

Relative Risk Aversion and Social Reproduction in Intergenerational Educational Attainment:
Application of a Dynamic Discrete Choice Model¹

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ABSTRACT

The theory of Relative Risk Aversion (RRA) claims that educational decision-making is ultimately motivated by the individual's desire to avoid downward social class mobility, and that this desire is stronger than the desire to pursue upward mobility. This paper implements a dynamic programming model which tests the central behavioral assumption in the RRA theory stating that (1) individuals are forward-looking when choosing education and (2) that the RRA mechanism comprises an important component in the educational decision-making process. Using data from the Danish Youth Longitudinal Study, we find strong evidence of RRA in educational decision-making over and above the effect of traditional social background variables.

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1. INTRODUCTION

The persistent social inequalities in educational attainment in the Western industrialized countries remain a puzzle for researchers and politicians alike. The comparative literature on educational stratification repeatedly demonstrates that a wide range of socioeconomic, familial, and demographic characteristics continue to be of great importance with respect to educational outcomes (e.g., Müller, Lüttinger, and Karle 1989; Treiman and Yip 1989; Müller and Karle 1993; Shavit and Blossfeld 1993; Erikson and Jonsson 1996a; Sieben and de Graaf 2001; Lauer 2003).¹ This persistent inequality is paradoxical since in the post-war period huge public investments have been made in most countries in education systems and social security with the explicit aim of equalizing educational opportunities.

But what is the cause of this persisting inequality in educational attainment? While the literature on educational stratification has produced an impressive body of empirical studies which document the inertia of educational inequality across countries and over time, then this literature has been less successful in explaining *why* these inequalities persist or *how* they operate. The traditional sociological focus on the intergenerational reproduction of educational opportunities provides an explanatory force, although in recent years scholars have increasingly turned to rational choice theories for inspiration (e.g., Gambetta 1987; Goldthorpe 1996, 1998; Erikson and Jonsson 1996b; Breen and Goldthorpe 1997; Morgan 1998, 2001). In particular, the theory of Relative Risk Aversion (RRA) has received considerable attention in the recent literature (see Goldthorpe 1996; Breen and Goldthorpe 1997; Davies, Heinesen, and Holm 2002; Need and de Jong 2001; Becker 2003; van de Werfhorst and Andersen 2005; Breen and Yaish 2006). The central argument in the RRA theory is that educational choices ultimately reflect the individual's desire to preserve the social status or class position of the family over generations and to avoid downward social mobility.

That is, education is an instrument with which individuals attempt to maximize the probability of entry into *at least* the same social class position as that of their parents. According to the RRA theory, the reason why inequalities in educational attainment persist even when higher education is formally available to everyone is because members of different social classes require different levels of education in order to reach the same social class as that of their parents. When individuals reach a certain “threshold” level of education which they believe will allow entry into the same social class position as that of their parents, the “costs” of pursuing further education (in terms of real costs, earnings foregone, and the risk of failure to complete) outweigh the utility of acquiring more education. Since this “threshold” level differs by social class background, the RRA theory predicts that children from working class backgrounds, *ceteris paribus*, obtain less education than children from higher-class backgrounds because they receive no utility from acquiring higher education in terms of promoting their future social class position.

The RRA theory posits a novel way of linking inequalities in educational outcomes to the status-preserving strategies used by members of different social classes. In particular, the central claim in the RRA theory is that individuals are forward looking with respect to educational decision-making and act with a specific goal in mind: That of maximizing the probability of maintaining intergenerational status quo. In recent years the theory has been subjected to some degree of empirical testing (see Need and de Jong 2001; Davies et al. 2002; Breen and Yaish 2006). Unfortunately, none of the existing empirical studies test the full theoretical implications of the RRA theory. In particular, the central hypotheses in the RRA theory that individuals are intrinsically forward looking, that the strategic objective is to reach at least the same social class as that of one’s parents (i.e. RRA “behavior” is pursued), and finally that educational decision-making

constitutes a stochastic process clouded by uncertainty, have not been analyzed in the existing literature.

In order to advance the literature, in this paper we implement a dynamic programming model in which the forward-looking and utility-maximizing behavior posited in the RRA theory is tested in a direct and comprehensive way. More specifically, using a special class of dynamic programming models known as Dynamic Decision Process (DDP) models (Rust 1994), we introduce a dynamic framework in which both the instantaneous and future utility derived from RRA behavior (in terms of the social class position reached in adulthood) is estimated in relation to several choice situations in the education system. This approach allows for a comprehensive testing of the RRA theory that has not previously been carried out. Moreover, we extend the modeling framework as to overcome an important limitation in the original RRA model: the assumption that social class differences in the cultural values attached to education are ultimately reducible to differences in socioeconomic resources (see Devine 1998; Hatcher 1998; Nash 2003). In the dynamic framework we are able to separate *instantaneous* or *current utility* of educational decisions (i.e. the utility or return to education derived in the actual choice situation which may be attributable to cultural values or preferences) from *future utility* of educational decisions (which may serve long-term or strategic goals such as those proposed in the RRA theory). In this way the RRA hypothesis describing a particular type of educational decision making may be tested while at the same time allowing for heterogeneous value preferences to be present in the model. In the empirical analysis, we utilize data from the Danish Youth Longitudinal Study (YLS); a longitudinal survey of Danes born around 1954 and followed up to age 47. As will be argued below, the institutional features of the Danish education system makes this country a particularly appealing case for testing RRA behavior in educational decision-making. The results of the empirical analysis using the YLS data provide

strong empirical support for the RRA theory and also some support for traditional social reproduction theory.

The paper is organized into 6 sections. In the next section we present the theoretical background, as well as review previous studies on the RRA theory. This section also describes the Danish education system. Section 3 describes the data and variables used in the paper. In section 4 we present the Dynamic Decision Process (DDP) model used in the paper. This section also discusses the estimation strategy used. Section 5 presents the results of the empirical analysis of the role of RRA in educational decision-making, while in section 6 we provide a conclusion and discuss several avenues for future research.

2. RELATIVE RISK AVERSION AND EDUCATIONAL DECISION-MAKING

Rational choice theory has traditionally not received much attention in the sociological literature on educational stratification (see e.g., Hechter and Kanazawa 1997; Goldthorpe 1998; Boudon 2003 for general reviews). One of the first scholars to apply rational choice arguments in the sociology of education was Boudon (1974). In contrast to standard human capital theory, in which individuals are typically assumed to carry out informed and rational cost-benefit calculations of the monetary returns to educational choices (e.g., Manski 1989, 1993; Lauer 2003), Boudon argues that the rationality criterion guiding educational choices, as well as the utility derived hereof, is non-monetary and more socially encompassing than hypothesized in classical economic theory.

This basic argument is taken up and formalized in the theory of Relative Risk Aversion (RRA) (Breen and Goldthorpe 1997; see also Goldthorpe 1996) in order to explain why social class differences in educational attainment persist, even in light of significant expansions of access to

education in most countries. Boudon argues that inequalities in educational attainment between social classes arise from two types of social origin effects: *primary* and *secondary* effects. Primary effects relate to the relationship between social class background and academic ability, with children from advantaged social backgrounds on average exhibiting higher academic ability compared to children from less advantaged backgrounds. Secondary effects, on the other hand, relate to impact of social class and other background characteristics on educational decisions *over and above* the impact of primary effects. The RRA theory represents an attempt to explain the observed persistency of secondary effects with respect to educational attainment; i.e. why students from different social class backgrounds having equal academic ability choose systematically different types of education.

FIGURE 1 HERE

Similar to Boudon (1974), the central behavioral assumption in the RRA theory is that the rationality criterion guiding educational decision-making is the desire to avoid downward social class mobility (Breen and Goldthorpe 1997). In fact, this desire is assumed to be stronger than that of pursuing upward mobility. This mechanism is depicted in figure 1. Assuming for simplicity the existence of only three social classes (I-III), the figure shows that individuals from all social class backgrounds gain utility from reaching higher destination classes. In addition, when individuals reach the same social class as their origin class, they receive additional utility, here denoted by the parameter δ , as a “reward” for avoiding downward mobility.² As a consequence, in the RRA theory education comprises an instrumental means of minimizing the risk of entering a lower social class than that of one’s parents. Young people, along with their parents, weigh the potential utility derived from different educational choices against the costs of education (real costs and earnings

foregone) and the subjective probability of failing to complete educational levels (i.e. the “risks” associated with educational investments).

According to the RRA theory, the reason why class inequalities in educational attainment persist is because young people from different social class backgrounds require different levels of education in order to maximize the probability of maintaining their social class position. Since pursuing education is a means of securing future social status, the RRA theory posits that individuals with e.g. working class backgrounds have a lower incentive to take up higher education compared to people from more advantaged social backgrounds. This is true because, for individuals with a working class background, the utility derived from accumulating education with the intent of securing entry into the working class no longer improves beyond a certain level of education, while the costs of staying on (due to diverging levels of economic resources and primary effects) go up. Similarly, children from more advantaged backgrounds need higher education in order to secure access to the same social class as that of their parents. Generally, the RRA theory then posits that class-varying subjective “threshold” levels of desired education exist, at which the combined costs of education outweigh the utility of continuing education (Breen and Yaish 2006). As a consequence, when reaching this “threshold” RRA behavior sets in and individuals stop their educational careers. Since these thresholds differ among social classes, the RRA mechanism explains, at least in part, why inequalities in educational attainment persist over time in spite of increasingly open education systems.

RRA and “class cultures”

One of the central claims in the RRA theory is that people’s values regarding education do not vary among social classes. Only two conditions do: average academic ability and economic resources

(Breen and Goldthorpe 1997; Breen 1999). Variations in educational aspirations across social classes are then hypothesized to be reducible to differences in economic resources and opportunities. In this respect, The RRA approach disregards cultural reproduction theory suggesting that intrinsic social class differences in norms, values, and “cultural capital” constitute an important source of intergenerational educational inequality (e.g., Bourdieu 1977; Mehan 1992; De Graaf, de Graaf, and Kraaykamp 2000).³ Several critics have argued that the disavowing of “class cultures” in the RRA theory is theoretically reductionist (Devine 1998; Hatcher 1998), and furthermore that empirical evidence exists as to suggests that this assumption is not correct (Hatcher 1998; Nash 2003). Hatcher (1998) and Nash (2003) cite a number of studies which find significant variation in values regarding education held by young people with different socioeconomic backgrounds which cannot be argued to reflect merely materialist and economic preconditions (see also Murphy 1981; Gambetta 1987). These arguments highlight a limitation in RRA theory in terms of considering education solely an investment rather than a “consumption” good (Hatcher 1998; Need and de Jong 2001). In order to circumvent this limitation, in the dynamic model presented below we allow for social class differences in the instantaneous utility derived from occupying different educational states (in addition to future utility of educational choices). Thus, our model incorporates the fact that cultural heterogeneity may exist with respect to the non-monetary returns to education associated with specific class backgrounds.

Previous tests of the RRA theory

Several attempts at testing the RRA theory have been carried out. Relying on different operationalisations of RRA, existing empirical studies generally find mixed support for RRA behavior in educational decision-making. In this section we review the approaches and findings of the existing literature. Only very few studies have tested the RRA theory in its comprehensive form

as pertaining to educational decision-making as a vehicle for facilitating entry into certain *social class* positions. In most cases, a lack of appropriate data has led analysts to formulate “reduced-form” RRA hypotheses in relations to students aiming at reaching the same level of *educational attainment* as that of their parents.

This is the case in Need and de Jong’s (2001) longitudinal analysis of Dutch students’ choices of post-secondary education in the early 1990s. Consistent with RRA theory, Need and de Jong find students’ educational aspirations, subjective beliefs about their own academic ability, and Grade Point Average to be significantly associated with social background characteristics. Furthermore, in a multinomial logit model of students’ actual choice of post-secondary education they find expected significant effects of educational aspirations on educational choices, even when subjective ability, Grade Point Average, and social background characteristics are controlled for. Their results then indicate that students who aspire to reach either vocational or academic types of education are likely to realize their expectations and opt for these particular types of educations, even when differences in social background and academic ability are taken into account. Need and de Jong interpret this finding to indicate that RRA exists in educational decision-making.

A similar definition of RRA is utilized by Davies et al. (2002), in which the total educational careers of a sample of approximately 4,000 Danish students are analyzed. Developing a transition model of educational decision-making akin to that originally proposed by Mare (1980, 1981), the authors formulate the RRA theory as a test of a particular distributional form of the effect of parental education on the probability of students making several types of educational transitions. More specifically, if RRA behavior exists, the authors expect to find a “kink” in the effect of parental education on the probability of making educational transitions when students reach the

same level of education as that of their parents. This “kink” varies according to the level of education held by parents. This approach suggests that when students reach the same level of education as their parents, they gain no further utility from continuing education with respect to minimizing the risk of downward mobility. Davies et al. test this assumption of “kinked” effects by applying equality constraints on the effect parameters of parents’ level of education on students’ educational choices, and they find evidence of RRA in 10 out of a total of 17 analyses.

Consequently, they provide some but not definite support for the reduced-form RRA hypothesis.

Breen and Yaish (2006) set out to investigate the full implications of the RRA theory: that education is pursued with the intent of minimizing the risk of downward *social class* mobility. Using data from male respondents in the National Child Development Study, they present the RRA hypothesis as a test of the existence of a minimum acceptable “threshold” of education, which students recognize in order to gain access to the same social class position as that of their parents. They approximate this threshold level by calculating the actual returns to educational choices in terms of reaching certain class destinations, as derived from a secondary data source (the Oxford Mobility Survey). After controlling for ability, school performance, and other socioeconomic variables, Breen and Yaish find the anticipated effects of social class background on post-compulsory educational choices (students could enter either post-secondary vocational training, university, or enter the labor market). That is, everything else being equal, students with working class backgrounds are more likely to leave the education system or enter vocational training compared to service class students, who in turn have a higher probability of entering university.

To our knowledge, the three studies cited above are the only ones focusing explicitly on testing the RRA theory. Other studies test part of the theory. For example, Becker (2003) finds that German

parents' subjective preference for avoiding intergenerational status decline on behalf of their children is a significant predictor of their children attending upper secondary education as opposed to lower or intermediate secondary educational (see also Gambetta 1987). Like Need and de Jong (2001), also Sullivan (2000) finds that students' normative evaluations of education as well as their educational aspirations are significantly influenced by social class background. In addition to this literature on RRA specifically, other studies investigate the role of rational choice in educational decision-making. For example, Morgan (1998) finds that high school seniors' educational aspirations are positively associated with "exogenous" average earnings returns to education over time, even when the effect of social origins has been controlled. Morgan's results then indicate that high school seniors are "rational" in the sense of being responsive to the future economic benefits of education when planning their educational careers. Kane (1994) and Beattie (2002) reach similar conclusions. Finally, Jonsson (1999) proposes and finds support for a rational choice model of gender differences in educational attainment in Sweden in which men and women are hypothesized to have different sex-specific comparative advantages in different fields of study.

The existing literature then provides mixed support for the RRA theory. However, as existing studies infer RRA behavior from indirect measures or reduced-form models, they do not carry out explicit tests of the central behavioral claim in the RRA theory that individuals are forward-looking. Before presenting our dynamic model in which we formalize and test forward-looking behavior with respect to educational decision-making, we need to present the central features of the Danish education system, as well as the data used in the analysis.

The Danish Education system

The respondents in our analysis typically acquired their education during the 1970s. Consequently, we describe the features of the Danish education system of this period (see figure 2). Elementary school consists of 9 years of mandatory schooling. Children normally begin school at age 6. Upon completing elementary school at around age 16, pupils may drop out or attend one of two types of secondary education: upper secondary education or vocational secondary education. Upper secondary education is the “academic” and general track in secondary education and normally takes 3 year to complete. A second type of secondary education is vocational education. Vocational training is typically initiated after elementary school, and most types of vocational education take 3-4 years to complete. The Danish system of vocational education resembles the German “dual system” in that the student shifts between school-based training in branch-specific schools (e.g. carpentry, bricklaying, and mechanics) and practical training as an apprentice with an employer.

FIGURE 2 HERE

Higher or tertiary education in Denmark is normally classified into of three levels of education: Lower, intermediate, and higher tertiary education. There are no tuition fees or any other types of direct costs in Danish tertiary education. *Lower tertiary educations* (LTE, 1-2 years in length) are in many respects similar to vocational educations in that they embrace a wide range of technical educations and educations directed towards lower-level public sector occupations (social and health services, agricultural or industrial diplomas, some mercantile educations etc.). When our respondents went through the education system, LTE was typically the only type of tertiary level education which did not require upper secondary education as a formal requirement for admission. *Intermediate tertiary educations* (ITE, 3-4 years in length) comprise a large group of educations typically aimed at the public welfare and health sectors (nurse, elementary school teacher, child care

worker, physiotherapist, midwife etc.). Furthermore, a significant number of technical educations, such as electrical and mechanical engineering, belong in this group. *Higher tertiary educations* (HTE, 5-6 years in length) make up all types of education at the university (master's degree) level. These educations normally take 5-6 years to complete (a PhD degree is an additional 3 years on top of a HTE).

Unlike in many, and especially Anglo-American education systems, the different levels of tertiary education in Denmark only to a very limited degree constitutes a "ladder" type of progression that allows for continual upgrading of educational qualifications. This is one important reason why RRA behavior might be expected in Denmark. The three levels of tertiary education are very different with respect to which types of education are offered (theoretical/practical), curricula, and to which sectors of the labor market graduates are typically channeled. Also, institutional "closure" with respect to credential recognition and internal mobility between the three levels of tertiary education is very strong. This means that educational careers in Denmark are highly "path dependent" since switching tracks or levels of education is extremely difficult and cumbersome.

3. DATA AND VARIABLES

Data for this study comes from the Youth Longitudinal Study (YLS). The YLS consists of a nationally representative panel study of approximately 3,100 Danish respondents, all of whom were born around 1954. The respondents were first interviewed at age 14 in 1968 when attending 7th grade of elementary school. Additional waves were carried out in 1969, 1970, 1973, 1976, 1992, and finally in 2001 when respondents were around 47 years old. Attrition to the panel over time is comparatively low. In 2001, 33 years after the first wave, 2,507 of the original sample of 3,151 respondents were successfully re-interviewed. This yields a response rate of 79.6 percent.

In the paper we use information from the 1968, 1992, and 2001 YLS waves. The survey contains rich information on the educational and occupational histories of the respondents up to age 47. In addition, we have detailed information on the socioeconomic and social class position of the respondents' parents. Finally, three standardized cognitive ability tests were carried out when respondents were 14 years old, thereby providing some information on the scholastic ability of the respondent at a fairly young age. The YLS is well-suited for this analysis because in order to analyze RRA, we need extensive longitudinal information on respondents' social class backgrounds, cognitive ability, a detailed account of their educational careers, and finally an indicator of social class position at a "mature" age at which further mobility is unlikely (here age 47).

Replicating the existing empirical literature on RRA, we code the social class position of the respondents and their fathers (which is customarily used as the primary indicator of social class background) into a three-category classification of the Erikson-Goldthorpe-Portocarero social class scheme (see Erikson and Goldthorpe 1992), distinguishing between the service class (I), the working class (II), and finally the lower class (III) (see Breen and Yaish 2006). Educational attainment is coded in more detail since we analyze the respondent's entire educational career rather than just the final level of education (see Cameron and Heckman 1998, 2001; Breen and Jonsson 2000). In the analysis, we distinguish both between which type of secondary education was chosen by the respondent (upper secondary, vocational secondary, or no secondary education) as well as, where applicable, the type of tertiary education chosen (LTE, ITE, or HTE). The different educational transitions analyzed are presented in detail below. For cognitive ability, we use the individual scores of the first factor from a principal axis factor analysis of the three cognitive ability

tests carried out at age 14 testing the respondent's language, math, and spatial ability (see Härnqvist 1968 for more information on the tests used). This factor accounts for approximately 63 percent of the total variance in the test items, and the factor loadings of each of the three tests are in all cases above .72. The factor scores used in the analysis were standardized to lie in the range -3 to 3. Finally, we also include a gender dummy variable equal to 1 for male respondents.

Descriptive analysis

In order to provide an impression of the relationship between the variables in the data, we begin with a descriptive analysis before presenting the dynamic model of RRA behavior in educational decision-making. Some descriptive statistics are shown in table 1.

TABLE 1 HERE

The table shows mean scores of cognitive ability by gender and origin social class. From the table we observe a strong relationship between social class background and cognitive ability at age 14. For both men and women, we find that respondents from more privileged social class backgrounds on average display higher average cognitive ability than do respondents from a disadvantaged class background. This figure then clearly illustrates the primary effects suggested by Boudon (1974).

FIGURE 3 HERE

In figure 3, we present the educational pathways chosen by the respondents given their social class background. With respect to the first stage choices, we observe significant differences between members of different social classes. For example, among respondents from social class I, 56.4

percent enter upper secondary education, whereas only 16.7 percent of respondents from social class III enter this type of education. Similarly, the likelihood that the respondent terminates his or her educational career immediately after elementary school is much higher among respondents who originate in class III compared to classes I and II. At the second stage choices after upper secondary education, social inequalities are less pronounced. Here, we find small differences among the social classes with respect to the propensity to enter either ITE or HTE as compared to stopping. It would then seem that once respondents have acquired upper secondary education, social class inequalities with respect to subsequent educational choices are less important. Each of the educational routes provides a certain “gateway” to each of the destination social classes, here observed at age 47. However, the probability of entering each of the destination social classes is highly contingent upon the respondent’s educational career. We shall return to this point in the section below.

4. A DYNAMIC MODEL OF RRA BEHAVIOR IN EDUCATIONAL DECISION-MAKING

The empirical literature on educational stratification typically analyzes educational attainment either in terms of completed education or through a sequence of educational transitions (e.g., Mare 1980; Shavit and Blossfeld 1993). In our analysis, we present a dynamic programming model which takes into account the non-uniform progression that characterizes the Danish education system and which also incorporates dynamic selection effects and unobserved heterogeneity (e.g., Cameron and Heckman 1998, 2001; Breen and Jonsson 2000; Lucas 2001; Lauer 2003). This type of model is known in the econometrics literature as the Dynamic Decision Processes (DDP) model (Rust 1994). Compared to conventional methodologies, a major advantage of the DDP model is that it allows for both current and future utility of educational choices to be analyzed simultaneously. This means that the DDP model facilitates the idea in the RRA theory that educational choices serve long-term strategic aims, provide utility or some type of return in the short term, and furthermore that reaching

the same social class as that of one's parents results in an extra utility "reward". In this model, individuals decide on educational choices in light of their present utility of occupying the different educational states (which may be influenced by socioeconomic background characteristics, as argued in social reproduction theory), as well as the perceived utility of occupying *future* educational states and social class locations. Economists have previously analyzed educational decision-making processes using DDP type models (see Taber 2001; Arcidiacono 2004).

The decision and outcome process in our model consists of three stages (cf. figure 3). The first decision is taken upon completion of elementary school, after which the individual has to decide between entering upper secondary education, vocational education, LTE, or leave the education system. A second decision exists for those individuals who finish upper secondary education. These individuals must choose between entering ITE, HTE, or leave the educational system. Finally, a third "choice" or transition occurs when individuals move from their final educational level (including no education after elementary school) and to a social class destination. Uncertainty is introduced into the model by allowing the individual's information on the likelihood of moving from educational levels and into certain social class destinations (i.e. the third stage "choices") to be known only at a probabilistic level. Accordingly, when individuals assess the total level of utility derived from educational decisions, they have to take this uncertainty into consideration.⁴

Parameterization

In order to formalize the DDP framework, we propose the following transition model between educational states and class destinations:

$$p_{yj}^* = \frac{\exp(\beta_{ij}x_{ij})}{\sum_{s=I}^{s=III} \exp(\beta_{is}x_{is})}; j = I, II, III \quad (1)$$

where p_{yj}^* is the probability of reaching social class j from educational state y , where y equals either of the following educational states: (1) leaving education after compulsory school, (2) leaving education after upper secondary school, (3) leaving education after vocational education, (4) leaving education after LTE, ITE, or HTE. β_{yj} and x_{yj} , $j = I, II, III$ are coefficients and regression variables affecting transition probabilities between educational states and class destinations.

We then propose a joint model for the utility of occupying educational states and reaching social class destinations, also taking into consideration the uncertainty of reaching different social classes from different educational states. In this process, individuals are hypothesized to choose the educational path that yields the highest total utility derived from both 1) the current utility of occupying different educational states, as well as 2) the expected future utility from occupying certain destination social classes. As the model is solved recursively backwards by the individual making educational decisions, we begin by formulating perceived utility at the terminal level of the model, that is, the perceived utility when reaching the final social class destination at age 47.

The utility associated with reaching a certain social class destination depends on individual characteristics (gender and cognitive ability), social class background, and whether or not one reaches the social class position of one's father (i.e. the RRA utility "bonus"). We formulate perceived utility on each class level as:

$$\begin{aligned}
U_{III} &= \beta_{III}x_{III} + e_{III}, \\
U_{II} &= \beta_{II}x_{II} + \delta \cdot \mathbf{1}(II \geq \text{Origin social class}) + e_{II}, \\
U_I &= \beta_I x_I + \delta \cdot \mathbf{1}(I \geq \text{Origin social class}) + e_I,
\end{aligned} \tag{2}$$

where $x_j; j = I, II, III$ are individual characteristics affecting the perceived utility of occupying each social class, $\beta_j; j = I, II, III$ are corresponding vectors measuring the effect of each individual characteristic on perceived utility in each class. The coefficient δ measures the influence of RRA on the perceived utility of reaching each of the class destinations and is a crucial parameter in the model. RRA is captured through the indicator variables

$\mathbf{1}(II \geq \text{Origin social class})$ and $\mathbf{1}(I \geq \text{Origin social class})$, where $\mathbf{1}(\cdot)$ is a binary indicator variable taking the value one when the condition in the bracket is true, and zero otherwise. Thus the two indicator variables measure whether social class II and I are equal to, or lower than the respondent's social class of origin. For example, if the individual comes from social class I then $\mathbf{1}(II \geq \text{Origin class}) = 0$ but $\mathbf{1}(I \geq \text{Origin class}) = 1$. Finally, $e_j; j = I, II, III$ captures the effect of unobserved variables at each class level.

Moving back one step, for individuals who pursue upper secondary education a choice exists after secondary education between leaving the education system or entering ITE or HTE. The utility of each of these choices depends both on current utility, either when staying on or leaving education, but also on the perceived utility associated with reaching each of the destination social classes.

Furthermore, utility is also conditional upon previously having made the choice between either leaving after secondary education or enrolling into a particular type of tertiary education. Formally we have:

$$U_{y'} = \beta_{y'}' x_{y'} + \lambda_{y'}' \left(\sum_{j=1}^{j=III} p_{y',j}' U_j \right) + e_{y',y'} = 1, 2, 3, \quad (3)$$

where $y=1$ indicates leaving education after upper secondary school, $y=2$ indicates taking up ITE and $y=3$ means enrolling in HTE. $\beta_{y'}$, and $x_{y'}$; $y' = 1, 2, 3$ are coefficients and regression variables affecting the utility of occupying the two educational states. $\lambda_{y'}$; $y' = 1, 2, 3$ are discounting factors, capturing the possibility that the individual does not equate one unit of current utility with one unit of future utility. If no discounting exists with respect to future utility, i.e. if individuals are not forward-looking, these factors are equal to zero. Discounting implies that individuals assign different weight to future utility compared to present utility. With equidistant time periods, discount factors lower than one indicate that future utility “units” are considered less favorable compared to present utility units. When time units are not equidistant, as is the case in our analysis, the discount parameters have no straightforward interpretation, except for fact that they may be different from zero (Train 2003). Finally, $e_{y',y'}$; $y' = 1, 2, 3$ are error terms capturing unobserved variables affecting the utility of occupying each of the educational states. Note that the unobserved variables affecting the utility of reaching different social class destinations are included in the utility of educational choices through the (discounted) utility of destination classes.

Moving back to first stage choices, all individuals have to make educational choices after elementary school. At this stage the choice set consists of entering upper secondary education, vocational education, LTE, or leave the education system. The utility of each choice consists of the current utility of occupying each of the above states and the perceived utility of future states. When entering LTE, vocational education or leaving the education system, total utility consists of current

utility of this specific choice and the perceived expected utility of reaching each of the different class levels. Formally we have:

$$U_y = \beta_y x_y + \lambda_y \left(\sum_{j=I}^{j=III} p_{yj} U_j \right) + e_y, y = 2, 3, 4, \quad (4)$$

where $y = 2$ indicates LTE, $y = 3$ indicates vocational education, and $y = 4$ indicates leaving the education system. β_y and x_y ; $y = 1, 2, 3, 4$ are coefficients and regression variables affecting the utility of occupying the different educational states and λ_y ; $y = 1, 2, 3, 4$ are discounting factors similar to the λ_y 's described above. Finally e_y ; $y = 1, 2, 3, 4$ are errors terms capturing unobserved variables affecting the utility of occupying each state.

Note that when individuals enter upper secondary education, the range of future educational options complicates the situation. Here, total utility consists of current utility of being in upper secondary education, discounted utility of choices made after upper secondary education yielding the maximum future utility, which again depends on perceived utility of entering the different social class destinations. Formally we have:

$$U_1 = \beta_1 x_1 + \lambda_1 \max_{y' \in \{1, 2, 3\}} (U_1', \dots, U_3') + e_1, \quad (5)$$

where $U_{y'} = \beta_{y'} x_{y'} + \lambda_{y'} \left(\sum_{j=I}^{j=III} p_{y'j} U_j \right) + e_{y'}$; $y' = 1, 2, 3$ and where $y = 1$ indicates upper secondary education and $y' = 1, 2, 3$ indicates either leaving education after upper secondary education (1), ITE (2) or HTE (3).

Estimation

In order to estimate the DDP model of educational decision-making, certain normalizing restrictions are required if we want to include the same explanatory variables in all utility functions. We propose the following normalization restrictions: $\beta_4 = \beta_1' = \lambda_1' = 0$; that is, the regression coefficients for leaving the education system in the first stage choices and leaving the educational system after upper secondary education for the second stage choices and the discount factor for this choice are all set to zero. These restrictions are analogous to the normalizations in static discrete choice regression models, and they imply that we are only able to identify utility in the first and second educational states as well in social class relatively to a reference category. In appendix 1 we show how these normalizing restrictions identify the remaining parameters in the model.

By assuming all error terms in the model to be identically extreme value distributed

($f(e_j) = f(e_y) = f(e_{y'}) = f(e_s) = \exp(-\exp(e_s))$); $j = I, II, III$, $y = 1, 2, 3, 4$, $y' = 1, 2, 3$, we obtain closed form solutions for the first stage choices, conditional on second stage and third stage errors, and closed form solutions for second stage choices conditional on third stage errors (Train 2003).

Formally, for first stage choices we obtain:

$$\begin{aligned}
 P(Y = y) &= P(U_y > U_1, \dots, U_y > U_4) \\
 &= \frac{\exp\left(\beta_y x_y + \lambda_y \left(\sum_{j=I}^{j=III} p_{yj} U_j\right)\right)}{\exp\left(\beta_1 x_1 + \lambda_1 \max_{y' \in \{1, 2, 3\}} (U_1', \dots, U_3')\right) + \sum_{s=1}^{s=4} \exp\left(\beta_s x_s + \lambda_s \left(\sum_{j=I}^{j=III} p_{sj} U_j\right)\right)}, \quad y = 2, 3, 4,
 \end{aligned} \tag{6}$$

and

$$\begin{aligned}
P(Y = 1) &= P(U_1 > U_2, \dots, U_1 > U_4) \\
&= \frac{\exp\left(\beta_1 x_1 + \lambda_1 \max_{y' \in \{1,2,3\}} (U_1, \dots, U_3)\right)}{\exp\left(\beta_1 x_1 + \lambda_1 \max_{y' \in \{1,2,3\}} (U_1, \dots, U_3)\right) + \sum_{s=1}^{s=4} \exp\left(\beta_y x_y + \lambda_y \left(\sum_{j=I}^{j=III} p_{y,j} U_j\right)\right)}, \quad (7)
\end{aligned}$$

and, for the second stage choices, conditional on choosing upper secondary school:

$$P(Y' = y' | y = 1) = \frac{\exp\left(\beta'_{y'} x'_{y'} + \lambda'_{y'} \left(\sum_{j=I}^{j=III} p'_{y',j} U_j\right)\right)}{\sum_{s=1}^{s=3} \exp\left(\beta'_{y'} x'_{y'} + \lambda'_{y'} \left(\sum_{j=I}^{j=III} p'_{y',j} U_j\right)\right)}, \quad y' = 1, 2, 3. \quad (8)$$

Note that if discount parameters are zero (i.e. individuals are completely myopic in the educational decision-making process) the choice probabilities, (6), (7) and (8) reduce to two standard multinomial logit models, one for choices made after elementary school (6) and (7), and one for choices hereafter, conditional on completing upper secondary education (8). Hence, in our model discount parameters significantly different from 0 indicate that forward-looking behavior exists with respect to educational decision-making. The λ' 's represent discounting factors, while the parameter δ represents the RRA effect which is of particular interest (see (2)).

In the model, first stage choices are still conditional on second and third stage errors and second stage choices are still conditional on third stage errors. There is no convenient way to obtain a closed form solution for this model (Train 2003).⁵ As a consequence, in order to integrate out the error terms we apply simulation methods and simulate each of the choice probabilities. More specifically, for each individual, we draw c values from the distributions of the error terms and obtain the individual average choice probabilities. Formally, for the first stage choices we get:

$$\begin{aligned}
P(Y = y) &= \frac{1}{c} \sum_{l=1}^{l=c} P(Y = y | \mathbf{e}_l) = \\
&\sum_{l=1}^{l=c} \frac{\exp\left(\beta_y x_y + \lambda_y \left(\sum_{j=I}^{j=III} p_{yj} U_j(e_{jl})\right)\right)}{\exp\left(\beta_1 x_1 + \lambda_1 \max_{y'}(U_1, \dots, U_3)\right) + \sum_{s=1}^{s=4} \exp\left(\beta_y x_y + \lambda_y \left(\sum_{j=I}^{j=III} p_{yj} U_j(e_{jl})\right)\right)}; \\
&y = 2, 3, 4.
\end{aligned} \tag{9}$$

where $U_{y'} = U_{y'}(e'_{y'1}, e_{II}, e_{III}, e_{III})$; $y' = 1, 2, 3$ and where $\mathbf{e}_l = e_{II}, \dots, e_{III}, e_{1l}, \dots, e_{4l}, e'_{1l}, \dots, e'_{4l}$ is the l 'th draw of from the distribution of the errors (having independent extreme value distributions) and where $P(Y = 1)$ is obtained in a similar fashion. Note that in (9) we have made the dependency of utilities on error terms explicit, whereas this is not the case in equations (6) – (8) in which dependency on error terms is suppressed for simplicity of exposition. For the second stage choices we only require draws for the third stage errors, and here we use the same draws as from the first stage choices. When using these simulated probabilities to construct a likelihood function for first and second stage choices we obtain a simulated likelihood function (Gouriéroux and Monfort 1996; Train 2003). This likelihood function may be maximized to obtain estimates of the parameters of the model. These parameters will generally be biased for a small number of draws in the simulated likelihood. However, by increasing the number of draws this bias diminishes, and with a large number of draws one obtains approximately unbiased maximum-likelihood estimates (Gouriéroux and Monfort 1996).

Correlation between error terms

As the model is presented above, we assume that the unobserved variables in one educational or social class state captured in the error terms are independent of unobserved variables in the other states. Hence, if we think of the error terms as capturing unobserved heterogeneity, the assumption

of independence is equivalent of assuming that the effect of omitted variables in the different states of the model are independent. In order to eliminate this assumption, we propose that the error term may be decomposed into:

$$e_j = \eta_j + \varepsilon_j \quad (10)$$

where e_j is a generic term where index j refers to any of the different error terms in the model. ε_j is now an idiosyncratic error term that is independently extreme value distributed across utilities, and η_j is an error term independently distributed of all of the idiosyncratic error terms but correlated with other η_s across utilities. η_j might then capture the effect on utilities of unobserved variables appearing in all the different utility equations, but perhaps with different effects. Furthermore, we assume that $\boldsymbol{\eta}$, where $\boldsymbol{\eta}$ is the vector of all the different η_j , follows a finite discrete distribution. Several authors, e.g. Wedel and DeSarbo (2002), suggest this as a non-parametric approach in the form of latent classes where individual heterogeneity is conceptualized as Q unobserved (latent) classes with different propensities to choose among the different alternatives. As discussed by Greene and Henscher (2002), one may also think of this as a discrete approximation to any unknown distribution of unobserved heterogeneity. In practice, when estimating the model with latent classes, this just involves another loop in (9) by latent classes in addition to the loop by the simulated idiosyncratic error terms. When doing so, we get the unconditional probabilities of, for example, the first stage choices:⁶

$$P(Y = y) = \sum_{q=1}^{q=Q} \frac{1}{c} \sum_{l=1}^{l=c} P(Y = y | \boldsymbol{\eta}_q + \boldsymbol{\varepsilon}_l) p(\boldsymbol{\eta}_q), \quad (11)$$

where $\boldsymbol{\varepsilon}_l = \varepsilon_{II}, \dots, \varepsilon_{III}, \varepsilon_{IV}, \dots, \varepsilon_{AI}, \varepsilon'_{IV}, \dots, \varepsilon'_{AI}$, $\boldsymbol{\eta}_q = \eta_{Iq}, \dots, \eta_{IIIq}, \eta_{IVq}, \dots, \eta_{4q}, \eta'_{IVq}, \dots, \eta'_{4q}$ and where $p(\boldsymbol{\eta}_q)$ is the mass associated with the q 'th latent class.

5. RESULTS

The empirical model consists of two independent parts. These are 1) models for transition probabilities from different educational outcomes to social class destinations, cf. equation (1), and, conditional on these transition probabilities, 2) a model of educational attainment taking into account the expected RRA utility from reaching the different social class destinations, cf. equations (6) – (8). In the presentation of the empirical findings we discuss these two parts in turn.

Transitions models

We begin with a descriptive analysis of the transition probabilities between educational outcomes and social class destinations. These transition probabilities are modeled using gender, cognitive ability and origin social class as explanatory variables. In figures 4-7 we show the estimated transition probabilities of reaching destination social class I and III for men and women. In the figures, destination class II is used as the reference class, and we show transition probabilities as a function of respondents' cognitive ability.

FIGURES 4, 5, 6 AND 7 HERE

From the figures we find that for both men and women, higher levels of education generally lead to higher probabilities of reaching higher destination classes. For example, women with mean cognitive ability (= 0) and with either ITE or HTE have an approximately 60 percent probability of

reaching class I, whereas females with the same level of cognitive ability, but having no education above elementary school only have an approximately 15 percent probability of reaching the same social class position. For respondents with no or lower levels of education, cognitive ability has a large effect on the probability of reaching social class I, whereas for respondents with ITE or HTE cognitive ability has a much more limited impact. This situation might either reflect selection mechanisms (see Cameron and Heckman 1998) or be due to the fact that these types of education enable entry into higher social class positions irrespective of individual mobility. If the latter mechanism is true (which we implicitly assume⁷ and which is the assumption in most empirical research on social mobility), a high level of education is especially valuable for individuals from origin class I with low cognitive ability who want to avoid downward social mobility. Finally, we note that for upper secondary education, cognitive ability has a non-monotonic effect on the probability of reaching destination class I. For low levels of cognitive ability, increasing cognitive ability leads to a higher probability of reaching social class I, whereas for high levels of cognitive ability more cognitive ability leads to a lower probability of reaching social class I. As the probability of reaching destination social class III is uniformly decreasing by cognitive ability for this type of education, this gives the impression that for high-ability individuals, upper secondary education is a likely gateway to destination social class II.

Dynamic models of RRA behavior in educational decision-making

In this section we present the empirical results of the DDP models of RRA behavior in educational decision-making. The results of these models are shown in table 2. In order to test the RRA hypothesis, three different model specifications are considered: 1) the standard multinomial logit model of educational choice using no education beyond elementary school as the reference category, 2) the DDP model without unobserved heterogeneity, and 3) the DDP model with

unobserved heterogeneity. The models represent an increasingly sophisticated treatment of the dynamics of educational decision-making and RRA behavior. Among the three models, the multinomial logit model is the most “crude” model type since it does not allow for a separate identification of the effect of forward-looking behavior in educational decision-making from the effect of other social background factors. The DDP model without unobserved heterogeneity allows for a direct test of forward-looking behavior through the estimation of RRA and discount utility parameters, but this model assumes that this process is “error free” and not affected by unobserved variables. Finally, the DDP model with unobserved heterogeneity has the same properties as the former DDP model, but in this specification we allow for unobserved heterogeneity to enter the model through correlated error terms. For both DDP models we use 80 draws from the simulated maximum likelihood to obtain the model parameters. This number of draws was chosen since increasing the number of draws beyond 80 did not change the parameters of the model, meaning that an unbiased maximum likelihood solution was reached.

TABLE 2 HERE

Several important findings appear from table 2. First, with respect to model fit, the model log-likelihood of both DDP models is superior to that of the multinomial logit model. This would indicate that the DDP models capture more of the complexity in the data. Furthermore, the DDP model with unobserved heterogeneity displays a better fit than the DDP model without unobserved heterogeneity, although comparing model fit among these models using the log-likelihood value is difficult.⁸ Again, this comparison would indicate that unobserved factors are present and should be accounted for.

Second, we find that in the DDP model with unobserved heterogeneity the RRA parameter δ and several of the discount parameters λ are significantly different from zero. This means that our analysis provides empirical support for forward-looking behavior in educational decision-making, and, most importantly, of RRA behavior playing a significant role in this context. We find considerable differences in the estimates of the RRA parameter in the two DDP models, with the RRA estimate of .263 being statistically insignificant in the model without unobserved heterogeneity but significant and of much greater magnitude (1.096) in the model which corrects for unobserved heterogeneity. It would then seem that unobserved social background characteristics jointly affecting educational decision-making and attainment are significant in the model and need to be controlled in order to isolate the RRA effect. Comparing the results of the standard multinomial logit model to the DDP model with unobserved heterogeneity provides an interesting illustration of the importance of forward-looking behavior in educational decision-making. By and large, the effect of father's social class in our multinomial logit model is similar to that found in most studies: The higher the social class of the respondent's father, the higher the probability of the respondent having obtained a higher level of education (e.g., Shavit and Blossfeld 1993). While interesting in its own right, this result does not provide any insights into the social processes or mechanisms generating inequalities in educational attainment. In the DDP model with unobserved heterogeneity, father's social class has only very small effects on respondents' educational attainment, while the RRA and the other discount parameters are highly significant. Accordingly, the DDP model illustrates that forward-looking RRA behavior exists and accounts for some of the "simple" correlation between father's social class and the respondents' educational attainment. This finding is not surprising since it is exactly what is predicted in the RRA theory.

Furthermore, it should be noted that we do find empirical evidence to support social reproduction theory. For example, even though we only find a modest effect of father's social class on the utility of occupying different educational states, the results show that the sign of the coefficient and effect of father's social class is as expected for all educational states in the first stage (LTE, upper secondary education and vocational education). That is, individuals with fathers from social class I (and, in part, class II) have higher utility of occupying upper secondary education, and lower utility of occupying vocational education and no education beyond elementary school compared to individuals whose fathers belong to social class III. With respect to the second stage educational states and final social class destinations, the effect of father's social class is less clear. For example, the utility of occupying ITE is significantly lower for individuals with fathers from social class II compared to individuals whose fathers belong to social class I and III. Other results concerning father's social class are less straight-forward.

TABLE 3 HERE

In order to illustrate the magnitude of the RRA effect, in table 3 we use the parameters of the DDP model with unobserved heterogeneity and simulate the extent to which educational decisions are attributable to the RRA effect. The table compares the odds ratio for making certain educational transitions for individuals from origin classes I and III (with social class II being the reference class). Here, we find that when including the RRA effect and calculating the odds ratios, individuals from social class I have .33 lower odds of having acquired elementary school as the highest level of education compared to individuals from social class III. When calculating the same odds ratio, but fixing the RRA parameter to zero, we find that the odds ratio increases to .56. According, in this calculation roughly one third of the "total" social class inequality with respect to obtaining post-

compulsory education is attributable to the RRA effect. The picture is very similar if we simulate the odds of obtaining ITE or HTE compared to all lower levels of education. Here, the odds ratio for acquiring ITE or HTE for individuals from origin class I become almost doubled from 3.17 to 6.96 when taking the RRA effect into account. Finally, it seems that RRA behavior has only very a modest effect on choosing a vocational education compared to other educations in the first stage choice set. This is due to the fact that, according to figures 4 and 5, vocational education has a very limited impact on reaching class destination I, and, hence this type of education is only of limited value for individuals from origin class I in terms of reaching destination class I.

6. DISCUSSION

The objective of this paper was to test the theory of Relative Risk Aversion (RRA) (Goldthorpe 1996; Breen and Goldthorpe 1997). The RRA theory provides a rational-choice approach to understanding why inequalities in educational attainment persist in advanced, industrialized countries in which education is formally available to all citizens. According to the RRA theory, inequalities persist because individuals' choices of education are first and foremost guided by their subjective desire to avoid downward social mobility. In order to fulfill this rationality criterion, members of different social classes choose educational paths which they believe minimize the risk of experiencing downward social mobility. This means that educational inequality is preserved because member of different social classes need (and pursue) different levels of education in order to fulfill the rationality criterion implied by the RRA theory.

The RRA theory states that individuals apply a specific type of forward-looking behavior when choosing education. Unfortunately, existing empirical studies of the RRA theory do not implement forward looking-behavior in their empirical analyses, and, as a consequence, they do not test if

RRA actually explains educational inequalities (Need and de Jong 2001; Davies et al. 2002; Breen and Yaish 2006). In this paper we propose a Dynamic Decision Process (DDP) model which allows for a direct empirical test of the claim in the RRA theory that individuals are forward-looking with respect to educational decision-making, and furthermore that the rationality criterion guiding educational decisions is the desire to reach the same social class position as that of one's parents (here: the social class position of one's father). This is done by implementing a DDP model which explicitly allows individuals to derive both *current* and *future* utility from making certain educational choices, as well as enabling parameters pertaining to both current and future utility functions to be estimated empirically. This means that we are able to determine if people are myopic with respect to the future consequences of their educational choices, or if, as suggested by the RRA theory, they choose education in light of their *future* ambition of entering the same social class position as that of their fathers.

Using data from the Danish Youth Longitudinal Survey, in the empirical analysis we find strong evidence of forward-looking behavior. Furthermore, as predicted by the RRA theory, individuals utilize education as a means of avoiding downward social mobility. In addition, we find some evidence to support social reproduction theory. The proposed DDP model is rather complex, but it turns out to be statistically superior to more traditional statistical models used to explain intergenerational educational attainment. Interestingly, the analysis indicates that when forward-looking behavior is included in the model, traditional sociological predictors of educational attainment, here father's social class, are attenuated. This finding would suggest that forward-looking behavior, being an aspect of the "total" social background effect shaping inequalities in educational outcomes, comprises an independent explanatory factor which should also be recognized. The merit of the framework proposed in this paper is that, unlike previous tests of the

RRA theory, it allows us to isolate and test the effect of the central behavioral mechanism in the RRA theory: that educational decision-making is intrinsically guided by the future aim of ensuring entry into the same social class position as that of one's parents.

Future research might follow different avenues. First, one avenue would be to allow for non-rational behavior in certain fractions of a population. Non-rational behavior in parts of a population was introduced by Houser et al. (2004) who presented experimental evidence suggesting that, in a dynamic experiment mimicking real life educational and occupational choices, only fractions of a population of individuals follow "rational" behavior. If only part of a population behave according to the RRA theory, we should expect the average RRA effect in a whole population (such as the one studied here) to be lower than the RRA effect for individuals actually making rational decisions according the RRA theory. Modeling fractional or heterogeneous RRA effects might be accomplished by allowing the RRA parameter in our model to vary over the latent class capturing unobserved variables. Second, our model assumes that individuals always successfully complete their education. Obviously, this is not always the case, and the risk of educational failure might also be incorporated into the model. Given the considerable complexity of the framework in the paper, we chose to disregard this aspect of the RRA theory. Finally, a third extension of our study, in addition to the RRA-type return to education in terms of avoiding downward social mobility, would be to explicitly allow for utility in the monetary returns to education (see Arcidiacono 2004). Among other aspects, such an approach would allow for computation of the economic "loss" of belonging to social origin class III rather than classes II or I in terms of educational attainment.

APPENDIX: IDENTIFICATION OF THE EMPIRICAL MODEL

In this appendix we show which parameters are identifiable in the model presented in section four.

First, reconsider equation (6):

$$\begin{aligned}
P(Y = 4) &= \frac{\exp\left(\beta_4 x_4 + \lambda_4 \left(\sum_{j=I}^{j=III} p_{4j} U_j\right)\right)}{\exp\left(\beta_1 x_1 + \lambda_1 \max_{y' \in \{1,2,3\}} (U'_1, \dots, U'_3)\right) + \sum_{s=2}^{s=4} \exp\left(\beta_s x_s + \lambda_s \left(\sum_{j=I}^{j=III} p_{sj} U_j\right)\right)} \\
&= \frac{1}{\exp\left(\beta_1 x_1 - \beta_4 x_4 + \lambda_1 \max_{y' \in \{1,2,3\}} (U'_1, \dots, U'_3) - \lambda_4 \left(\sum_{j=I}^{j=III} p_{4j} U_j\right)\right) + \sum_{s=2}^{s=4} \exp\left(\beta_s x_s - \beta_4 x_4 + \lambda_s \left(\sum_{j=I}^{j=III} p_{sj} U_j\right) - \lambda_4 \left(\sum_{j=I}^{j=III} p_{4j} U_j\right)\right)} \\
&\stackrel{\text{iff } x_i = x'_i}{i=1,2,3,4}}{=} \frac{1}{\exp\left((\beta_1 - \beta_4)x + \lambda_1 \max_{y' \in \{1,2,3\}} (U'_1, \dots, U'_3) - \lambda_4 \left(\sum_{j=I}^{j=III} p_{4j} U_j\right)\right) + \sum_{s=2}^{s=4} \exp\left((\beta_s - \beta_4)x + \lambda_s \left(\sum_{j=I}^{j=III} p_{sj} U_j\right) - \lambda_4 \left(\sum_{j=I}^{j=III} p_{4j} U_j\right)\right)} \\
&= \frac{1}{\exp(A) + \sum_{s=2}^{s=4} \exp(B_s)}
\end{aligned}$$

where

$$\begin{aligned}
A &= (\beta_1 - \beta_4)x + \lambda_1 \max_{y' \in \{1,2,3\}} (U'_1, \dots, U'_3) - \lambda_4 \left(\sum_{j=I}^{j=III} p_{4j} U_j\right) \\
&= \tilde{\beta}_1 x + \lambda_1 \max_{y' \in \{1,2,3\}} (U'_1, \dots, U'_3) - \lambda_4 \left(\sum_{j=I}^{j=III} \beta_j p_{4j} x + \delta \sum_{j=I}^{j=III} p_{4j} \mathbf{1}(j \leq \text{Origin class}) + \sum_{j=I}^{j=III} p_{4j} e_j\right) \\
&= \tilde{\beta}_1 x + \lambda_4 \sum_{j=I}^{j=III} \beta_j x_{4j} + \lambda_4 \delta \sum_{j=I}^{j=III} p_{4j} \mathbf{1}(j \leq \text{Origin class}) + \lambda_1 \max_{y' \in \{1,2,3\}} (U'_1, \dots, U'_3) - \lambda_4 \sum_{j=I}^{j=III} p_{4j} e_j
\end{aligned}$$

and

$$\begin{aligned}
B_s &= (\beta_s - \beta_4)x + \lambda_s \left(\sum_{j=I}^{j=III} p_{sj} U_j\right) - \lambda_4 \left(\sum_{j=I}^{j=III} p_{4j} U_j\right) \\
&= (\beta_s - \beta_4)x + (\lambda_s - \lambda_4) \left[\sum_{j=I}^{j=III} \beta_j \Delta p_{sj} x + \delta \sum_{j=I}^{j=III} \Delta p_{sj} \mathbf{1}(j \leq \text{Origin class}) + \sum_{j=I}^{j=III} \Delta p_{sj} e_j\right] \\
&= \tilde{\beta}_s x + \tilde{\lambda}_s \sum_{j=I}^{j=III} \beta_j x_{sj} + \tilde{\lambda}_s \delta \sum_{j=I}^{j=III} \Delta p_{sj} \mathbf{1}(j \leq \text{Origin class}) + \tilde{\lambda}_s \sum_{j=I}^{j=III} \Delta p_{sj} e_j
\end{aligned}$$

and where $x_{sj} = \Delta p_{sj} x$, $\Delta p_{sj} = p_{sj} - p_{s4}$, $\tilde{\beta}_s = \beta_s - \beta_4$, $\tilde{\lambda}_s = \lambda_s - \lambda_4$, $s = I, II, III$, $j = 1, \dots, 4$. From these equations we find that, when all utilities are affected by the same explanatory variables, there is no difference in the probability of making first stage choices from a model with $\beta_4 = 0$ and with redefined parameters for the other choices: $\tilde{\beta}_1 = \beta_1 - \beta_4, \dots, \tilde{\beta}_3 = \beta_3 - \beta_4$. Furthermore λ_1 is identified

as a regression coefficient to $\max_{y'}(U_{y'})$ which is a non-linear function of the x 's, due to the max-operator. We can also identify the RRA parameter and the remaining three discount parameters $(\lambda_2, \lambda_3, \lambda_4)$, because they are regression coefficients for two linear combinations of the RRA indicator variable, $\sum_{j=I}^{j=III} p_{4j} \mathbf{1}(j \leq \text{Origin class})$ and $\sum_{j=I}^{j=III} \Delta p_{sj} \mathbf{1}(j \leq \text{Origin class})$, $s = 2, 3, 4$, with two linearly independent terms each (only two are identified because $\sum_{j=I}^{j=III} p_{4j} = 1$ and $\sum_{j=I}^{j=III} \Delta p_{sj} = 0$).

Finally, we can identify two of three vectors of β_j , $j = I, II, III$, as the term $\sum_{j=I}^{j=III} \beta_j x_{sj}$ has two linearly independent terms.

For the second stage choices, equation (8), we have:

$$\begin{aligned}
 P(Y' = 1 | y = 1) &= \frac{\exp\left(\beta'_1 x'_1 + \lambda'_1 \left(\sum_{j=I}^{j=III} p'_{1j} U_j\right)\right)}{\sum_{s=1}^{s=3} \exp\left(\beta'_s x'_s + \lambda'_s \left(\sum_{j=I}^{j=III} p'_{sj} U_j\right)\right)} \stackrel{x'_1 = x'_2 = x'_3}{=} \frac{1}{1 + \sum_{s=2}^{s=3} \exp\left(\left(\beta'_s - \beta'_1\right) x'_1 + \left(\lambda'_s - \lambda'_1\right) \left(\sum_{j=I}^{j=III} (p'_{sj} - p'_{1j}) U_j\right)\right)} \\
 &= \frac{1}{1 + \sum_{s=2}^{s=3} \exp\left(\tilde{\beta}'_s x'_1 + \tilde{\lambda}'_s \left[\sum_{j=I}^{j=III} \beta_j \Delta p'_{s'j} x + \delta \sum_{j=I}^{j=III} \Delta p'_{s'j} \mathbf{1}(j \leq \text{Origin class}) + \sum_{j=I}^{j=III} \Delta p'_{s'j} e_j\right]\right)} \\
 &= \frac{1}{1 + \sum_{s=2}^{s=3} \exp\left(\tilde{\beta}'_s x'_1 + \tilde{\lambda}'_s \left[\sum_{j=I}^{j=III} \beta_j x_{s'j} + \tilde{\lambda}'_s \delta \sum_{j=I}^{j=III} \Delta p'_{s'j} \mathbf{1}(j \leq \text{Origin class}) + \sum_{j=I}^{j=III} \Delta p'_{s'j} e_j\right]\right)},
 \end{aligned}$$

from which we observe the need to normalize a vector of regression coefficients of the utility of the second stage choices. Also, only two out of three discount parameters are identified from the linear combinations of the RRA indicator variables. Note we do not need to identify δ , as this parameter is already identified from first stage choices. The reasons why we cannot identify all discount parameters for the second stage choices are because, compared to the first stage choices, there are no non-linear terms of maximum utility of future choices. Following arguments similar to those for

the first stage choices, from second stage choices alone, we can identify two of the three vectors of regression coefficients for the utility of social class destination. Hence, by modeling both first and second stage choices we improve the identification of these parameters.

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TABLES AND FIGURES

Table 1
 Summary statistics. Means with standard deviations in parenthesis

Gender	Origin social class	Mean cognitive ability	Number of observations
Males	I	.362 (.936)	258
	II	.103 (.801)	481
	III	-.193 (.958)	447
Females	I	.227 (1.110)	241
	II	.153 (.952)	452
	III	-.156 (1.014)	434
Total	I	.321 (1.023)	499
	II	.127 (.877)	933
	III	-.175 (.986)	881
Total		.054 (.971)	2,313

Table 2

Results of Multinomial logit and Dynamic Models. Parameter estimates and standard errors.
Reference category is no education beyond elementary school

		Multinomial model	Dynamic model	Dynamic model w. unobserved heterogeneity
Education	Variable	Estimate	Estimate	Estimate
LTE	Male	.000 (.036)	-.254 (.230)	.044 (.388)
	C. ability	.344 (.073)**	.262 (.063)*	.273 (.217)
	F. class I	.968 (.243)**	-.033 (.209)	.349 (.456)
	F. class II	.358 (.155)	-.144 (.138)	.113 (.235)
Upper secondary education	Male	.630 (.125)**	.459 (.182)*	.482 (.467)
	C. ability	1.360 (.096)**	1.073 (.045)*	1.114 (.166)*
	F. class I	2.350 (.245)**	1.040 (.367)	.628 (.395)
	F. class II	1.057 (.172)**	.179 (.290)	.143 (.445)
Vocational education	Male	1.042 (.110)**	.912 (.076)*	1.017 (.205)*
	C. ability	.274 (.067)**	.112 (.156)	.308 (.177)
	F. class I	.748 (.238)**	-.119 (.387)	-.182 (.466)
	F. class II	.292 (.148)**	-.042 (.126)	.056 (.291)
ITE	Male	-1.476 (.396)**	-.803 (.466)	-.976 (1.822)
	C. ability	.070 (.176)	.638 (.101)*	.123 (.058)*
	F. class I	.307 (1.139)	.091 (1.387)	.301 (.877)
	F. class II	-.179 (1.511)	.229 (.471)	-.900 (.213)*
HTE	Male	-.179 (.416)	-.504 (.138)*	-.077 (1.148)
	C. ability	.246 (.185)	.963 (.264)*	.428 (.631)
	F. class I	.763 (1.397)	-.171 (1.045)	.119 (.827)
	F. class II	-.012 (1.886)	-.187 (.138)	-.354 (.180)
Destination social class I	Male		-1.087 (.741)	-.481 (1.602)
	C. ability		.369 (.200)	-1.160 (.312)*
	F. class I		.198 (.937)	.145 (.741)
	F. class II		.228 (.285)	-.478 (.092)*
Destination social class II	Male		.618 (.762)	.624 (.660)
	C. ability		.897 (.383)**	.628 (.780)
	F. class I		.287 (.305)	-.398 (1.174)
	F. class II		.025 (.368)	-.169 (.605)
Discount parameters	λ'_1		1.646 (.291)*	1.610 (.292)*
	λ'_2		.686 (.233)*	.927 (.505)**
	λ'_3		1.595 (.213)*	.989 (.511)**
	λ'_4		.419 (.261)	.048 (.071)
	λ'_5		1.152 (.305)*	.602 (2.026)

	λ'_6		.710 (1.972)	.925 (.638)
RRA parameter	δ		.263 (.593)	1.096 (.473)*
Latent class parameters	η'_{12}			.221 (.241)
	η'_{22}			-.140 (1.619)
	η'_{32}			.258 (.166)
	η'_{12}			-.216 (1.380)
	η'_{22}			-.183 (3.370)
	η_{12}			-1.950 (.401)*
	η_{112}			.240 (1.843)
	$p(\boldsymbol{\eta}_q)$.776 (.084)
Model -2 LL		6,036.71	5,957.64	5,885.21
AIC		6,086.71	6,037.64	5,981.21
BIC		6,230.37	6,267.49	6,257.03
No. of draws in Simulated Maximum Likelihood			80	80

Note. – ** $p < 0.05$, * $p < 0.1$ Two tailed tests. In order to facilitate the presentation of the results the estimated parameters for the constant terms in the models are suppressed. Abbreviations: F. class = Father's social class (social class III is the reference category). C. ability = Cognitive ability. LTE = Lower Tertiary Education. ITE = Intermediate Tertiary Education. HTE = Higher Tertiary Education.

Table 3

Odds ratios of making educational transitions between origin social class I and III with and with out RRA behaviour

Origin social class	Out versus any type of further education	Vocational secondary education versus Out + LTE + Upper secondary education	HTE + ITE versus Out + LTE + Upper secondary education + vocational education
With RRA	0.33	0.40	6.96
Without RRA	0.56	0.41	3.17

Fig. 1. – Utility from class destinations derived from RRA theory

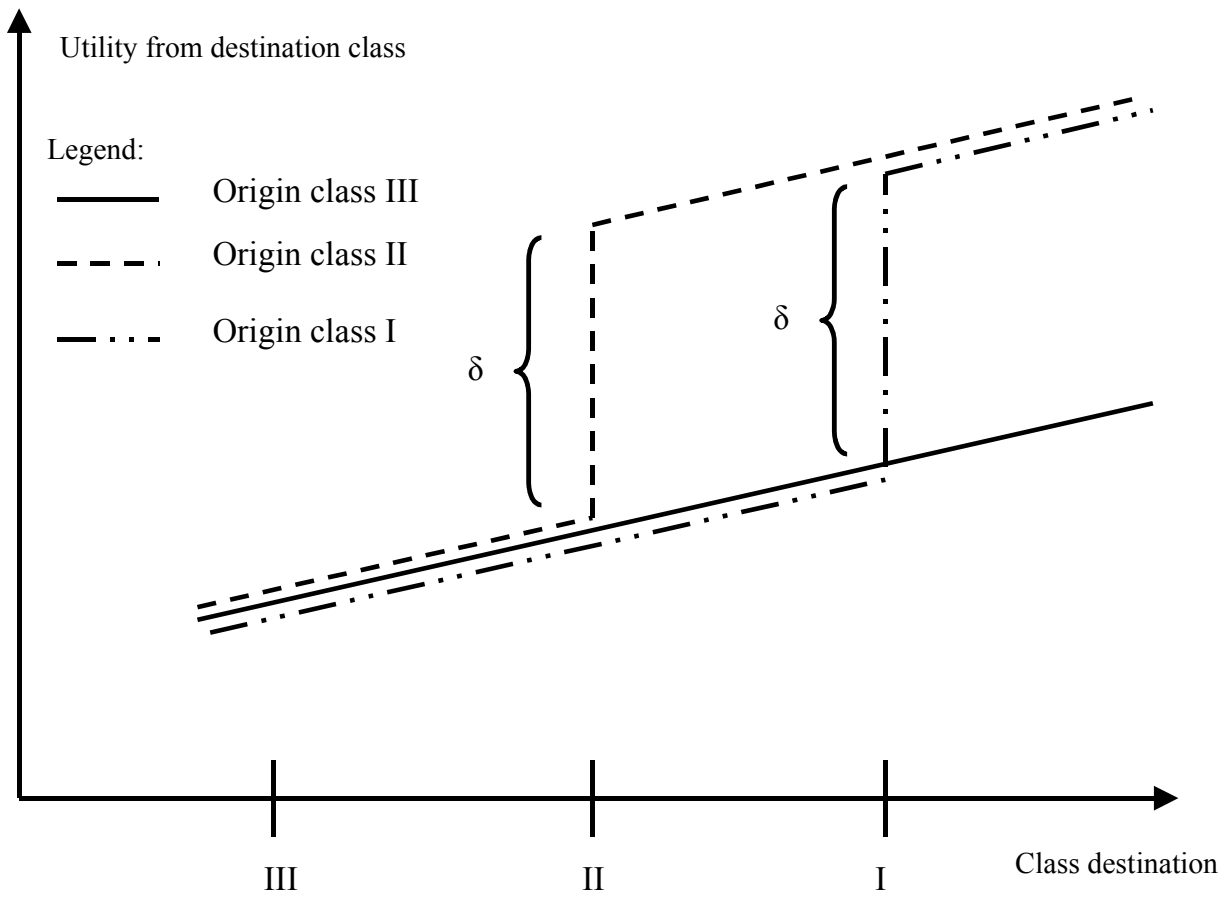


Fig 2. – Typical pathways in the Danish educational system

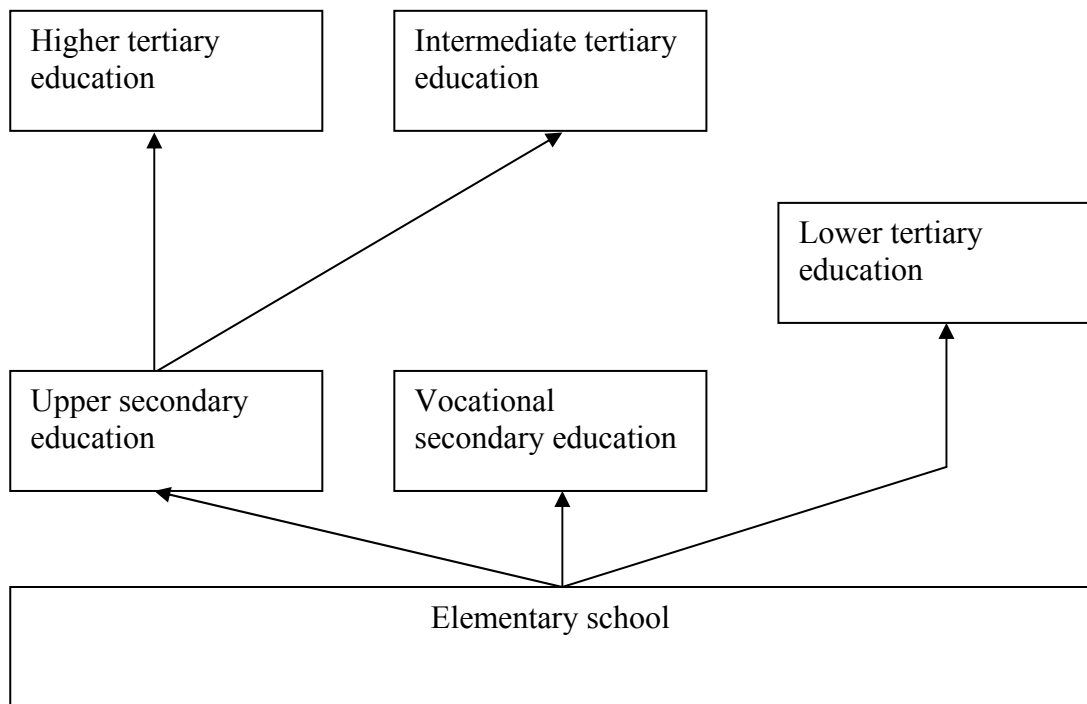


Fig. 3. – Educational pathways, by social class background

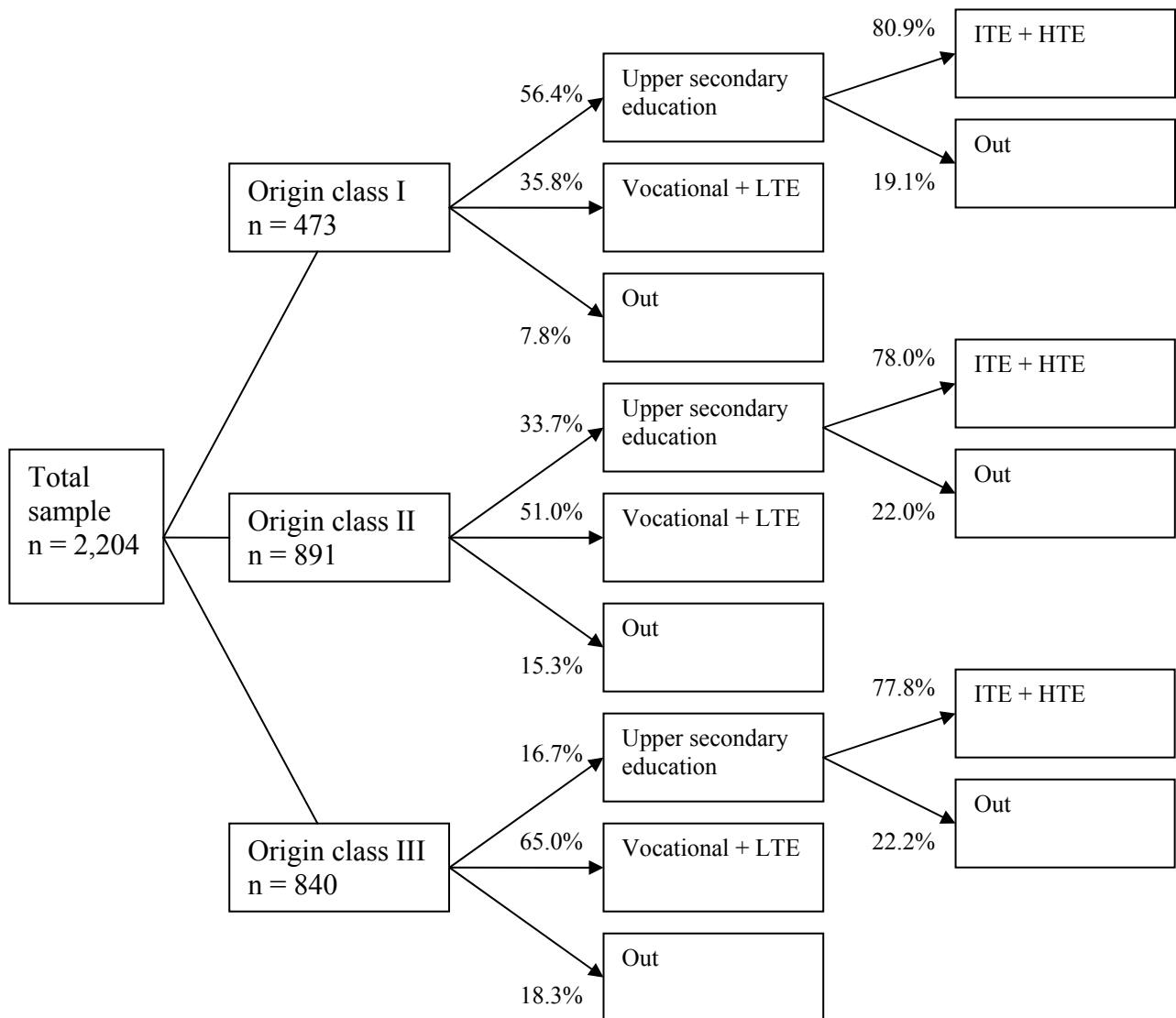


Fig 4. – Transition probabilities into destination Class I by educational attainment, women

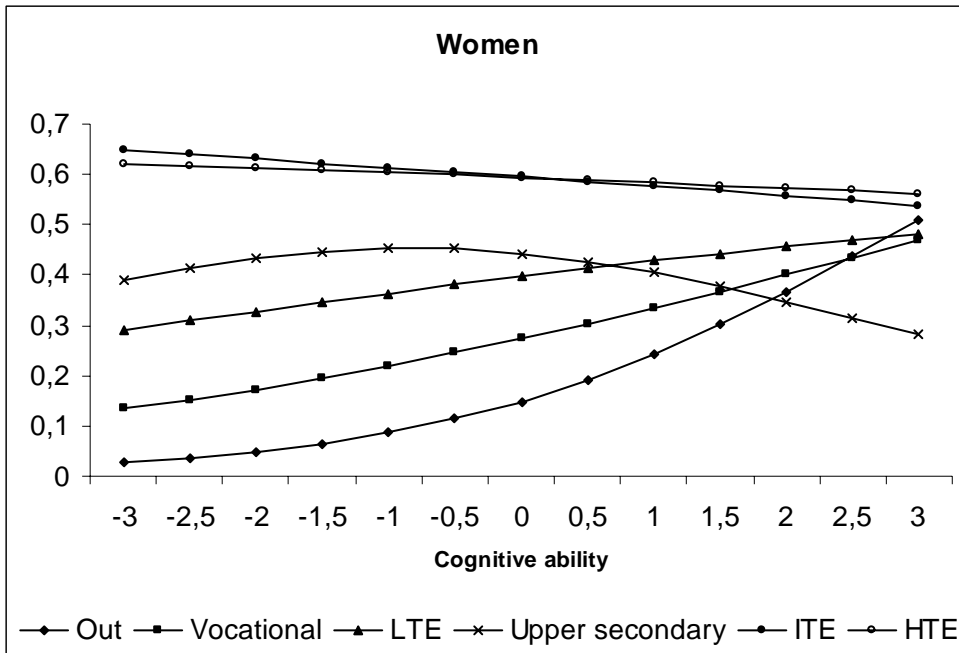


Fig 5. – Transition probabilities into destination Class I by educational attainment, men

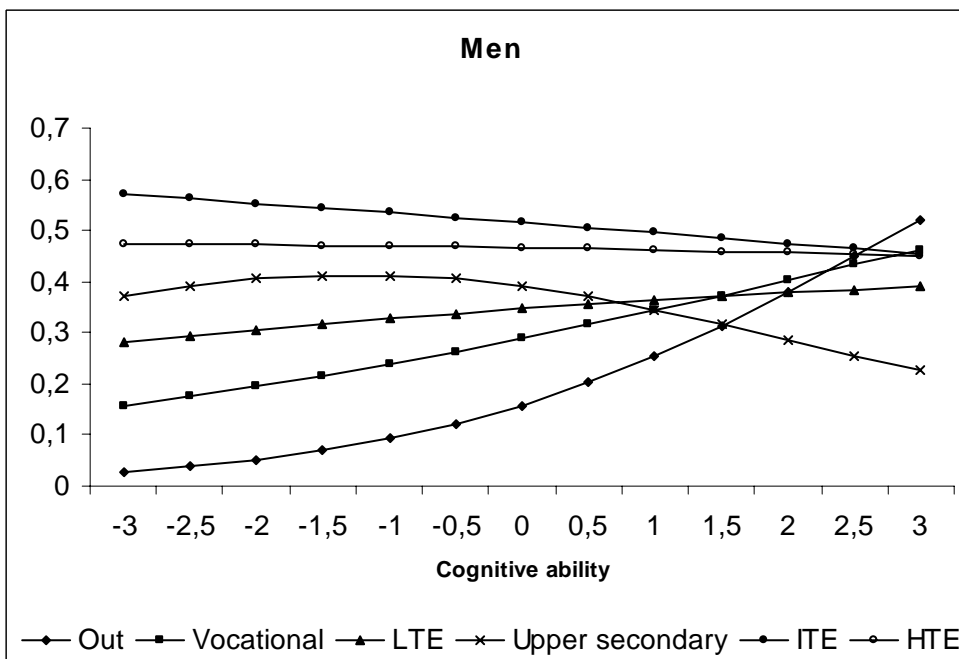


Fig. 6. – Transition probabilities into destination Class III by educational attainment, women

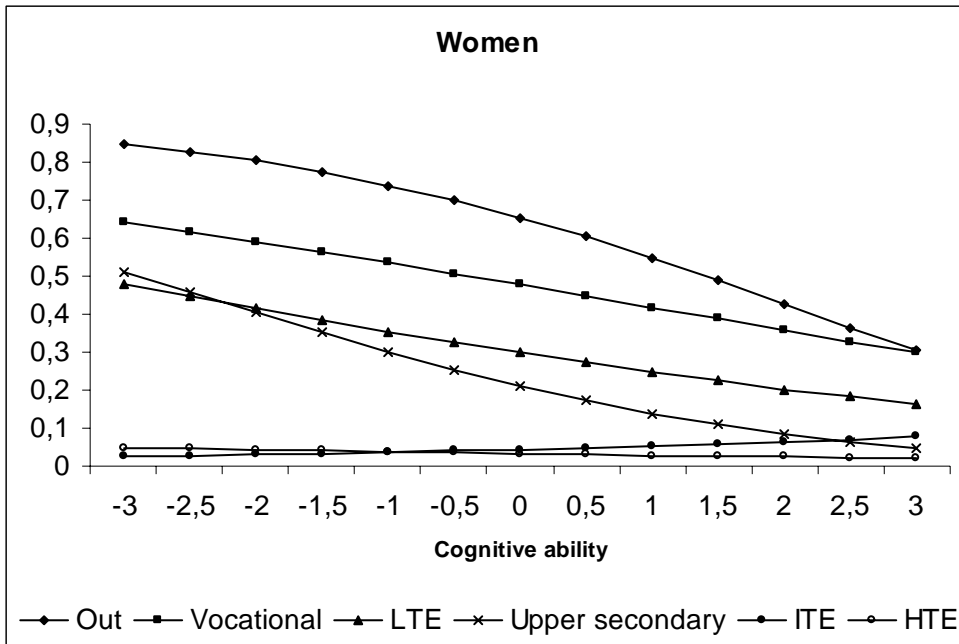
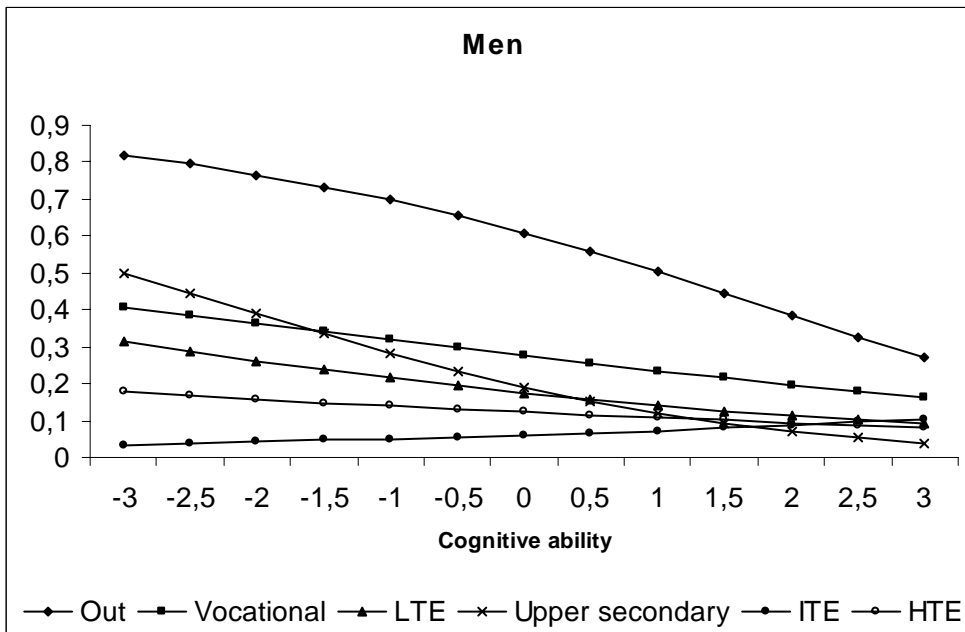


Fig. 7. – Transition probabilities into destination Class III by educational attainment, men



¹ For single country studies see: United States (Hout, Raftery, and Bell 1993; Stolzenberg 1994; Lucas 2001), United Kingdom (Micklewright 1989; Kerckhoff and Trott 1993; Sullivan 2001), Ireland (Smyth 1999), Canada (Davies 1995), Australia (Graetz 1987; Marks and McMillan 2003), Switzerland (Buchmann, Charles, and Sacchi 1993), Germany (Blossfeld 1993; Bauer and Gang 2001; Lauer 2003), France (Smith and Garnier 1986; Duru-Bellat 1996; Lauer 2003), the Netherlands (de Graaf and Ganzeboom 1993; Dronkers 1994; De Graaf, de Graaf, and Kraaykamp 2000), Italy (Gambetta 1987; Cobalti and Schizzeretto 1993; Shavit and Westerbeek 1998), Sweden (Jonsson 1993; Erikson and Jonsson 1996a; Breen and Jonsson 2000), Norway (Hansen 1997; Lindbekk 1998), Finland (Kivinen and Rinne 1996; Kivinen, Ahola, and Hedman 2001), Denmark (Davies, Heinesen, and Holm 2002), Japan (Treiman and Yamaguchi 1993), and Israel (Shavit and Featherman 1988; Ayalon and Shavit 2004).

² This formulation is based on a linear utility function. In Breen and Yaish (2006) this formulation is relaxed and a non-linear utility function is introduced which implies a decreasing marginal utility when individuals approach the same destination social class as their origin class.

³ Breen (1999) demonstrates how class-specific cultural differences in the perceived utility of education might be explained in rational choice terms. This contribution, however, still awaits incorporation into models of the type presented here.

⁴ It should be noted that in this analysis we do not incorporate the behavioural outcomes of the risks associated with choosing *but not completing* a given level of education. This aspect of RRA was omitted in order to keep the model empirically feasible, but in principle this type of risk could be incorporated into the model in a straightforward manner. On the other hand, our analysis provides a fairly elaborate empirical treatment of the risks associated with the transitions from different educational levels and into social class locations. Given the fact that so far this crucial aspect of the RRA theory has received only little attention in the literature, we believe that an emphasis on this dimension of RRA is justified.

⁵ With a less flexible model one could arrive at a nested logit type model. However, as the nested logit model makes no explicit assumptions about the influence of the transition probabilities between educational attainment and destination class we consider this model less suitable for our application.

⁶ When jointly estimating both first and second stage choices, looping over latent class involves looping over the joint probabilities of first and second stage choices.

⁷ We could, at significant computational cost, have allowed for a simultaneous estimation of the transition probabilities in the latent class model of educational attainment, thereby allowing for a correlation between unobserved variables in the model for educational attainment and the model for the transition probabilities. However, this strategy was not pursued.

⁸ There is no direct test statistic available for testing between the dynamic models with and with out latent classes, as the null-hypothesis of no latent classes is on the boundary of the parameter space of the latent class model. Hence we resolve to use alternative test strategies, such as directional derivatives (see Lesperance and Lindsay 2001).