THE RESEARCH INSTITUTE OF INDUSTRIAL ECONOMICS

Working Paper No. 613, 2004

Trapped, Delayed and Handicapped

by Anna Sjögren and Susanna Sällström

IUI, The Research Institute of Industrial Economics
P.O. Box 5501
SE-114 85 Stockholm
Sweden

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Anna Sjögren† and Susanna Sällström‡

March 16, 2004

Abstract

The dynamics of self-confidence are modelled in an environment where rational individuals optimally choose educations and occupations with the aim to acquire productive skills while learning about ability. It is shown how the presence of uninformative options can trap individuals below their potential. Furthermore, the trade-off between probability of success and value of skills may induce uncertain individuals to acquire less productive skills on their way to ability intensive occupations. The value of information also induces uncertain individuals to delay their labor market entry. The model can explain differences in perseverance in the face of failure.

Keywords: Self-confidence, self-selection, skill accumulation, Bayesian learning.

JEL-classification: D83, J24.

*This research has benefitted from discussions and comments from colleagues at Cambridge and IUI and from seminar participants at University of Chicago, SOFI Stockholm, the Stockholm School of Economics and the Institute of International Economic Studies, Stockholm. Anna Sjögren gratefully acknowledges financial support from the Bank of Sweden Tercentenary Foundation.

† The Research Institute of Industrial Economics (IUI), Stockholm, Sweden. e-mail: annas@iui.se

‡Faculty of Economics and Politics, Cambridge University, and St John's College, Cambridge, CB2 1TP, UK. e-mail: SE.Sallstrom@econ.cam.ac.uk.

1 Introduction

Many of us regret having missed some opportunity because we at the time successfully convinced ourselves that it was no use even trying or because we decided a not so challenging path was good enough for us. Regret is there because we know that of those who grabbed the chance and succeeded some had, in our view, no objective reason to believe they were better suited than we were ourselves. The purpose of this paper is to show how this phenomenon which we shall call negative self-selection can arise when individuals are fully rational but have uncertain perceptions of ability, i.e. when individuals lack self-confidence.[1] We further suggest that social and gender differences in ability perceptions through such a mechanism have a role in explaining differences in educational and labor market choices and attainment.

Family background and gender differences in educational and labor market choices and attainment are well documented.[2] Altonji and Blank(1999) state that gaps tend to persist, albeit at a lower level, in spite of massive educational expansion, public funding of schooling, increased labor market participation of women and laws against discrimination. Explanations for gaps in labor market attainment have typically been sought in differences of preferences, various forms of discrimination in the case of gender gaps, and in imperfect capital markets in the case of social gaps.[3]

[1] We use the term self-confidence to capture the mean (self-image) and variance (precision= 1/variance) of the individual's perception about his endowment of ability for a given task. There is an abundance of concepts of self in the psychological literature. Bandura's self-efficacy concept is fairly close to our own. See Bandura (1977) and Baumeister (1999).

[2] E.g. Haveman and Wolfe 1995, Altonji and Blank 1999 and Solon 1999 and Blackaby and Frank (2000), Booth and Burton with Mumford (2000), Altonji and Blank (1999), Kolpin and Singell (1996), and Erikson and Jonsson (1996).

[3] See Altonji and Blank (1999) and Mulligan(1997) for reviews of different explanations, and-Lundberg and Startz (1998) for a review of the discrimination literature.

The presence of family background and gender influences on individuals' self-perceptions documented in Baumeister(1999), Frieze et al (1978), Gecas (1989), and Pulford and Coleman (1997), provide fuel for an additional approach to understanding social and gender differences labor market attainment and behavior. We shall argue that differences in self-perceptions, and in particular in the degree of ability uncertainty, can provide a unified explanation for some empirical patterns that have previously typically been interpreted as results of discrimination or resource constraints as well as some other empirical findings brought into focus in this paper that do not find straightforward interpretation in the previous literature. The empirical patterns we aim to explain are captured by the words, *trapped, delayed, handicapped* and *stubborn.*

1) We show in section 2 that there is a non-trivial overlap in the ability distributions of Swedish university graduates and non-university graduates. This indicates that there are a number of potential university talents who could have made it had they only tried. These are candidates of people *trapped* below their potential. Moreover, Svensson (1997) presents evidence that educational choices differ by family background and gender for given high school grades and other measures of ability, indicating social and gender gaps in the risk of being trapped.[4]

2) We also show evidence, in section 2 below, of that Swedish men (women) graduating from female (male) dominated university educations do so at a higher age than their female (male) colleagues. They are *delayed.* A similar delay pattern is presented for Swedish university freshmen, where low parental education implies delayed university entry.

3) Singell, McDowell and Ziliac (2000) partly explain lower female research pro-

[4]In particular, Svensson's results indicate that girls and/or children from less privileged background require stronger signals on ability in order to opt for higher education.

ductivity, measured in terms of publications, by a female tendency to have acquired less hard core or ability intensive skills. They are in a sense *handicapped* by the choices they made along their career path.

4) Gustafsson et al (2000) presents evidence that Swedish children from working class background who fail their SATs tend to give up the idea of higher education, while children of well educated parents with the same test results are more *stubborn*, i.e. take the test over and over until they get results good enough to be admitted to university.[5]

In studies on US data, Monk (1997) and Light (1995) find a significant negative effect on wages of delayed college studies. This suggests that there is a connection between *delay* and *handicap*. Interestingly, Light (1995) concludes that her finding of lower wages due to delay cannot be explained as a consequence of that delayed individuals are drawn from the bottom end of the ability distribution, nor does she find that individuals who re-enroll do so because they have experienced negative wage shocks or that they are delayed because of financial constraints.

In order to understand why some people give up a career before they have tried, some take time before they commence their studies, some avoid challenging options even if they have good grades while others stubbornly persist when they have failed, we model the career choice of a rational, but uncertain individual.[6]

Consider an agent who is about to make her career choice. She does not know her ability.[7] She has to decide what skills to acquire by choosing between different options

[5] The evidence refers to results from Swedish SAT's in the 1990's. These SAT's can be taken by anyone who wants to qualify for university. The SAT's serve as a substitute for a high school diploma or a diploma with insufficient grades.

[6] A similar choice situation is modelled in Weinberg (2000). Weinberg, however, considers a one period framework and assumes that self-perceptions enter the utility function directly.

[7] The reason for not knowing are left out of this analysis, but absence of role models is a candidate.

where her probability of success depends on how able she is. Being successful results in productive skills, while success as well as failure reveal information about ability. While, failure will induce her to pick less ability intensive and revealing options, success will make her opt for more and more ability intensive options. Self-selection of task difficulty, hence, implies that success speeds up (slows down) learning one is able (not so able), whereas failure slows down (speed up) learning one is able (not so able), compared to an environment where choices do not affect the informativeness of the signals one receives.

The mechanism at play is that the more uncertain the agent is about her ability the more will her perception of ability be affected by the signals of success and failure. If she receives numerous positive signals not only will she start to believe she is able, she will also be increasingly sure that she is.

In such an environment, ability uncertainty and bad luck implies that an individual can be trapped below his potential without knowing it. The uncertain individual also risks not reaching his full potential, because he has acquired too little skills, even in the case when he finally realizes his ability and ends up in the appropriate option. We shall refer to these two risks of unrealized potential due to negative self-selection as the *trap of ignorance* and the *handicap of uncertainty.*[8] Ability uncertainty also creates costs related to positive self-selection since the option value of risky alternatives can cause individuals to experience frequent failures and end up with limited skills.

Models similar to ours are presented in Breen (1999), and Breen and García-Peñalosa (2002). Breen emphasizes socially determined differences in perceptions

[8]The symptoms of the trap of ignorance bare similarities to what psychologists call inaction inertia. The mechanisms are however different since inaction inertia is a result of that the individual does not want to alter his behavior (doing nothing) since this would imply that he had to admit to making the wrong choice of behavior previously. See Tykocinsky, Pittman & Tuttle (1995).

regarding the relative importance of ability vs effort in succeeding in education where individuals from disadvantaged background are typically stuck with the self-fulfilling belief that effort does not matter. However, while Breen's model gives an understanding of different educational attainments it does not capture why some individuals who have obviously worked hard and achieved high grades still do not go on to higher education. In order to explain this we introduce uncertainty about ability.

Our model of self-confidence, or perception of ability, is based on the same fundamental hypotheses as the model due to Benabou and Tirole (2000,2001), namely 1) imperfect information about ability; and 2) Bayesian updating of the individual's perception of ability and probability of success.

An important difference in a dynamic context is that we decompose self-confidence into two parts: (i) self-image - which is the individual's beliefs about his ability and, (ii) precision - which captures how certain the individual is in his self-image.[9] As a result, a person can be very self-confident in the sense of being certain, without believing himself to be a genius. Similarly a person can lack self-confidence (in the sense of being uncertain about his ability) and still have a high perceived probability of success.[10]

The point we make is that the more certain the individual, the less will he adjust his self-image as a result of success or failure and hence, the more likely he is to persevere in his original choice of career path.[11] Also the nature of the task matters

[9]Benabou and Tirole also define self- confidence and one's distribution over one's true ability, but ability in their model is synonymous to the probability of succeeding in a given task. In our model the probability of succeeding is a function of ability.

[10]In Benabou and Tirole, an individual is more self-confident the more clever he thinks he is. However, our definition of being relatively more self-confident coincides with theirs in the particular case where two individuals are equally uncertain (or confident) but have different self-image.

[11]An alternative explanation for perseverance in decision making is found in Prendergast and Stole

for how self-image is updated. If a task is so complex that even the brightest face a substantial risk of failing, then success will boost self-image while failure will have less influence on self-image. If, on the other hand, the task is so simple that very little ability is sufficient to almost guarantee not failing, then success will have little impact on self-confidence while failure will have a large negative impact on self-image.

The paper proceeds as follows. We present empirical evidence of the phenomena we wish to explain in section 2. In section 3, we outline a career choice model and in section 4 we show the consequences for behavior and outcomes of self-confidence and its dynamics. Section 5 concludes.

2 Empirical Observations

This section presents data on the types of educational choice patterns and behaviors this paper attempts to model. Our hypothesis is that these patterns can be the result of rational choice behavior of individuals or groups of individuals who have different degrees of uncertainty with regard to their own ability, i.e. who differ in terms of self-confidence. The data are taken from the "Evaluation through follow-up" (UGU) survey of Swedish school kids born in 1953 and from Statistics Sweden. The ability test scores reported are results from ability tests performed at age 12.[12]

(1996). In their model, individuals signal that they are well informed by sticking to past decisions. However, their mechanism cannot explain the perseverance of students trying to obtain an SAT score high enough to get accepted at university.

[12] A description of the data and variable definitions are found in the appendix.

2.1 Trapped and ignorant

The verbal ability distributions for university graduates and individuals without university education, non-graduates in figures 1 and 2, show that while Swedish university graduates constitute a selected group, the ability distribution of the non-university educated is close to normal. The large overlap in ability distribution indicates that there are a number of potential university talents who could have made it had they only tried.

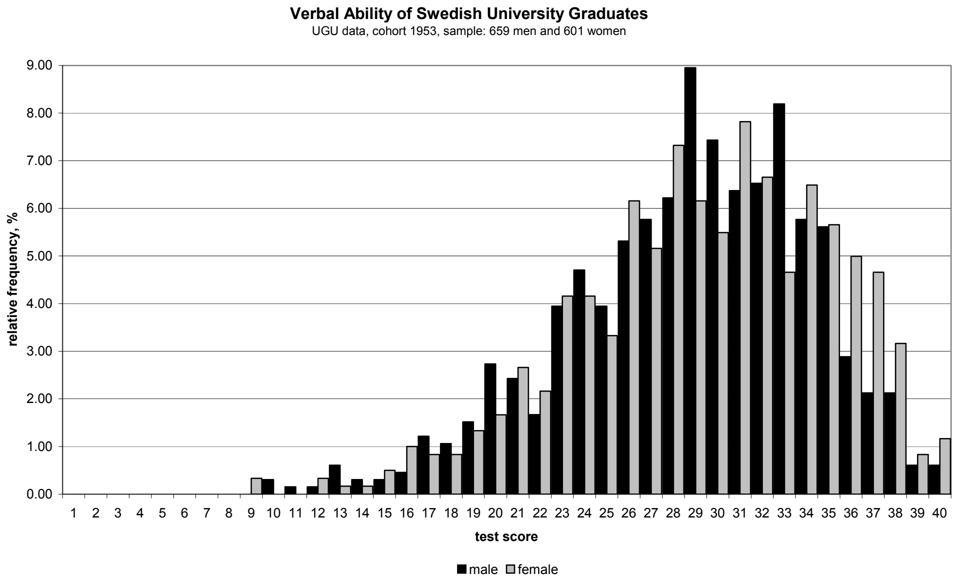


Figure 1:

The argument in this paper rests on that at least some of these potential university talents opted out because they did not believe they would make it. There may of course be other reasons for not choosing university education. Lack of other necessary abilities, lack of self-dicipline or simply having other intrerests in life are but a few. However, the basic point remains intact if we try to control for some of these reasons.

Figure 3 attempts to control for the lack of other necessary abilities by instead,

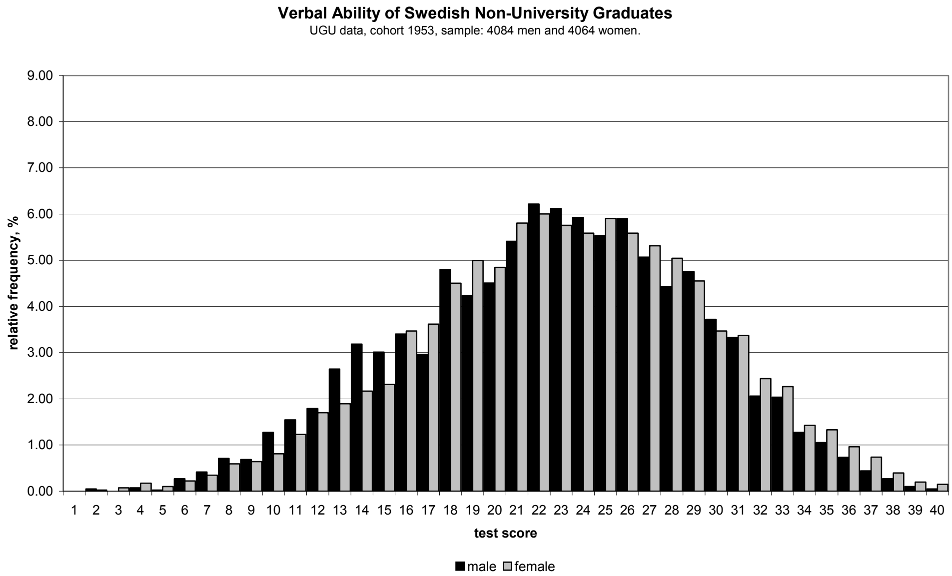


Figure 2:

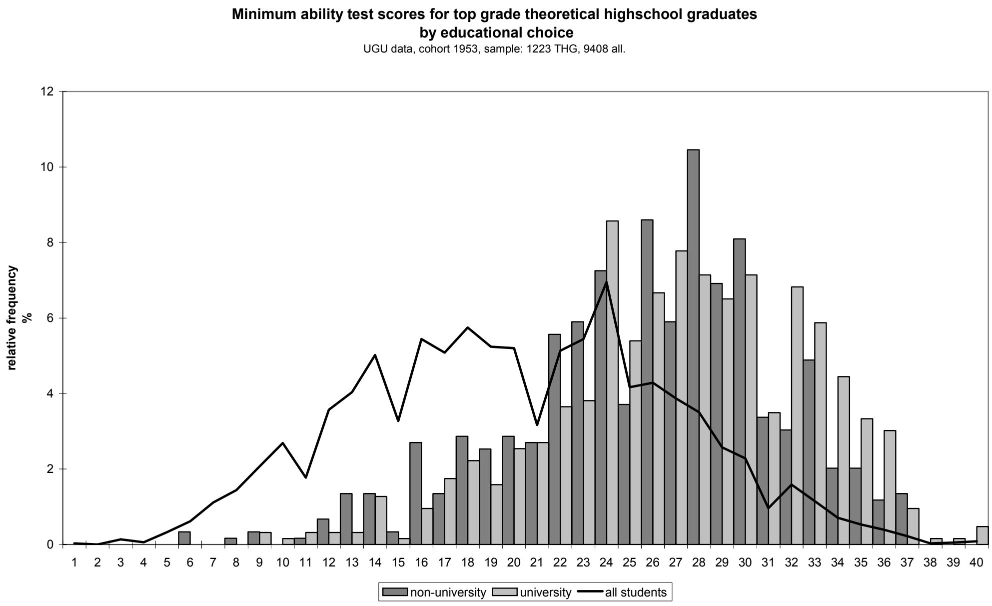


Figure 3:

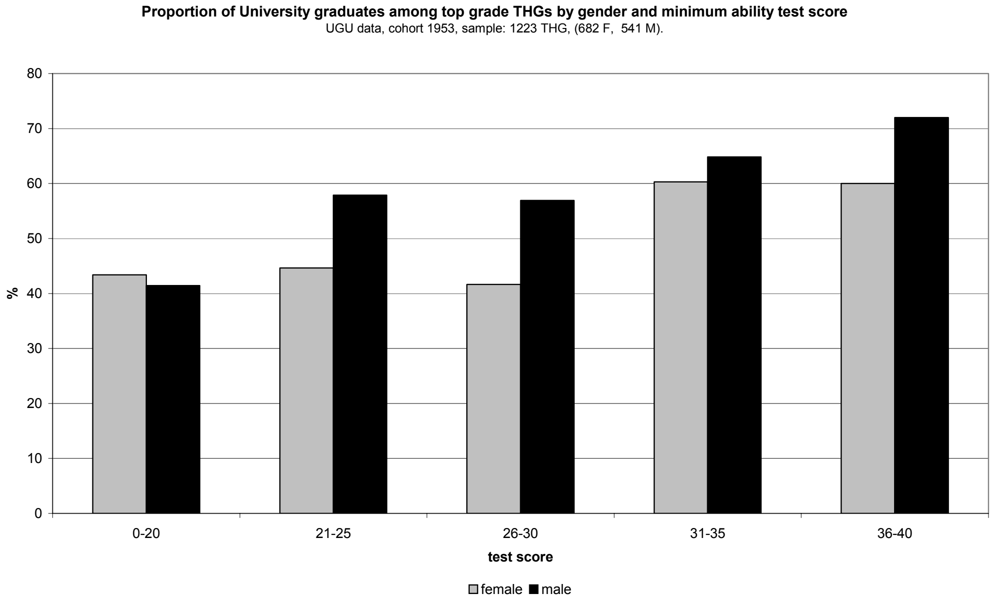
looking at the individual's minimum ability score - i.e. the minimum of the individuals scores from verbal, spacial and logical ability tests.[13] We also attempt to control for possible differences in self-discipline and school interest by restricting the sample to those who received top marks in the core subjects maths and Swedish in grade 6 (age 12). Furthermore, the sample in Figure 3 is restricted to individuals who graduated from a theoretical, university preparing high school program (THP) in order to further control for interest in theoretical subjects and higher studies.

The ability distribution of the non-graduates is no longer normal, but rather positively scewed, as is the distribution if the university graduates. Importantly, the overlap remains and it is not straigh forward to tell the distrubutions apart.

Figures 4 and 5 show that even in this very select group of students, i.e. top grade, THP graduates, the proportion of students going on to university, for a given minimum ability score, differs between male and female students and according to the educational attainment of the parents.

A reason for the differences in proportion pursuing a university degree may be resource constraints. Although this can hardly explain the gender difference, it could be part of the story in relating differences in choices to the educational attainment of the parents. However, free tuition and the generous and accessible state subsidized loans available to Swedish students since the early 1960, cast doubt on whether credit constraints are actually present. Willingness to loan finance studies may, however, differ across social groups, but this is again something which could have its reasons in differences in the perception of the risks involved in persuing a university degree. A reason for of such differences in risk perceptions, we would argue, are differences in ability uncertainty.

[13] See definition in the appendix



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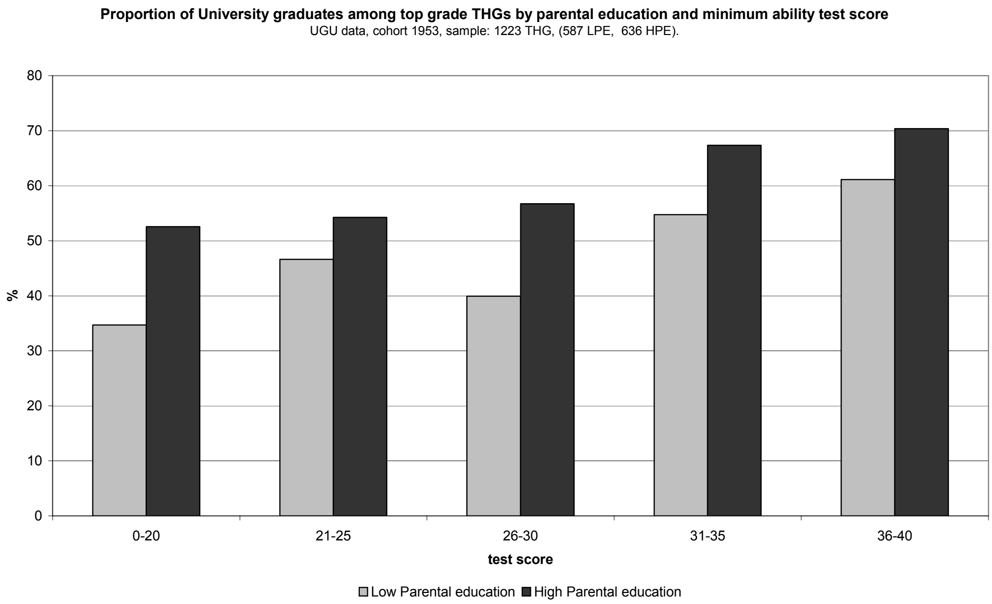

Figure 5:

2.2 Delayed

The age distributions at graduation of male and female students in male and female dominated university educations, and the distribution of parental background of university freshmen in figures 6,7, and 8 indicate that people are delayed when they enter careers in which they have reason to have relatively little knowledge of their ability. This paper presents two reasons for why uncertain individuals are delayed, both related to the incentive to test ones abilities.

First, delay into a risky career option may be caused by the individuals' incentive to find out about ability in a moderately risky alternative before daring to opt for a risky unfamiliar alterative. Second, delayed entry into a moderately risky or fairly safe career option may be caused by the individual's failed attempt to pursue a risky career alternative. To the extent that the test score averages of individuals in male and female dominate university educations, presented in the appendix, reflect how male and female dominated career options differ with respect to how ability intensive they are, we would expect the first explanation to be more prevalent for female delay and the second more valid for male delays.

Figure 6 shows that the delay of men in female dominated university educations is particularly strong. A year of this delay could be explained by the fact that most of these Swedish men were subjected to roughly a year's compulsory military service, but even taking a year off their graduation age would not change the pattern.

The military service year would make the female delay pattern in Figure 7 more pronounced. A possible explanation for the wider dispersion for both men and women in the female dominated fields is that these are relatively low paying fields in which the opportunity cost of stying on another year is not as pronounced.

In Figure 8, the average age of university freshmen between 1990 and 1998 shows

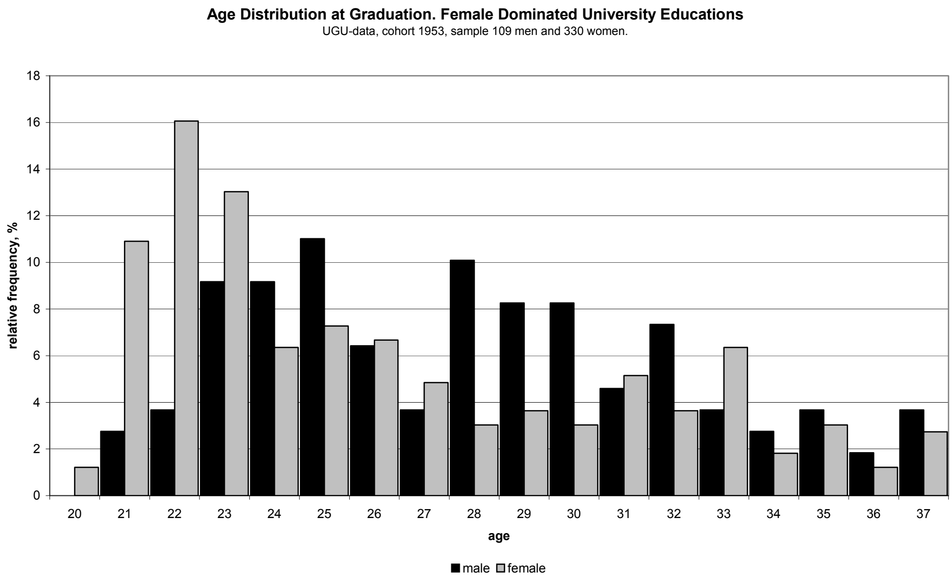

Figure 6:

a pattern which can be interpreted in an analogous fashion. Compare the relative frequency distribution across parental education categories of freshmen of ages less than 21 (the black bars) to the relative frequency distribution of freshmen aged 25-34 (the light gray bars). It is clear that the young freshmen typically have well educated parents, while the old freshmen have less educated parents.

The reason, proposed in this paper, why students from educationally disadvantaged families are delayed in their decision to go to university is that they have relatively little knowledge about their academic abilities. However, here there are numerous reasons to be cautious! Since we have no possibility of controlling for ability and grades in this table, a potential explanation is that low educated background is associated with poorer grades, making it more prevalent for such students to take advantage of the possibility offered by Swedish universities to be admitted on a quota where work experience grants qualifying credentials. Furthermore, to the extent that

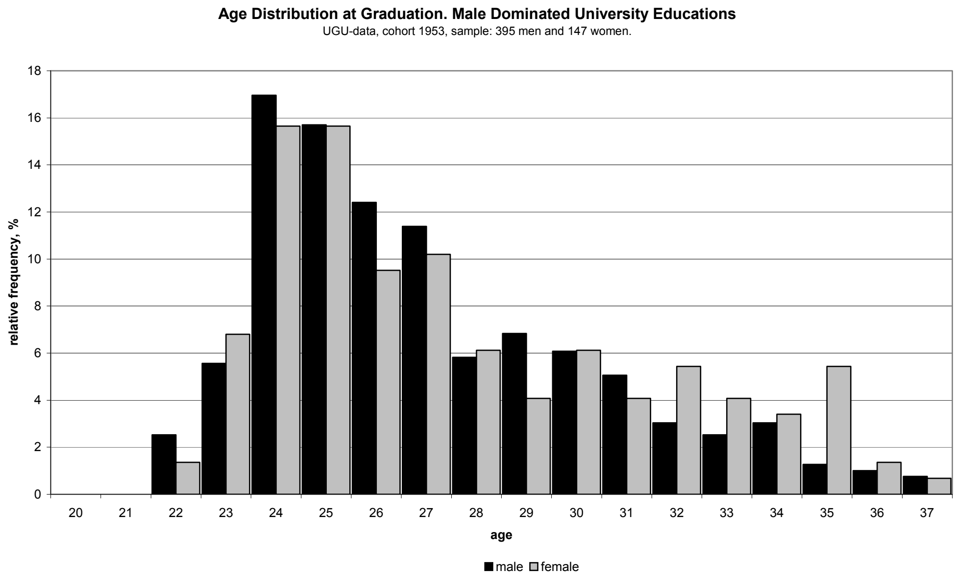

Figure 7:

low parental education means being poor could also affect the delay pattern. However, the effects could pull in different directions.[14] Scarcity of resources increase the opportunity cost of education - which would tend to increase the incentive to finish early in order to maximize the pay back time, given that the individual decides on an education in the first place, while credit market imperfections may cause poor students delay their studies in order to save first, or pursue part-time studies while working themselves through university thus delaying their graduation. Given that student loans are readily available in Sweden, the first effect is more likely to dominate.

[14]See Monk (1997), Jacoby (1994), and Light (1994).

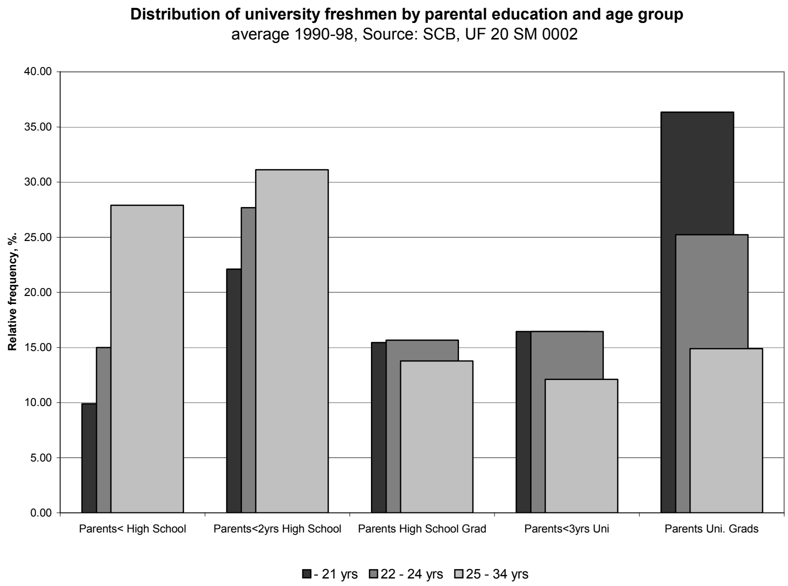

Figure 8:

3 The Model

We present a two period career choice model. At the beginning of the first period individuals choose what type of skills to acquire. At the end of the period they have either succeeded or not in acquiring the skills which leads them to update their prior beliefs about their ability. In the beginning of the second period the individual chooses a career (or an occupation) in which to work and earn a living. Second period, and hence lifetime, income depends on success on the job and on skills acquired in school.

3.1 Period one - school

Consider an individual faced with the following options. The individual can go to school to acquire

1. R - highly advanced skills (risky option),

2. M - advanced skills (moderate option),

3. O - general skills (outside option).

Let the individual's ability be $a \in [0,1]$. Furthermore, let the probability of successfully acquiring skills in the different options $C_1 \in \{R, M, O\}$ at $t = 1$, be $P_{C_1}(a) = a^{c_1}$, where $c_1 \in \{r_1, m_1, 0\}$ in the risky, moderate and outside option respectively and where $r_1 > m_1 > 0$.[15] The outside option is an option in which success does not depend on ability. The probability of success in the outside option is perfectly inelastic. If successful in school, the individual acquires skills which add h_C to working life productivity.[16] A necessary condition for all options to be considered is that $h_R > h_M > h_O$, i.e. skills that are harder to acquire are more productive. Failure at t implies that the individual gained no incremental skills at that t.

Assuming risk neutrality and that earnings are fully determined by productivity, the expected addition to working life productivity is what matters for individual choices. The expected value of skills, i.e. the addition to working life productivity acquired if option C_1 is chosen is:

$$E[H_{C_1}] = P_{C_1}(a)h_{C_1}. \tag{1}$$

Further assuming that advanced skills are preferred to less advanced if they give at least as high expected addition to productivity, an individual who is fully informed of his ability would make the following choices:

- the risky if $a \geq \overline{a}$,

- the moderate if $a \in [\underline{a}, \overline{a})$,

[15] The parameter c in a^c is $(1 -$ (the ability elasticity of success)).

[16] We assume that this is the only effect of skills, hence, excluding that skills may also influence the probability of being successful in the future.

- the outside if $a < \underline{a}$,

  where

$$\overline{a} = \left(\frac{h_M}{h_R}\right)^{\frac{1}{r-m}}, \tag{2}$$

  and

$$\underline{a} = \left(\frac{h_O}{h_M}\right)^{\frac{1}{m}}. \tag{3}$$

Assume instead that the individual does not know his ability, but that the individual has a prior distribution over ability with continuous density $\rho_0(a)$, and support $[0, 1]$. Then expected addition to productivity is:

$$E[H_{C_1}] = h_{C_1} \int_0^1 P_{C_1}(a)\rho_0(a)da. \tag{4}$$

Hence, in order for the individual to prefer option I to option J when $i > j$, the following condition has to hold:

$$\frac{h_I}{h_J} \geq \frac{\int_0^1 P_J(a)\rho_0(a)da}{\int_0^1 P_I(a)\rho_0(a)da}. \tag{5}$$

If $i < j$, strict inequality is required. The individual is trading off the probability of successfully acquiring skills to acquiring skills of higher productive value. If $\rho_0(a)$ is uniform and $P_{C_1}(a) = a^{c_1}$ this condition is equivalent to

$$\frac{h_I}{h_J} \geq \frac{1+i}{1+j}.$$

It will prove useful to introduce the following assumption.

Assumption 1 (Prior Indifference) *An individual who has received no information has a uniform prior and is indifferent between the three options if* $E[H_R] = h_R/(1+r) = E[H_M] = h_M/(1+m) = E[H_O] = h_O$.

This assumption allows us to focus our attention on: (i) the implications of dynamic considerations, and (ii) how the relative ability sensitivity between different options r, m influences choices when higher risk is exactly compensated for by higher productivity.

The effect of uncertainty in general on the expected returns in different options depends on the parameter c.

Proposition 1 *Uncertainty about ability makes options more/less attractive if the probability of success is $P_C(a) = a^c$ and c is greater/smaller than* 1*.*

Proof. The perceived probability of success in option C for an uncertain individual is greater/smaller than the probability of success for an individual who knows he is average if

$$\int_0^1 P_C(a)\rho(a)da \gtrless P_C(\int_0^1 \rho(a)da), \tag{6}$$

which holds when $P_C(a)$ is convex/concave in ability. With a uniform prior this condition becomes

$$\frac{1}{1+c} \gtrless \frac{1}{2^c} \text{ if } c \gtrless 1. \tag{7}$$

■

Thus uncertainty makes risky options more attractive if there are increasing marginal returns to ability. Note that uncertainty can affect the relative attractiveness of options. E.g. an individual who would prefer the moderate option in the absence of uncertainty, could be inclined to go for the risky option in the presence of uncertainty.

Using Assumption 1 and assuming $h_o = 1$, one can illustrate this point in a diagram in $r, m-$space. For these parameter values the cut-off abilities for an individual with known ability are $\overline{a} = \left(\frac{1+m}{1+r}\right)^{\frac{1}{r-m}}$ and $\underline{a} = \frac{1}{(1+m)}^{\frac{1}{m}}$. This implies that if ability is known to be $a = 1/2$, then $a < \overline{a}$ and the individual prefers the moderate option for parameter ranges corresponding to the white area in Figure 9. The outside option would be preferred in the light gray area and the risky option in the medium gray area. An individual with expected ability $\mu = 1/2$ would opt for the risky due to the indifference assumption.

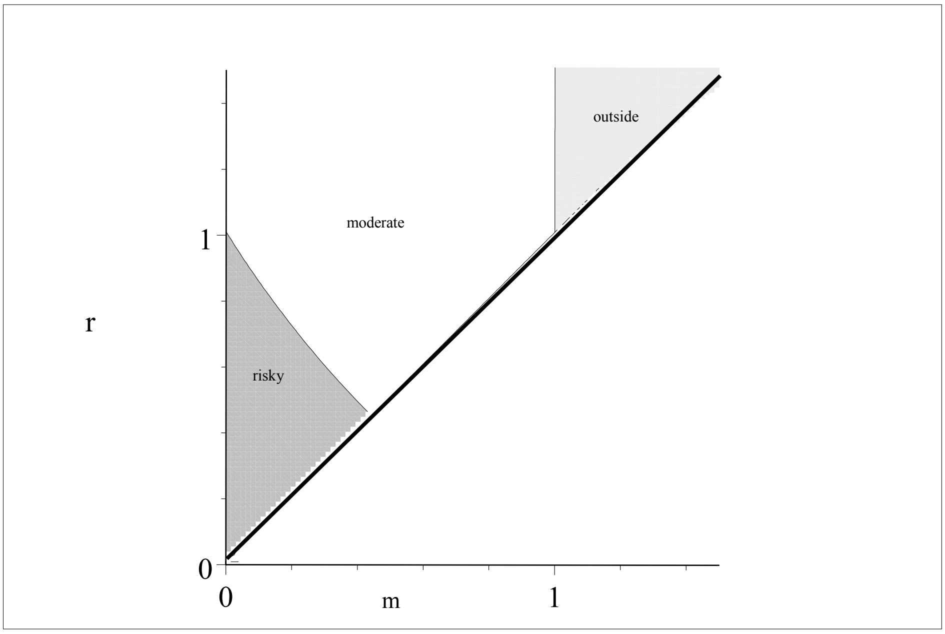

Figure 9: Optimal choices when $a = 1/2$.

3.2 Period two - working life

We model productivity, and hence earnings, in working life as either fully determined by skills acquired in school in period one or as determined by the skills acquired in school and on successfully learning skills in a chosen occupation. The probability of successfully learning on the job is assumed to depend on ability only.[17]

If working life productivity is determined by skills acquired in school, no choices are made in period two and the model reduces to the myopic one period choice model with $T = 1$. If, on the other hand, productivity in working life depends both

[17]Allowing skills acquired in school to influence the probability of learning on the job would complicate the model.

on previously acquired skills and on being successful in a chosen occupation, then the choice of occupation is of course also of importance and we have a two period, sequential skill accumulation model , $T = 2$. Skills are transferrable, which implies that successfully acquired skill from any option at $t = 1$ are productive at $t = 2$ whether or not the individual is successful in his $t = 2$ choice.

Assume that there are three possible occupations in working life, $C_2 \in \{R_1, M_1, O_1\}$, just as there were in school, and that working life productivity, H is determined by previously acquired skills H_{C_1} and on successful on the job training in the chosen occupation, $E[H_{C_2}]$, such that:

$$E[H] = H_{C_1} + E[H_{C_2}] \tag{8}$$

where $E[H_{C_2}] = P_{C_2}(a)h_{C_2}$ is the expected present value of the productivity of skills learned in occupation C_2. P_{C_2} is the probability of successfully learning on the job in occupation C_2, and h_{C_2} is the value of skills learnt on the job in C_2.[18] Conditions for optimal choice behavior of individuals who know their ability are analogous to the conditions derived for schooling choices. Uncertain individuals have, however, had a chance to learn something about their ability from their successes and failures while in school. This new information causes them to update their ability prior and hence affects their perceived probability of success in different job options.

The possibility of learning about ones ability from the experience of success and failure will also be taken into consideration in the choice of option in period one. Hence, the uncertain individual's choice situation can be seen as choosing an option, C_t in each period t given some prior information about ability. The outcome in each period is either success or failure, and since success depends on ability, success and

[18] Hence, H_{C_2}, implicitly takes into account a discount factor. The more impatient are individuals, the lower their H_{C_2} relative to H_{C_1}.

failure yield signals, $y_t \in \{s, f\}$, which are informative of ability.

Denote the probability of receiving the signal y, conditional on ability, in option C_1, $g^{C_1}(y \mid a)$, where

$$g^{c_1}(y \mid a) = \begin{cases} P_{C_1}(a) & \text{if } y = s \\ 1 - P_{C_1}(a) & \text{if } y = f. \end{cases} \tag{9}$$

Further, let the individual's prior belief about his ability at time $t = 1$ be represented by the density $\rho_0(a)$ with support $[0, 1]$. After having observed y, beliefs are updated according to Bayes' rule to form a posterior $\rho_1(a)$:

$$\rho_1(a \mid y) = \frac{g^{C_1}(y \mid a)\rho_0(a)}{\int_0^1 g^{C_1}(y \mid a)\rho_0(a)da}. \tag{10}$$

When the young individual makes his first choice of what skills to accumulate he solves the following maximization problem:

$$V_1(\rho_0) = \max_{C_1 \in \{R,M,O\}} E[H] = h_{C_1} \int_0^1 \rho_0(a) P_{C_1}(a)da + E[V_2(\rho_1) \mid y], \text{ where} \tag{11}$$

$$V_2(\rho_1) = \max_{C_2 \in \{R,M,O\}} E[H_{C_2}]$$

The individual thus has an incentive to acquire skills not only for their own sake, but also because success may improve future self-perception and chosen career option.

To gain the self-confidence to opt for a risky occupation it may be necessary for an uncertain individual to have received a signal of success in a sufficiently informative option when acquiring skills. However, aiming high to begin with is accompanied with the risk of failing to gain productive skills with subsequent low earnings whatever the choice of occupation. Thus the individual faces a trade-off between probability of gaining productive skills and a boost in self-image, and the level of productivity and size of the boost.

Let us illustrate these points by solving the individual's maximization problem under Assumption 1 and assuming a uniform prior.

First let us consider the effect on the individual's choice behavior from the first period's outcome. The individual chooses an occupation $C_2 \in \{R, M, O\}$ to maximize

$$E[H_{C_2} \mid y] = h_{C_2} \int_0^1 \rho_1(a \mid y) P_{C_2}(a) da. \tag{12}$$

The posterior from choosing option C_1 in the first period is

$$\rho_1(a \mid y) = \begin{cases} (1 + c_1)a^{c_1} & \text{if } y = s \\ \frac{c_1+1}{c_1}(1 - a^{c_1}) & \text{if } y = f. \end{cases} \tag{13}$$

For $c_1 > 0$ success gives a boost in self-perception, and failure a blow. It is easily verified that the boost is increasing in c whereas the blow is decreasing.

The expected value from choosing option C_2 in the case of success is

$$E[H_{C_2} \mid s] = \frac{(c_1 + 1)h_{C_2}}{(c_1 + c_2 + 1)} = \frac{(c_1 + 1)(1 + c_2)h_{O_2}}{(c_1 + c_2 + 1)}, \tag{14}$$

which is clearly increasing in c_2, implying that expected period two gain in productivity is maximized when $c_2^* = r_2$ (i.e. as high as possible). Thus an individual who is successful in either the risky or the moderate option in the first period, opts for the risky occupation in the second period, on the assumption of prior indifference. After a boost in self-confidence, the individual is no longer indifferent.

By symmetry of the argument, failing in either the risky or the moderate option implies that the uninformative option will be optimal. Here we have that

$$E[H_{C_2} \mid f] = \frac{h_{C_2}(c_1 + 1)}{(c_2 + 1)(c_1 + c_2 + 1)} = \frac{h_{O_2}(1 + c_2)(c_1 + 1)}{(c_2 + 1)(c_1 + c_2 + 1)} \tag{15}$$

which is decreasing in c_2. Hence, given failure, the expected value is clearly maximized when c_2 is as small as possible (i.e. the uninformative option).

Thus, if the individual has a uniform prior and is hence indifferent between the three options given $T = 1$, choice behavior in the second period if $T = 2$ will only be affected by whether the individual is successful or not, and will not depend on whether he goes for the risky or the moderate in the first period.

In the first period the individual chooses the option that will maximize the expected productivity over both periods, which for this example becomes

$$\max_{C_1 \in \{R,M,O\}} E[H \mid C_1] = \frac{1}{1+c_1}\left[h_{C_1} + h_{R_2}\frac{1+c_1}{1+c_1+r_2}\right] + \frac{c_1}{1+c_1}h_{O_2}. \tag{16}$$

It will prove useful to highlight an important aspect of the behavior of the uncertain individual who has the opportunity to learn about ability in school before he makes his occupational choice in a lemma, before we go on to characterize the conditions for optimal choice behavior.

Lemma 1 (Information is valuable) *The initially indifferent individual, strictly prefers an informative option in school when he has the opportunity to learn about ability.*

Proof. To see this, use Assumption 1 and define the information value, I_{C_1}, of choosing C_1 :

$$I_{C_1} \equiv E[H \mid C_1] - (h_{O_1} + h_{O_2}) = \underbrace{\frac{1}{1+c_1}}_{i}\underbrace{\left[\frac{(1+c_1)}{1+c_1+r_2} - \frac{1}{(1+r_2)}\right]}_{ii}h_{R_2} \tag{17}$$

Where $(h_{O_1} + h_{O_2})$ is the maximum expected productivity of an individual with uniform prior who does not learn about ability. For any value of $c_1 > 0$, I_{C_1} is clearly larger than zero. ■

Maximizing 16 is equivalent to picking the informative option which maximizes the information value I_{C_1}. From the right-hand expression in 17, it is clear that the individual faces a trade-off between probability of success, i, which decreases in c_1, and the magnitude of the boost in perceived probability of success, ii, which is increasing in c_1.

Proposition 2 (The easy track) *When the individual has an opportunity to learn about ability, he will prefer the moderate (easy track) to the risky option (hard track) if it is informative enough and if the future is not too ability intensive.*

Proof. From 17 it is straight forward to derive the following condition:

$$I_M \lesseqgtr I_R \text{ if } m_1 \lesseqgtr \frac{1+r_2}{r_1}. \tag{18}$$

■

It follows from this condition that individuals will prefer to start off in the moderate option rather than the risky, provided that the moderate option is informative enough.[19] The more risky the future, the higher is r_2, the larger the returns to information and, hence, the more informative need be the moderate option to be preferred to the risky option at $t = 1$. The riskier is the risky option (the higher is r_1), the smaller is the demand on informativeness on the moderate option for it to be preferred.

4 Effects of Self-Selection and the Dynamics of Self-Confidence

This section analyses the consequences for individual labor market behavior of the outlined model of schooling and occupational choice of individuals who are uncertain

[19] This margin in $(r - m)$-space is shown as the gray line in Figures 11 under the assumption that $c_1 = c_2$, and $h_{O_1} = h_{O_2} = 1$. It can be shown for $c_1 = c_2 = c_3$ that the margin at which the individual is indifferent between the two informative options shifts to the advantage of the moderate option if T is extended to 3. That is, further possibilities to acquire skills, makes it even more valuable to opt for safer but less productive skills.

about their ability, but who rationally update their perception of ability when they succeed or fail in their endeavors.

4.1 Delay, handicap of uncertainty, and the trap of ignorance

Lemma 1 illustrates that the possibility of learning about ability in order to make better future career decisions is obviously of value to the individual. An uncertain individual, if given a choice would *ex ante* therefore prefer to sequentially gain skills in two periods to having a one shot career choice situation.

Proposition 3 (Delay) *Uncertain individuals prefer sequential to one shot career decisions even if they are delayed if skills acquired in school are not too inferior to skills acquired on the job.*

Proof. Define a one shot career option as one which gives the possibility of gaining $2h_{C_2}$ if successful, which happens with probability a^{c_2}. The expected life time productivity of an uncertain individual with uniform ability prior, maintaining the indifference assumption, is hence $E[H_{oneshot}] = 2h_{O_2}$. It follows from lemma 2 that sequential skill accumulation gives ex ante expected productivity

$$E[H_{sequential}] = I_{C_1} + (h_{O_1} + h_{O_2}).$$

If $E[H_{sequential}]$ exceeds $E[H_{oneshot}]$ then the individual would prefer a sequential career decision even if this implied delayed labor market entry, i.e. if:

$$I_{C_1} + (h_{O_1} + h_{O_2}) > 2h_{O_2},$$

which holds if

$$h_{O_1} > h_{O_2} \frac{(1 + c_1)^2 + r_2}{(1 + c_1)^2 + (1 + c_1)r_2},$$

where the second term on the RHS is clearly smaller than unity. ■

We would hence expect uncertain individuals to enter the labor market at a higher age than certain individuals. This is exactly the pattern that was found for men graduating from female dominated university educations.

Other consequences of uncertainty that follow directly from Proposition 2 and Lemma 1 are what we call the *handicaps of uncertainty.* These capture the idea that learning about ability is costly in terms of working life productivity precisely because the individual trades off the probability of gaining skills and getting a boost in self-confidence against the amount of skills and magnitude of boost if successful. From Proposition 2 it follows that:

Corollary 1 (Costly modesty) *Uncertain individuals who reach the top via the easy track have less productive skills than confident individuals.*

To see this, compare the confident and uncertain individual who is successful at the top. The confident will have productivity $h_{R_1} + h_{R_2} > h_{M_1} + h_{R_2}$ which is the productivity of the uncertain individual who took the easy track. The first *handicap of uncertainty* is the risk of unrealized potential of those, previously uncertain individuals who eventually end up in the option suitable for their ability, but who have rationally taken the route via less demanding options and who have hence accumulated less productive skills on the way. The condition determining when it is optimal to take the easy track implies that there will be less risk of a productivity gap between confident and uncertain individuals in occupations that are very demanding in terms of ability (where r_2 is high). Similarly there will be less of a gap if the "hard track" in school is in fact not so hard (r_1 is low).[20] From Lemma 1, it follows that:

[20] Preliminary analysis of Swedish UGU-data on earnings of graduates from male dominated university educations indicate that the gender earnings gap declines as we go up the earnings distribution,

Corollary 2 (Costly conceit) *Uncertain individuals who end up at the bottom due to failure in more difficult options are less productive compared to confident individuals in the safe option.*

When there is only one period in which to learn about ability, learning is obviously incomplete. This implies that there are two types of mistakes that an individual who is uncertain about his ability at date 0 can make at date T.

1. Type I error: *overplacement* occurs when $C_T = R$ for $a < \overline{a}$, or $C_T = M$ for $a < \underline{a}$.

2. Type II error: *underplacement* occurs when $C_T = M, O$ for $a \geq \overline{a}$, or $C_T = O$ for $a \geq \underline{a}$.

If we consider a situation where the individual could gain productivity and knowledge about ability throughout his lifetime, i.e. $T \to \infty$, only underplacement errors would occur with a positive probability due to the presence of an outside option. This will be referred to as a *trap of ignorance* - the individual is trapped below his potential because he has not found out how able he really is.

Proposition 4 (Trap of Ignorance) For all $a \in (\underline{a}, 1)$ there exists a period $t < \infty$ in which the individual will pick the outside option with a positive probability, and stay there ever after.

Proof. There exists a $\mu_t > 0 \mid C_t = O = \arg\max V_t$ for $t < \infty$. To see this, suppose that the individual starts in the moderate option, and assume for convenience that $mt = m$. The probability that he will fail t times in a row is $(1 - a^m)^t$, in which case his posterior will be

$$\rho_t = \frac{(1 - a^m)^t \rho_0}{\int_0^1 (1 - a^m)^t \rho_0 da}. \tag{19}$$

Sjögren and Sällström (2004c).

After these repeated failures his self-image is $\mu_t = \int_0^1 a\rho_t(a)da$. Note that if he always fails then $\lim_{t\to\infty} \mu_t \to 0$. Thus there exists a point in time prior to that event when the individual prefers to switch to the outside option. ■

4.2 Stubbornness

So far we have focussed the analysis to effects of the opportunity to learn about ability rather than on the process of learning itself, i.e. the dynamics of self-confidence. These dynamics are vital for understanding differences in perseverance or stubbornness. Persevering in a career choice in the face of hardships and failure requires a large portion of confidence - or stability of self-image. In our terminology, perseverance in the face of failure requires the individual's variance of self-image to be small enough for a failure not to cause a large enough blow to self-confidence for the individual to opt for an uninformative option. Likewise, a confident individual will not consider success as strong a signal of ability as an uncertain individual. In the extreme, a certain individual of course does not update his perception of ability at all in the face of success and failure.

Consider two agents Perseveria and Rationella. Perseveria has had the chance to gain confidence earlier in life without changing the mean of her prior ability distribution. In particular, assume Perseveria's prior is the result of succeeding once and failing once in two equivalent endeavours where the probability of success was a, hence her ability prior $\rho_{0P} = 6(a - a^2)$. Rationella, on the other hand, has never attempted anything and hence has a uniform prior on the unit interval. Hence, Perseveria's variance is smaller than Rationella's. We know, from the previous section, what is optimal behavior of Rationella's in a two period situation, under the assumption of prior indifference. If she succeeds in her period one choice she should go for the risky option in period two and if she fails she should opt for the safe outside option. We also know that given her optimal behavior at $t = 2$, Rationella will opt for R at t=1, unless M is informative enough. (See Proposition 2)

What about Perseveria? She is obviously not indifferent in the $T = 1$ situation, she would if T were 1, opt for the moderate option if it were concave in ability, $m < 1$, and the outside otherwise. To see this note that with this prior her expected payoff from picking option C_1 is given by

$$(1 + c_1)h_{O_1}6 \int_0^1 (a^{1+c_1} - a^{2+c_1})da = \frac{6(1 + c_1)}{(2 + c_1)(3 + c_1)}h_{O_1}. \tag{20}$$

This payoff is higher than the outside option if $c_1 < 1$, i.e. concave in ability, and less than the outside option if $c_1 > 1$, i.e. convex in ability. Perseveria would be indifferent between the outside and the moderate if $m = 1$, and strictly prefer them to the risky. Similarly if Perseveria faced a world with only risky alternative options, such as $r > m > 1$, she would prefer the uninformative outside option, as opposed to Rationella who is simply indifferent. However, a forward looking Perseveria may have an incentive to experiment, i.e. by choosing a costly but more informative action in the first period. The condition for doing this is that the information value is substantial enough to compensate the lower expected payoff at $t = 1$.

It is easily verified that if Perseveria receives strong signals, i.e, if she succeeds in R or fails in M at $t = 1$, her $t = 2$ choices will be as Rationella's. However, because of her smaller variance and her non-marginality, weak signals will affect her differently. Depending on the relation between r and m, failing in R will not necessarily make Perseveria opt for the outside option, nor will succeeding in M, necessarily make her opt for the risky option at $t = 2$. Figure 10 illustrates when this is the case under the assumption that $r_1 = r_2$, $m_1 = m_2$, $h_{O_1} = 1$.

For r sufficiently large, and m sufficiently small, (above $E[H_{M_2} \mid f_{R_1}] = E[H_{O_2} \mid$

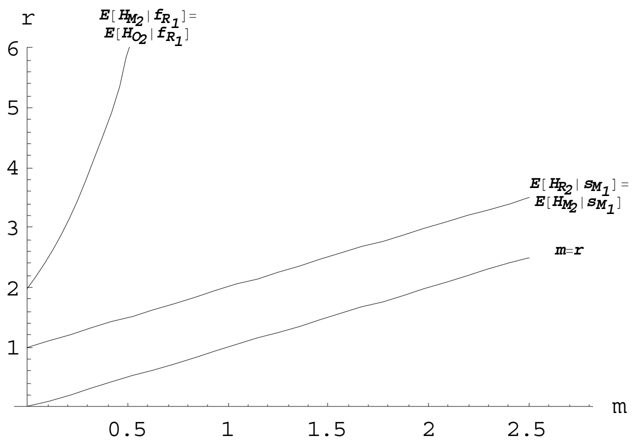

Figure 10:

$f_{R_1}]$), Perseveria prefers M to O if she fails in the risky option if $T = 2$. The reason is that failing in R, when r is so large is only a very weak signal of inability, and hence since the moderate option is not too demanding it will be preferred to the outside option at $t = 2$. For m sufficiently small relative to r, and r large enough, (above $E[H_{R_2} \mid s_{M_1}] = E[H_{M_2} \mid s_{M_1}]$), success in M is not strong enough a signal of ability to make Perseveria dare opt for R at $t = 2$, when she has succeeded in M at $t = 1$. Instead she will opt for the less demanding M.

Will Rationella and Perseveria ever make the same $t = 1$ choice but end up in different options at $t = 2$ even if they receive the same signal at $t = 1$? The answer to this is yes.

The gray line in Figure 11 shows when Rationella is indifferent between R and M, i.e. when the information values of the options are equalized, $I_M = I_R$, given prior indifference. Above, and to the right of the gray line, Rationella opts for the M, below and to the left, Rationella opts for the R-option. The thin black lines from Figure 10, show when Perseveria's behavior is potentially different from Rationella's. Only below the $E[H_{R_2} \mid s_{M_1}] = E[H_{M_2} \mid s_{M_1}]-$line, will Perseveria react in the same

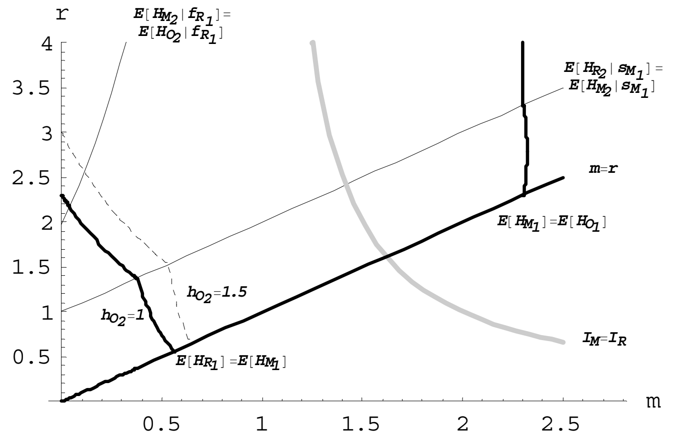

Figure 11:

way to signals of success and failure as Rationella.

Perseveria's $t = 1$ choice is shown by the thick black lines. Below, and to the left of $E[H_{R_1}] = E[H_{M_1}]$, Perseveria opts for the Risky option. Her reaction to success and failure will be the same as Rationella's except in the tiny range of r and m above the $E[H_{M_2} \mid f_{R_1}] = E[H_{O_2} \mid f_{R_1}]$. In this area, first period choice is the same, but Perseveria perseveres opts for the Moderate option if she fails, whereas Rationella then goes for the outside option.

If the value of working life human capital is large relative to school human capital, $h_{O_2} > 1$, the area in which Perseveria perseveres is larger. The dashed line in figure 11 shows the margin at which perseveria is indifferent between R and M if $h_{O_2} = 1.5$.

Between the $E[H_{R_1}] = E[H_{M_1}]$ and the $E[H_{M_1}] = E[H_{O_1}]$, Perseveria opts for the Moderate option at $t = 1$. Hence, above the gray line, Perseveria and Rationalla would make the same first period choice. While Rationella always goes for the risky when she succeeds, Perseveria only does so for small values of r. For larger r, Perseveria will instead opt for the moderate if she succeeds. We summarize the result of this section as follows:

Lemma 2 *Smaller prior variance results in smaller boost/bust in self-image in case of success/failure.*

Proof. It is verified in the appendix that Perseveria's self-image, $\int_0^1 a\rho_{1P}da$ after success (failure) in C_1 is lower (higher) than Rationella's. ∎

Proposition 5 (Stubbornness) *Smaller prior variance leads to more persistent behavior when signals are weak.*

Proof. Given Perseveria's updated priors from Lemma 2 the solutions to the equations $E[H_{R_1}] = E[H_{M_1}]$ and $E[H_{M_1}] = E[H_{O_1}]$ (in Fig 11) show that if $r_1 = r_2$, $m_1 = m_2$, $h_{O_1} = h_{O_2} = 1$, there exist pairs (m, r), for which Rationella and Perseveria opt for R (M) at $t = 1$, such that Perseveria's optimal choice at $t = 2$ is M in the event of failure (success). ∎

It is interesting to note that perseverance depends not only on the variance of the prior, but also on the informativeness of the signal received. The point is that the smaller the variance of the ability prior, and the higher the probability of failing for brilliant individuals, i.e. the larger is c, the smaller will be the blow to self-perception of a failure. Confident enough individuals will, hence be able to endure failures without being totally discouraged. At the same time, confident individuals people can experience success without making large upward adjustments in their self-perception, especially if the option they succeed has a high probability of success, (c is low). As a result it takes long time to improve self-image for an individual with low mean and variance. The reason is that such an individual is likely to chose options resulting in weak signals of ability in case of success.

5 Concluding discussion

We have studied the effects of ability uncertainty on career choices and shown that several labor market phenomena can be explained by our model of educational and occupational choices under ability uncertainty and Bayesian updating.

We have taken differences in self-percetion as our starting point. Trying to understand the emergence of group differences in perceptions of self is a natural continuation. Absence of role models - individuals who can serve as points of reference when the individual forms his perception of self, is one possible story.[21] Another example of informational role-models is present in Chung (2000).[22]

This paper has emphasized the adverse consequences of being trapped and remaining ignorant, but, of course, the outside option can be both curse and blessing. If the outside option is lucrative enough, why force yourself through pain,sweat and hard work in a PhD program, when investment banking is really your mission in life. On the other hand, if the presence of an outside option - be it in the form of a high minimum wage, a generous welfare system or a safe future taking over the family trade - discourages you from exploiting your comparative advantage it can be a costly trap.

A relevant issue is how to solve problems of negative self-selection that arises from lack of confidence. One obvious solution is to increase and improve the signals individuals get on their ability at early stages in their career. The problem is, of course, how this can be done.

Clearly, some abilities are costly to reveal - typically those that require large

[21] We investigate this route in Sjögren and Sällström (2004)

[22] In Chung the emphasis lies on the role-model as a provider of information on the returns to effort in pursuing a career path where individuals know their own ability, but cannot distinguish whether others have failed as a result of insufficient ability or effort.

human capital investments. Some are more readily spotted - like beauty, soccer etc. Little surprise, talent scouts are typically found in areas requiring such easily revealed talents and where the talent scouts can extract rents because they have superior information on what it takes to be successful. Furthermore, some abilities need to be revealed early in life in order to have a chance to pay off - e.g. ballet, gymnastics or tennis. Other talents can be productive also late in life. This may explain why some parents encourage their young children to spend much time and effort nourishing and experimenting in order to reveal such "perishable" talents. Academic talents can wait - at least in some societies.

School is, of course, an important experimental arena for revealing certain abilities - apart from providing valuable general skills. The sociological literature provides evidence that extended compulsory schooling increases social mobility.[23] That more students from disadvantaged educational background opt for higher education seems to be evidence that more academic talents are revealed, which is supportive of our model. A problem arises, however, when schools do not provide signals or when the signals given to children are too weak and erroneous. We show in Sjögren and Sällström (2004b) that the costs of no signals can be higher than the costs of strong, but biased signals, especially in the tails of the ability distribution.

However, the structure of wages, has perhaps the largest influence on which talents it is worth spending time to reveal - either in school, in the basement with the guitar, in front of the computer hacking away or on the soccer field. If returns to education are low and if schools provide poor signals - the talents worth experimenting to reveal are likely to be other than academic talents.

[23] See also Meghir and Palme (1999).

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A Appendix

A.1 Description of UGU 1953 -Data[24]

Total sample 9408 individuals on which there is information om verbal ability from UGU53 cohort, which is a representative sample of about 10% of all individuals born in Sweden in 1953, are selected. Of these a sub-sample of individuals, 659 men and 601 women, have completed at least 3 years of university education. Out of these 1260 we have detailed information on highest degree completed and age at graduation for a sub-sample containing 981 individuals, 504 men and 477. The degrees (3-digit SUN codes) of these 981 individuals have been categorized into male and female dominated fields based on the ratio of men to women in UGU48 data set. The reason for using the UGU48 proportions of male to female is that choices are typically influenced on the information available prior to entering university. Another argument is that we want to avoid exaggeration of the delay effects by putting too much emphasis on those who enter an education late precisely because this education is under rapid change in its male female ratio. E.g. if the ban on female priests is suddenly lifted, it is not strange if, initially, female priest graduates are older than male.

[24] See also the information and code books available on http://www.ssd.gu.se/kid/indexval.html.

Sun code	Education	N obs Cohort-53	Male Proportion Cohort-53	Male Dominated Cohort-48
	Art and Humanities			
160	general	37	0.68	1
164	librarian	15	0.33	0
166	humanities	26	0.42	0
170	PhD arts	2	1.00	1
	Education			
260	Child Ped	78	0.04	0
261	Primary School Teacher	98	0.32	0
263	Special Teacher	20	0.35	0
264	Tech/Home Econ Teacher	35	0.23	0
267	Sen. High Teacher	47	0.62	0
268	Higher Ped Educ	25	0.26	0
269	Other Ped educ	34	0.56	1
	Social Science			
360	Journalism	13	0.38	1
362	Business	104	0.76	1
363	Behavioral/Psychology	137	0.32	0
364	Law	56	0.55	1
365	Master of Politics	1	1.00	1
366	Social Science Degree	50	0.47	1
370	PhD Social Science	29	0.59	0
	Science			
460	general	48	0.71	1
464	Civil engineer/architecture	165	0.88	1
470	PhD Science	26	0.81	1
	Transport			
560	general	13	0.92	1
	Medical			
660	Med Lic	81	0.58	1
662	Dentist	35	0.54	1
663	Physiotherapy	5	0.00	0
666	Adv Nurse	47	0.02	0
669	Other med	14	0.36	1
670	Med Dr	11	0.64	1
	Agriculture			
760	general	10	0.30	1
	Military			
860	general	17	1.00	1
866	Special Officer	24	1.00	1
	Other University Education			
960	general	12	0.67	0

Source: UGU48, UGU53

Table A1

A.2 Variable definintions

THG: three year theoretical university preparing highshool program

Minimum ability test score takes on values from 1 to 40. The distribution of the minimum of each individual's standardized test scores (from the verbal, spacial and logical tests) is divided into 40 quantiles. The individual is assigned the test score corresponding to his position in the distribution.

A.3 Stubborn self-image and behavior

A.3.1 Lemma 2

Success in C_1 gives Perseveria an updated prior

$$\rho_{1P|s \text{ in C}_1} = \frac{a^{c_1} 6(a-a^2)}{\int_0^1 a^{c_1} 6(a-a^2) da} = (c_1+3)(c_1+2) a^{c_1} \left(a-a^2\right). \quad (21)$$

Perseveria's self-image is hence:

$$\int_0^1 a \rho_{1P|s \text{ in C1}} da = \frac{2+c_1}{4+c_1} < \int_0^1 a(1+c_1) a^{c_1} da = \frac{1+c_1}{2+c_1}, \quad (22)$$

which is Rationella's self-image after success in C_1. Failure in C_1 gives Perseveria an updated prior:

$$\rho_{1P|f \text{ in C1}} = \frac{(1-a^{c_1}) 6(a-a^2)}{\int_0^1 (1-a^{c_1}) 6(a-a^2) da} = 6\left(1-a^{c_1}\right)\left(a-a^2\right) \frac{(c_1+3)(2+c_1)}{c_1(5+c_1)}. \quad (23)$$

Perseveria's self-image is then:

$$\int_0^1 a \rho_{1P|f \text{ in C1}} da = \frac{c_1^2+9c_1+14}{2\left(9c_1+c_1^2+20\right)} > \int_0^1 a \frac{(1+c_1)}{c_1}(1-a^{c_1}) da = \frac{1+c_1}{2(2+c_1)}, \quad (24)$$

which is the self-image of Rationella's after failure in C_1. Hence, success (and failure) has smaller positive (negative) effect on Perseveria's self-image than on Rationella's.

A.3.2 Proposition 5

If she has succeeded at $t=1$, Perseveria's expected gain in productivity from choosing C_2 is:

$$\begin{aligned} E_P[H_{C_2} \mid s_{C_1}] &= h_{C_2} \int_0^1 (c_1+3)(c_1+2) a^{c_1} \left(a-a^2\right) a^{c_2} da \quad (25) \\ &= \frac{h_{C_2}\left(c_1^2+5c1+6\right)}{(c_1+c_2+3)(c_1+c_2+2)} = \frac{h_{O_2}(c_2+1)\left(c_1^2+5c1+6\right)}{(c_1+c_2+3)(c_1+c_2+2)}. \end{aligned}$$

Hence, Perseveria's expected productivity is not necessarily increasing in C_2, as is Rationella's, which can be verified by taking the derivative of expected productivity with respect to ability sensitivity in the chosen option.

$$\frac{d\left(E_P[H_{C_2} \mid s_{C_1}]\right)}{d(c_2)} = h_{O_2}\left(5c_1 + c_1^2 + 6\right)\frac{c_1^2 + 3c_1 + 1 - 2c_2 - (c_2)^2}{\left(c_1 + 3 + c_2\right)^2\left(c_1 + 2 + c_2\right)^2} \tag{26}$$

This derivative is clearly negative if c_2 is large relative to c_1, implying that there are possible values of r_2 and m_1, m_2 such that M_2 is the preferred option.

We can make a similar argument for the situation following a failure at $t = 1$.

$$\begin{aligned} E_P[H_{C_2} \mid f_{C_1}] &= h_{C_2}\int_0^1 6\left(1 - a^{c_1}\right)\left(a - a^2\right)\left(c_1 + 3\right)\frac{2 + c_1}{c_1(5 + c_1)}a^{c_2}da \\ &= 6\frac{h_{O_2}(c_2 + 1)\left(c_1 + 3\right)\left(c_1 + 2\right)\left(c_1 + 2c_2 + 5\right)}{\left(c_2 + 2\right)\left(c_2 + 3\right)\left(c_1 + 5\right)\left(c_1 + c_2 + 2\right)\left(c_1 + c_2 + 3\right)}. \end{aligned} \tag{27}$$

The derivative of $E_P[H_{C_2} \mid C_1]$ with respect to c_2 can be shown to be positive for small c_2 when c_1 is very large.

If $r_1 = r_2$ and $m_1 = m_2$, $E_P[H_{M_2} \mid s_{M_1}] \gtreqless E_P[H_{R_2} \mid s_{M_1}]$ if

$$\frac{h_{O_2}(m + 1)\left(m^2 + 5m + 6\right)}{\left(m + m + 3\right)\left(m + m + 2\right)} \gtrless \frac{h_{O_2}(r + 1)\left(m^2 + 5m + 6\right)}{\left(m + r + 3\right)\left(m + r + 2\right)}$$

ie if

$$r \gtreqless m + 1.$$

Furthermore, it can be shown that $E_P[H_{M_2} \mid f_{R_1}] > E_P[H_{R_2} \mid f_{R_1}]$ and that there exits an $r(m)$ that solves $E_P[H_{M_2} \mid f_{R_1}] = E_P[H_{O_2} \mid f_{R_1}]$. This $r(m)$ is shown in figure 10.

Given that Perseveria behaves optimally at $t = 2$, her first period problem is to choose C_1 to maximize pay-off:

$$E[H_{C_1}] = \frac{6}{(c_1+3)(c_1+2)}\left((c_1+1)\,h_{O_1} + E_P[H_{C_2^{*s}} \mid s_{C_1}]\right) +$$
$$+\left(1-\frac{6}{(c_1+3)(c_1+2)}\right)E_P[H_{C_2^{*f}} \quad | \quad f_{C_1}],$$

where C_2^{*s} and C_2^{*f} are the optimal choice at $t = 2$ given success and failure in C_1 at $t = 1$.

The solutions to the equations $E[H_{R_1}] = E[H_{M_1}]$ and $E[H_{M_1}] = E[H_{O_1}]$, given optimal behaviour at $t = 2$ are shown as the thick black lines in Figure 11 for $h_{O_1} = h_{O_2} = 1$, and for $h_{O_1} = 1$, and $h_{O_2} = 1.5$. It is clear that there exist (m, r) such that Rationella and Perseveria make the same $t = 1$ choice, but make different $t = 2$ choices even if they receive the same (weak) signal.