utility depend on the student's time preferences. In the empirical example, we use observable

measures of risk aversion and time discounting preferences to infer about the role of these factors in educational decision-making.

Relative Risk Aversion

As it stands, our model assumes that the utility students assign to different educational options is independent of their socioeconomic background. However, previous rational choice models of educational decision-making argue that students have a desire to avoid downward social mobility (sometimes called the status maintenance or relative risk aversion mechanism: see Breen and Goldthorpe, 1997). Although this is not the main focus in the present article, we could incorporate the desire to avoid downward mobility into our theoretical model by including a term in the utility function for the different educational options that captures the weight students assign to avoiding downward social mobility. Let $W_j = 1$ if the jth level of education is sufficient to avoid downward social mobility and $W_j = 0$ if it is not. Then students seek to choose the level of education, j, that meets

$$\max_j (m\bar{S}_j - b\sigma_j^2)W_j \qquad (2)$$

The value of W for a given j will vary depending on socioeconomic origins and on individual preferences (Jæger and Holm, 2012).

Socioeconomic Mediation and Heterogeneity

Our model describes the utility of different educational choices from the perspective of the individual student and their family. However, we argue that risk aversion and time discounting preferences may also be directly related to inequalities in educational outcomes in two ways.

First, risk aversion and time discounting preferences may *mediate* the effect of socioeconomic background. This would be the case if socioeconomic background is related to risk perceptions and time discounting preferences, which, in turn, affect educational decision-making. Previous research finds that some types of subjective beliefs, linked to educational decisions, vary by social class background (Stocké, 2007; Gabay-Egozi, Shavit, and Yaish, 2010), so we would expect mediation to be of some significance. It might also be the case that risk aversion and time discounting preferences are, in fact, largely invariant between social classes (Van de Werfhorst and Hofstede, 2007). Below, we explore empirically socioeconomic gradients in risk aversion and time discounting preferences and the extent to which they mediate the effect of socioeconomic background on educational choices.

Second, risk aversion and time discounting preferences may have *heterogeneous effects* on educational decision-making, depending, for example, on the socioeconomic background of the student. This is the idea in the theory of relative risk aversion: students' schooling ambitions are defined in relative terms, based on the socioeconomic position of their parents (Breen and Goldthorpe, 1997). As a consequence, among students choosing between different educational options after elementary school, those from advantaged socioeconomic origins will almost always continue to the highest possible track (independently of academic performance and risk aversion). This choice affords the most direct route to higher education, and it is only by entering higher education that students from advantaged socioeconomic backgrounds may hope to avoid downward mobility. Students of more modest socioeconomic origins need less education to avoid downward mobility, which means that they have less incentive to pursue the academic track in secondary education compared with the vocational track or only compulsory education. A similar pattern can be expected to hold with regard to risk aversion and time discounting preferences. Students from advantaged socioeconomic backgrounds (and their families) will, given their overriding objective of avoiding downward mobility, choose academic secondary education, even if they are risk-averse or prefer short-term over long-term gains. Equation 2 formalizes this idea by letting utility of avoiding downward mobility vary by the student's socioeconomic background. In the empirical example, we analyse if the link between risk aversion/time discounting preferences and educational decisions varies by students' socioeconomic background.

Risk Aversion, Time Preferences, and Educational Decision-making

The key point in this article is that variation among students in the parameters m, b, and r is linked to educational decision-making. These parameters allow us to take into account variation among students in two subjective attributes: risk aversion (which is captured by the relative sizes of m and b) and time discounting preferences (captured in r). The greater the weight attached to b, relative to m, the more risk-averse the individual is. The other subjective attribute is time discounting preferences, and our model captures this through variation in r: students who attach little weight to the future have a larger absolute value of r. But how does risk aversion and time discounting preferences

affect the student's decision between the educational options A, V, or L?

With regard to *risk aversion*, it follows from our model that students who are more risk-averse will give greater weight, in their utility function, to the variance in expected returns, relative to the mean. All else equal, they will prefer less uncertainty in returns, captured by the variation in S_j over states, s, and less performance-based uncertainty in returns, captured by the variation in S_j over possible academic performance, a. Whether this increases their probability of choosing A or V, whose returns are likely to show less variation across different states of the world (as education protects against adverse labour market conditions), or their probability of choosing L, which entails no performance risk, will depend on their beliefs about how much of the variance in S_j derives from each of these two sources. Consequently, in our model, and depending on the student's beliefs, risk aversion could either increase or decrease the utility of choosing A or V over L. The reason why this is the case is that for individual students the risks associated with choosing A over L (performance risk in A and risks in any subsequent educational option) may outweigh the long-term benefits of A with regard to ensuring a high and stable return to education. Below, we explore these issues empirically. The same argument applies to choosing V over L, with the modification that performance risk and returns are lower in this case. With regard to choosing A over V, we apply a similar argument: A entails more performance risk than V (and a longer time horizon involving additional and risky educational decisions that are part of academic routes through education) but offers a higher expected return.

With regard to *time discounting*, it follows from our model that students who attach less weight to returns that will occur in the future, relative to the weight they attach to short-term returns, will be more likely to choose option L, which provides immediate (but lower) returns, relative to A or V whose returns are delayed (but higher). Furthermore, because, typically, returns are more delayed in A than in V (because of the greater length of the academic track and any subsequent higher education), we expect students who attach less weight to future returns to choose V over A.

Example Study: Educational Decision-making in Denmark

In the remainder of the aricle we provide descriptive evidence on several key mechanisms in our theoretical model. As an empirical example, we focus on the choice of secondary education in Denmark which is made when students are around 16 years old. The choice of secondary education in Denmark provides an interesting test case for our model because students face a choice between a vocational track (V) and an academic track (A), which are very different in terms of academic requirements, risk profile, time horizon, and likely economic returns. We analyse newly collected survey data that include empirical proxies for students' risk aversion and time discounting preferences, as well as information on educational choices, academic performance, and socioeconomic background.

In Denmark, compulsory education ends when students complete ninth grade of elementary school (usually around the age of 16 years). There is no tracking in elementary school. On completion of elementary school, students must choose between either leaving school or continuing in vocational or academic secondary education.

Vocational education (V) takes 3–4 years, with the student alternating between school-based training and working as an apprentice with an employer. Academic standards are comparatively low, and the student receives a salary while serving an apprenticeship. Long-term economic returns to vocational education are such that, on average, students can expect to end up in the middle of the income distribution (Christensen and Westergaard-Nielsen, 1999).

Academic secondary education (A) normally takes 3 years. The curriculum focuses on traditional academic subjects (science, foreign languages, history, etc.), and academic standards are fairly high. It is a prerequisite for admission to all types of higher education at university and University College, and the student's Grade Point Average (GPA) is the single most important factor determining eligibility for higher education. This means that academic secondary education represents a stepping stone to higher education, which, if completed successfully and coupled with a university degree, may yield comparatively high economic returns in the future (on average higher than those obtained from completing a vocational education; Christensen and Westergaard-Nielsen, 1999). However, academic secondary education is also risky because the student's GPA may be too low to ensure admission into the preferred field of study in higher education and because academic secondary education requires a commitment to a longer educational career.

We argue in our theoretical model that risk aversion might affect educational decisions in two different directions, depending on the relative weight of the m and b parameters in Equation 1. The potential economic returns are higher in A than in V or L, but the risks

(academic demands, risk of failure, longer time commitment, etc.) are also bigger. If, on average, students who are more risk-averse assign more weight to returns (m) than to risks (captured by the variance in returns, b), they will prefer A over V and L (and V over L). On the other hand, it may also be that more risk-averse students place greater emphasis on the risks associated with A relative to those associated with V and L, in which case they will prefer the less risky options V or L.[2] The latter scenario might be plausible in the Danish case because economic returns to higher education are lower in Denmark than in many other OECD countries (thus lowering m; Boarini and Strauss, 2010). Moreover, even though academic secondary education is universally required for admission to higher education, there is substantial variance in economic returns across different types of higher education (thus potentially increasing b).[3]

The predictions from our theoretical model regarding the role of time discounting preferences for educational decision-making are straightforward in the Danish case. We expect students who prefer a higher economic return in the future over a lower return in the present (i.e. students who have a low time discount rate) to prefer A over V and L and, moreover, V over L.

Data

We have collected new data in Denmark to analyse the basic claims of the theory we have developed. We gathered these new data in the context of the Danish Longitudinal Survey of Youth–Children (DLSY-C). The DLSY-C includes children of participants in a long-running cohort study, the Danish Longitudinal Survey of Youth (DLSY). Participants in the DLSY (3,151) were all born in or around 1954 and have been followed since 1968, and the DLSY-C samples all children born to all DLSY respondents. The DLSY-C data were collected in 2010, and mean age among respondents in the DLSY-C is 27.1 years (the response rate is 81 per cent; see Jæger, 2011). Because we study educational choices at around the age of 16 years, we restrict the DLSY-C sample to respondents aged 18 years and older. This restriction leaves a gross sample of 3,303 respondents. Table A1 summarizes descriptive statistics for all variables used in the analysis.

Choice of Secondary Education

In the DLSY-C, respondents provide information on their entire educational career up until the time of interview. Our outcome variable is the respondent's choice of secondary education at around the age of 16 years, and we distinguish between the following three options: (i) leave the educational system (L), (ii) enter vocational secondary education (V), and (iii) enter academic secondary education (A).

Risk Aversion

We measure risk aversion by means of a survey instrument developed in experimental economics. The respondent is presented with a hypothetical (or real) lottery in which the prize sum and probability of winning are known (Harrison, Lau, and Rutström, 2007; Harrison and Rutström, 2008). The respondent is asked the maximum she would pay for a ticket to this lottery, with the assumption being that the stated maximum or 'reservation price' for the lottery ticket elicits information about the respondent's fundamental risk perceptions.[4] In the DLSY-C, respondents were presented with the following hypothetical lottery: 'You get the opportunity to buy a lottery ticket. Ten people participate in the lottery, and the prize sum is DKK 20,000 (app. \$3,600/€2,700). The winner is drawn at random, so all participants have the same probability of winning. How much would you pay as a maximum for a ticket to this lottery?' In line with previous research, we convert respondents' stated reservation prices into the Arrow–Pratt measure of absolute risk aversion (ARA). ARA is defined as $ARA = (\alpha Z - \lambda)/(\lambda^2/2 + \alpha Z^2/2 - \alpha \lambda Z)$, where α is the probability of winning the lottery, Z is the lottery prize, and λ is the respondent's stated reservation price (Hartog, Ferrer-i-Carbonell, and Jonker, 2002). ARA has a straightforward interpretation because, in the hypothetical lottery, the probability of winning is 0.1 and the prize is DKK 20,000, which means that risk neutrality implies a reservation price of $0.1*20,000 = $ DKK 2,000. Thus, respondents who are risk-averse will have a reservation price of less than DKK 2,000, whereas risk-takers will have a reservation price above DKK 2,000.[5] In the empirical analysis, we standardize the ARA variable to make the scale of the variable easier to interpret.

Time Discounting Preferences

We measure time discounting preferences by means of an item in which respondents were asked to choose among three hypothetical jobs with different economic returns and time horizons. The DLSY-C respondents were asked: 'If you were offered three different jobs with different starting salaries, which one would you take?' The three alternatives are (i) a job with an average salary from the start, (ii) a job with a low salary for the first 2 years, then a high salary later on, or (iii) a job with a

very low salary for the first 4 years, then a very high salary later on. We use this variable because it asks respondents to choose between three employment options with clearly defined benefits (salary levels) and costs (time delay). We treat this variable as a continuous variable in all empirical analyses.[6]

Other Variables

We include two measures of socioeconomic background. First, we include father's education measured in five categories: (i) no education, (ii) vocational education, (iii) lower tertiary education (vocationally oriented education), (iv) University College, and (v) university.[7] These educational levels naturally fall into the following three main groups: no education beyond elementary school, vocational education (vocational education and short tertiary education), and higher education (University College and university). We also include a category for missing information on father's education. Second, we include the DLSY parent's monthly gross income in thousands of DKK in 1992 (either mother or father, depending on which parent took part in the DLSY study).[8]

We also include several control variables. First, we include a measure of academic performance in elementary school and a measure of cognitive ability. The measure of academic performance is the respondent's self-reported GPA from final exams taken at the end of elementary school (at around the age of 15–16 years). GPA is measured in six categories, with higher values indicating a higher GPA. The measure of cognitive ability is the respondent's score (0–20) on a subtest in the IST2000R, which is a general test of cognitive ability, very similar to the commonly used Raven Progressive Matrices test. Second, we include measures of the DLSY-C respondent's gender (female = 1, male = 0) and age in years, family situation (dummy variable for single-parent household), and number of siblings.

Analytical Strategy

We provide two sets of analyses to explore the predictions of our theoretical model.

First, we provide descriptive results on the link between risk aversion and time discounting preferences and educational decisions, and investigate how far they mediate the effect of socioeconomic background. Because, by virtue of the design of the DLSY-C, our indicators of risk aversion and time discounting preferences were collected after the respondents made their choice of secondary education, we are not able to make any claims about the causal effect of risk aversion and

time discounting preference on educational choices. We leave this type of analysis for future research. We use multinomial logistic regressions to model educational choices and use clustered standard errors to adjust for the presence of multiple siblings from the same family in the DLSY-C data.

Second, we extend the analysis of educational choices by running separate multinomial logistic regressions for students with different socioeconomic backgrounds (as captured by different levels of father's education and parental income). This analysis allows us to analyse whether the relationships between risk aversion/time discounting preferences and educational choices, which we observe in the baseline analyses, vary across socioeconomic backgrounds. In particular, we are interested in exploring whether students from privileged backgrounds are more or less sensitive to risk aversion and time discounting preferences than those from less privileged backgrounds.

Empirical Results

Table 1 shows results from descriptive multinomial logistic regressions predicting respondents' educational choices after elementary school. We estimate three models; a baseline model, which includes our measures of risk aversion and time discounting preferences only (model 1), and two full models, which also include the control variables (in model 2 the reference group is no education beyond elementary school, while in model 3 the reference group is vocational education). We report log-odds coefficients and average marginal effects.

The baseline model (1) shows that risk aversion and time discounting preferences are both statistically significantly correlated with the choice of secondary education. Adding the control variables to the model does not change results much. For risk aversion, we find that, compared with those who are less risk-averse (as measured by a low score on our ARA variable), respondents who are more risk-averse have a lower probability of having chosen academic secondary education over no education (model 2) and also a lower probability of having chosen vocational education (model 3). An increase of one standard deviation in our measure of risk aversion is associated with a decrease in the probability of having chosen the academic track over no education (or over the vocational track) by around 4 percentage points, holding other factors constant. Our theoretical model states that, compared with the other tracks, the utility of the academic track depends on the expected return in this track, minus the uncertainty arising from variance in returns. Our empirical results indicate that the combination of a

Table 1 Results from multinomial logistic regressions of educational choice. Log-odds, standard errors in parenthesis, and average marginal effects in brackets

Model Educational choice	Reference group: No Education				Reference group: vocational[a]
	1		**2**		**3**
	Vocational education	Academic education	Vocational education	Academic education	Academic education
Risk aversion[b]	−0.194*	−0.274***	−0.086	−0.316***	−0.230**
	(0.008)	(0.072)	(0.091)	(0.076)	(0.075)
	[0.003]	[−0.039]	[0.012]	[−0.042]	[−0.042]
Time discounting[b]	0.025	0.301***	−0.027	0.254***	0.280***
	(0.066)	(0.054)	(0.071)	(0.062)	(0.064)
	[−0.028]	[0.062]	[−0.020]	[0.040]	[0.040]
Control variables[c]	No		Yes		Yes
Pseudo R^2	0.020		0.221		0.221
Log likelihood	−2,416		−1,912		−1,912
Observations	2,843		2,843		2,843

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

[a]Results for contrast between vocational education and no education omitted because these results are reported in the models in which no education is the reference group.

[b]Variable is standardized.

[c]Control variables: GPA, cognitive ability, sex, age, father's education (including a dummy variable for missing data on father's education), parent's income, single parent family, and number of siblings. Standard errors corrected for clustering of respondents within families.

low rate of return to higher education in Denmark (which entails a low value of m) and high variance due to the academic track being the only gateway into many different types of higher education with different rates of return (thus, a high value of b) may deter risk-averse students from the academic track. In other words, in the Danish context, it seems that, for risk-averse students, the risks associated with the academic track (performance risk, long-term commitment, high variance in returns, etc.) outweigh the returns. For these students, the vocational track (or even leaving education) offers a more compelling mix of risks and benefits. We suspect results might be different in a context in which returns to education are higher (e.g., the United States or the United Kingdom), and in which case m is much higher.

In addition to risk aversion, we also find that respondents who express a low time discount rate (i.e., respondents who prefer a bigger economic reward in the future compared with a smaller reward in the present) are more likely to have chosen academic secondary education over no education (model 2) and vocational education (model 3). An increase of one standard deviation in our empirical measure of time discounting preferences is associated with an increase of about 4 percentage points in the probability of having chosen the academic track in secondary education over alternative options. This result is consistent with the predictions from our theoretical model in the sense that respondents who are willing to postpone (bigger) economic rewards

to the future have chosen the educational option, which offers the highest (but most delayed) return.

The empirical analysis illustrates the basic ideas in our theoretical model. We also argue that risk aversion may be linked to educational inequality through two mechanisms: socioeconomic mediation and socioeconomic heterogeneity. We address socioeconomic mediation by analysing whether the effects of the socioeconomic variables in the full model in Table 1 (father's education, parent's income, and single parent family) change in a statistically significant way when we include the measures of risk aversion and time discounting preferences in the model. We use the Karlson-Breen-Holm (KHB) method to equalize the scale of the log-odds coefficients in the two models and run formal tests for mediation effects (see Karlson, Holm, and Breen, 2012). Empirical analyses (details available upon request) show that our measures of risk aversion and time discounting preferences do not mediate the effects of the socioeconomic variables on educational choices. Thus, the reasons why students from privileged socioeconomic background fare better in the educational system than those of less privileged backgrounds appear not to be related to socioeconomic gradients in risk perceptions and time preferences.

Finally, we address socioeconomic heterogeneity in the relationship between risk aversion/time discounting preferences and educational choices by running the multinomial logistic regression models in different

socioeconomic subgroups. We construct three socio-economic groups on the basis of father's education and parent's income. For father's education, we distinguish between fathers who have (i) no education beyond elementary school, (ii) vocational education (vocational education or lower tertiary education), or (iii) higher education (University College or university). This classification captures the main educational divisions in Denmark. For parents' income, we divide income into three groups based on terciles. Table 2 shows results from models in the different subgroups defined by father's education and parent's income.

The main finding from Table 2 is that there appears to be no relationship between risk aversion and the likelihood of choosing academic secondary education over no education among respondents from advantaged socioeconomic backgrounds. This holds irrespective of whether we use father's education (higher education) or parent's income (third income decile) as indicators of an advantaged socioeconomic background. In our theoretical account, and building on previous research (Breen and Goldthorpe, 1997), we suggest that this arises because irrespective of risk tolerance students from advantaged backgrounds always choose academic secondary education as a way of ensuring that they reproduce their advantaged background. When using vocational secondary education as the reference group (results shown in the last three columns of Table 2), we find a similar pattern: risk aversion is negatively associated with the likelihood of choosing academic secondary education over vocational education only for respondents from disadvantaged socioeconomic backgrounds. Interestingly, Table 2 also suggests that the relationships between time discounting preferences and educational decisions, which we observed in Table 1, do not vary by socioeconomic background.

Conclusion

We propose a rational choice model of educational decision-making that incorporates risk aversion and time discounting preferences. These aspects, which have been neglected in previous rational choice models of educational decision-making, are core ingredients in how students and their families assess the relative attractiveness of competing educational alternatives. Whereas earlier studies have emphasized that educational inequality can be understood as resulting from rational behaviours of agents given their desire to avoid downward mobility, our theory includes essential elements that capture the 'forward looking' concerns of actors. In our theory, and following Hillmert and Jacob (2003), risk-averse students are predicted to enroll in those

educational options in which the returns—net of the uncertainties associated with these returns—are highest. Our theory also argues that students with lower time discounting preferences (i.e. those who prefer high economic rewards in the future to low returns in the present) are more likely to opt for academic secondary education, which is likely to yield the highest long-term pay-off. We also suggest that risk aversion and time discounting preferences may be related to educational inequality in two ways: if risk aversion and time discounting preferences mediate the effect of socioeconomic background on educational choices or if the effect of these factors on educational decision-making varies across socioeconomic groups.

We use Denmark as the test case for our theory and newly collected data to illustrate its core mechanisms. Based on descriptive analyses, we find that more risk-averse respondents are less likely to have enrolled in the academic track in secondary education than in vocational or no education. This result suggests, in the Danish case at least, that among risk-averse students the expected costs of academic secondary education (performance risk, commitment to a long educational career, significant variance in economic returns, etc.) outweigh the expected benefits (high returns). Instead, risk-averse students opt for vocational education in which the expected returns, but also the risks, are lower. These descriptive results are consistent with our theoretical model. We argue that patterns might be different in other institutional contexts in which the returns to academic education are higher. Our analysis also shows that students' time discounting preferences are associated with their educational choices in a manner consistent with our theory. Holding other factors constant, students who prefer bigger economic returns in the future to smaller returns in the present are more likely to have enrolled in the academic track in secondary education rather than in other tracks. This empirical association is also in line with theoretical expectations because the academic track, combined with higher education, is likely to yield large economic returns in the future.

We tested two additional predictions from the theory regarding the impact, on overall educational inequality, of risk aversion and time discounting preferences. First, we analyze whether risk aversion and time discounting preferences mediate the effect of socioeconomic background on educational outcomes. We find little evidence that this is the case. Second, we analyze whether the links between risk aversion, time discounting preferences, and educational outcomes differ for students with different socioeconomic backgrounds. We find that there is no relationship between risk aversion and educational choices among students from advantaged socioeconomic

Table 2 Results from multinomial logistic regressions of educational choice. Separate models by father's education and parent's income. Log-Odds, standard errors in parenthesis, and average marginal effects in brackets

Father's education: Educational choice	Reference group: no education						Reference group: vocational[a]		
	None		Vocational		Higher		None	Vocational	Higher
	Vocational education	Academic education	Vocational education	Academic education	Vocational education	Academic education	Academic education	Academic education	Academic education
Risk aversion[b]	0.221	−0.258	−0.279*	−0.427***	0.406	0.075	−0.480*	−0.148	−0.330
	(0.204)	(0.160)	(0.129)	(0.118)	(0.236)	(0.130)	(0.199)	(0.085)	(0.218)
	[0.049]	[−0.063]	[−0.001]	[−0.049]	[0.019]	[−0.011]	[−0.062]	[−0.049]	[−0.011]
Time discounting[b]	−0.006	0.231	0.030	0.293***	−0.405*	0.070	0.236	0.263**	0.475**
	(0.173)	(0.144)	(0.088)	(0.081)	(0.206)	(0.150)	(0.176)	(0.078)	(0.172)
	[−0.017]	[0.042]	[−0.020]	[0.047]	[−0.026]	[0.025]	[0.042]	[0.047]	[0.025]
Pseudo R²	0.169	0.169	0.186	0.186	0.201	0.201	0.169	0.186	0.186
Log-likelihood	−320	−320	−1,176	−1,176	−307	−307	−320	−1,176	−1,176
Number of observations	375	375	1,583	1,583	743	743	375	1,583	743

Parent's income decile: Educational choice	Reference group: no education						Reference group: vocational		
	First		Second		Third		First	Second	Third
	Vocational	Academic	Vocational	Academic	Vocational	Academic	Academic	Academic	Academic
Risk aversion[b]	0.050	−0.266**	−0.161	−0.332*	−0.081	−0.280	−0.315**	−0.172	−0.199
	(0.122)	(0.095)	(0.173)	(0.138)	(0.200)	(0.162)	(0.104)	(0.146)	(0.159)
	[0.029]	[−0.050]	[0.006]	[−0.043]	[0.009]	[−0.033]	[−0.050]	[−0.043]	[−0.033]
Time discounting[b]	−0.071	0.276**	−0.069	0.252*	0.011	0.234*	0.347***	0.322**	0.223*
	(0.101)	(0.094)	(0.128)	(0.108)	(0.130)	(0.108)	(0.096)	(0.118)	(0.110)
	[−0.033]	[0.053]	[−0.024]	[0.046]	[−0.012]	[0.031]	[0.053]	[0.046]	[0.031]
Pseudo R²	0.181	0.181	0.177	0.177	0.206	0.206	0.181	0.177	0.206
Log-likelihood	−844	−844	−636	−636	−553	−553	−844	−636	−553
Number of observations	1,054	1,054	902	902	984	984	1,054	902	984

*P < 0.05, **P < 0.01, ***P < 0.001.

[a]Results for contrast between vocational education and no education omitted because these results are reported in the models in which no education is the reference group. Models also include the control variables.

Standard errors corrected for clustering of respondents within families.

[b]Variable is standardized.

backgrounds (the relationship exists only for students from disadvantaged and middle socioeconomic status backgrounds). We argue that students from advantaged socioeconomic backgrounds choose academic secondary education irrespective of how risk-averse they are because they need this level of education to reproduce their privileged socioeconomic background.

Our theory extends existing research, which treats educational choices as outcomes of utility-maximizing decisions. We provide a formal model and direct measures of different dimensions that are core ingredients in individual educational decision-making. Certainly our measures of risk aversion and time discounting preferences are not perfect; for example, although stable over time, they are measured after the educational decision we study and we can make no causal claims. Notwithstanding these weaknesses of measurement, our results substantiate the idea that educational decisions are rational in the sense of being consistent with students' risk assessments and expected returns.

Notes

1 Constraining $b \geq 0$ means we assume that all students are either risk neutral (when $b = 0$) or risk-averse ($b > 0$).

2 In theory, students may complete both V and A (first V, then A, or vice versa) in an attempt to maximize future returns. Although technically possible, this strategy would not be very attractive in the Danish case because, both in the educational system and in the labour market, credentials earned in A yield little return in V (and vice versa) and, moreover, the student would need to commit to a very long (and uncertain) educational career.

3 For example, academic secondary education is required for admission both to Teacher College and medical school at a university. Yet, the mean hourly wages of medical doctors are around 65 percent higher than those of school teachers (2011 figures, calculated from Statbank Denmark, table SLON21).

4 Risk aversion need not only refer to economic risks. Individuals may also be more or less risk-averse with respect to, for example, drug use, mode of transportation, or sexual behaviour. Research suggests that risk aversion is a fixed psychological trait, which is formed early in life rather than as time-varying or situational preference (Hartog, Ferrer-i-

Carbonell, and Jonker, 2002; Andersen et al., 2008; Baucells and Villasís, 2010).

5 The majority of the DLSY-C respondents can be classified as risk-averse since 91 percent state a reservation price below DKK 2,000. Seven percent are risk neutral and only two percent are risk takers. These figures are similar to previous findings from Denmark (Harrison, Lau, and Rutström, 2007) and elsewhere (Holt and Laury, 2005).

6 We tested whether our data support treating our measure of time discounting as a continuous, rather than categorical, variable. We used likelihood ratio tests to compare the fit of a model that includes our measure of time discounting preferences as a categorical variable against a model in which it is treated as continuous. We found no evidence that the latter yielded a poorer fit to the data than the former.

7 We have also used mother's education and an indicator of highest educational level in the family (either mother or father, if present) instead of father's education in the analysis. Our results do not change if we use one of these alternative indicators of educational level.

8 We use the income of the DLSY parent (rather than that of the respondent's mother or father or the household income) because we have the most reliable income data on this respondent (from the 1992 wave).

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Appendix

Table A1 Summary statistics

	Mean	SD	Survey year
DLSY-C respondent			
Educational choice			
Leave	0.19		2010
Vocational	0.15		
Academic secondary	0.66		
Risk Aversion			
Risk Aversion[a]	0.00008	0.00004	2010
Time Discounting			
Preferred job[a]	1.82	0.69	2010
Controls			
Grade Point Average from elementary school (1–6 scale)	4.13	0.97	2010
Cognitive ability (0–20 scale)	9.59	3.34	2010
Sex (woman)	0.52	0.50	2010
Age	27.80	5.09	2010
Father's education			1992
None	0.14		
Vocational	0.38		
Lower tertiary	0.17		
University college	0.15		
University	0.11		
Missing	0.05		
Parent's income (DKK thousands)	17.33	8.50	1992
Single parent family	0.15	0.35	1992
Number of siblings	1.32	0.84	1992

[a]*Variable is standardized in the empirical analysis.*