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TRAPPED, DELAYED AND HANDICAPPED

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ABSTRACT

Trapped, Delayed and Handicapped*

The dynamics of self-confidence are modelled in an environment where rational individuals optimally choose education 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 labour market entry. The model can also explain differences in perseverance in the face of failure.

JEL Classification: D83 and J24
Keywords: Bayesian learning, self-confidence, self-selection and skill accumulation

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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. 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]

Who are the people with the regrets?

Regrets arise when people realize that they are themselves responsible for being trapped, delayed or handicapped. That is, when they understand that they could have reached further had they only taken that chance, if they had launched themselves in time and if they had not avoided the tough challenges.[2]

But why do some people give up a career before they have tried and why do others take such time in deciding what to become? Can the answer to these questions help us understand differences in labor market attainment and behavior that are related to gender and social background? These are the issues addressed in this paper.

In order to understand these phenomena, we model the career choice of a rational, but uncertain individual.[3] Consider Rationella. She has no idea how able she is.[4] She has to decide what skills to acquire by choosing between different options where her probability of success depends on how able she is. Being successful results in skills, while success as well as failure reveal information about ability. Rationella will opt for more and more ability intensive options in response to success. Failure will induce her to pick less ability revealing options. Self-selection of difficulty of the task implies

[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] Potential candidates for such regrets could be the women academics studied in Singell, McDowell and Ziliac (2000) who were shown to have lower productivity, measured in terms of publications, partly as a result of having acquired less ability intensive skills.

[3] 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.

[4] Her reasons for not knowing are that she knows of no women in the field she considers, neither does she have anyone in her family who has ever persued that kind of career.

that success will speed up (slow down) learning she is able (not so able), whereas failure will slow down (speed up) learning she is able (not so able), compared to an environment where she cannot affect the informativeness of the signals she receives.

The mechanism at play is that the more uncertain Rationella 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 realizes his ability and ends up in the appropriate option. We shall refer to these two risks of unrealized potential as the *trap of ignorance* and the *handicap of uncertainty.*[5] 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.

The presence of family background or gender influence on individuals' self-perceptions render the dynamics of self-confidence important for understanding social and gender biases in labor market attainment and behavior.[6] Indeed, evidence from experimental psychology support gender differences in some measures of self, indicating that men show greater tendencies of overestimating their capacities than do women.[7] Gecas (1989) also relates a large number of studies that have found significant gender and social differences in various measures of self-efficacy - the individual's perceptions of his own capacity to master a situation - both for children and adults.[8]

[5]The symptoms of the trap of ignorance bare similarities to what psychologists call inaction inertia. The mechianisms 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).

[6]See e.g. Blackaby and Frank (2000), Booth and Burton with Mumford (2000), Altonji and Blank (1999), Kolpin and Singell (1996), and Erikson and Jonsson (1996) for evidence on such biases.

[7]See Frieze et al 1978, Baumeister (1999), Pulford and Coleman (1997).

[8]While this paper deals with the consequences of self-confidence differences, we model the formation of ability priors and their relation to gender and social background in "Signals, Role Models, and the Perception of Ability" (in progress).

The notion that bad self-confidence can result from absence of role models or few points of reference due to minority position is supported in this passage from Steven Sedley's, Lord Justice of Appeal, 1999 Hamlyn lecture that was brought to our attention in Booth and Burton with Mumford(2000).

Our hypothesis is that differences in self-perception, and in particular, differences in degree of uncertainty, is one factor behind why 1) the educational choices of Swedish high school graduates reveal significant gender and social differences for given high school grades and other measures of ability.[9] 2) 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.[10] 3) a: Swedish men, graduating from female dominated university educations do so at a higher age than their female colleagues, i.e. they are *delayed*. b: Low parental education implies delayed university entry.[11] 4) Women in academic economics tend to have acquired less ability revealing skills that partly explain their lower research productivity when measured in terms of publications. They are in a sense handicapped by the choices they made along their career path.[12]

Explanations for biased labor market attainment have typically been sought in differences of preferences, discrimination, imperfect capital markets or in other constraints on individual choices that distort the relative returns to different alternatives as perceived by the individual.[13] However, as pointed out in Altonji and Blank(1999), these gaps are very persistent and survive albeit at a lower level when there are laws against discrimination and when education is publicly financed. Our model shows

"Women and members of ethnic minorities still face problems of self-confidence even when they are merely deciding to try to enter fields of activity where the white male dominates. For those who do enter, experience suggests that to succeed they have to do better than their white male counterparts." (Sedley 1999)

[9]See Svensson (1997). Svensson's results indicate that girls or kids from less privileged background require stronger signals on ability in order to opt for higher education. Svensson's results are partly confirmed in authors' preliminary analysis of UGU-1953 (Evaluation through follow-up). In particular, men in female dominated fields seem to have selected more strongly on verbal ability than men in male dominated fields. See Table 1 in section 2.

[10]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. Gustafsson et al (2000)

[11]See Histograms of graduation age for men and women in female/male dominated education in Figures 3 and 4 in section 2. Also study figure 5 portraying age at university entry of individuals by parental education in section 2. To our knowledge, such delays have not previously been studied.

[12]Singell, McDowell and Ziliac (2000)

[13]See Altonji and Blank (1999) for a review of different explanations and Lundberg and Startz (1998) for a review of the discrimination literature.

that a greater degree of uncertainty gives rise to a risk of being trapped or delayed with less skill, which can help explaining the persistence of these gaps.

An argument similar in flavor to the one presented in this paper is present in Breen (1999). Breen emphasizes socially determined differences in perceptions 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 individuals (typically girls) who have obviously worked hard and achieved high grades still do not go on to higher education.[14] 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.[15] In their model a person is more self-confident the cleverer he thinks he is. In our model, on the other hand, 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.[16]

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.[17] Also the nature of the task matters

[14] See evidence presented in Svensson 1996.

[15] 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.

[16] 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.

[17] An alternative explanation for perseverance in decision making is found in Prendergast and Stole (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.

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 be a major blast.

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 histrograms and a table that reveal interesting patterns relating to educational choice behavior. The hypothesis of this paper 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 born school kids born in 1953 and from Statistics Sweden. The ability test scores reported are results from ability tests performed at age 12.[18]

2.1 Trapped and ignorant

The verbal ability distributions for university graduates and individuals without university education in tables 1 and 2, show that while the university graduates constitute a selected group, the ability distribution of the non-university educated is close to normal. This pattern indicates that there are a number of potential university talents who could have made it had they only tried. In that sense they are candidates of people who are trapped below their potential.

[18] A description of the data is found in the appendix.

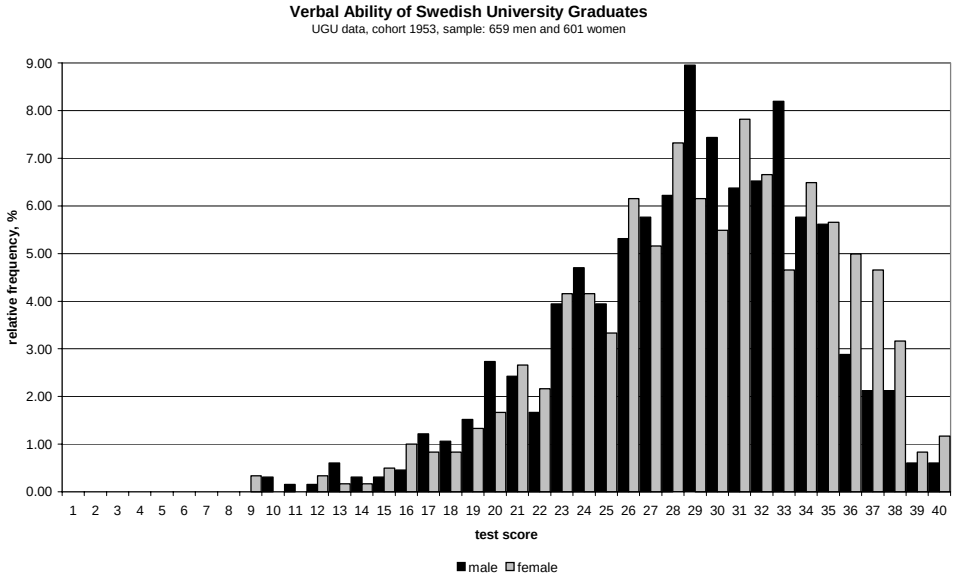

Figure 1

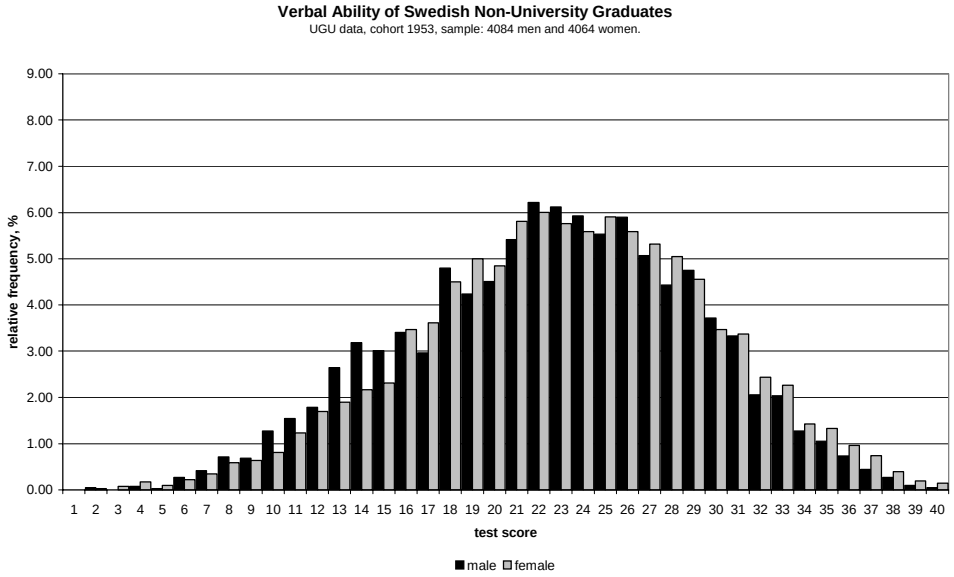

Figure 2

In table 1, another interesting pattern emerges. Groups of individuals differ in how they select into university educations. It is clear from table 1 that men have on average lower verbal ability than women. Interestingly this is true in all subcategories except for female dominated university educations. An interpretation of this, which is in line with the model presented in this paper, is that men are more strongly selected

on verbal ability in this category, precisely because female dominated educations are educations in which men face a significant degree of uncertainty.

Male-Female Comparison of Test Scores by Educational Category

		Logic Test Score				Verbal Test Score		
		male	female	All		male	female	All
No University	mean	19.42	19.39	19.41	mean	22.69	**23.17**	22.93
	s.d.	8.00	7.71	7.86	s.d.	6.49	6.49	6.49
	N	3948	3943	7891	N	3948	3943	7891
University								
male dominated	mean	26.25	26.47	26.31	mean	29.16	**30.39**	29.49
	s.d.	7.44	6.75	7.26	s.d.	5.36	5.44	5.40
	N	500	185	685	N	500	185	685
female dominated	mean	24.15	24.57	24.46	mean	27.97	28.81	28.59
	s.d.	6.98	6.94	6.95	s.d.	5.51	5.83	5.76
	N	141.00	403.00	544.00	N	141.00	403.00	544.00
All	mean	20.31	20.14	20.23	mean	23.56	**23.97**	23.76
	s.d.	8.22	7.86	8.04	s.d.	6.70	6.72	6.71
	N	4589	4531	9120	N	4589	4531	9120

Data: UGU 1953. Bold figures: female score significantly higher at 1%

Table 1

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 3,4, and 5 indicate that people are delayed when they enter careers in which they have reason to have relatively little knowledge of their ability.

Figure 3 shows that the pattern is particularly strong in female dominated university educations, where men are very delayed. 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.

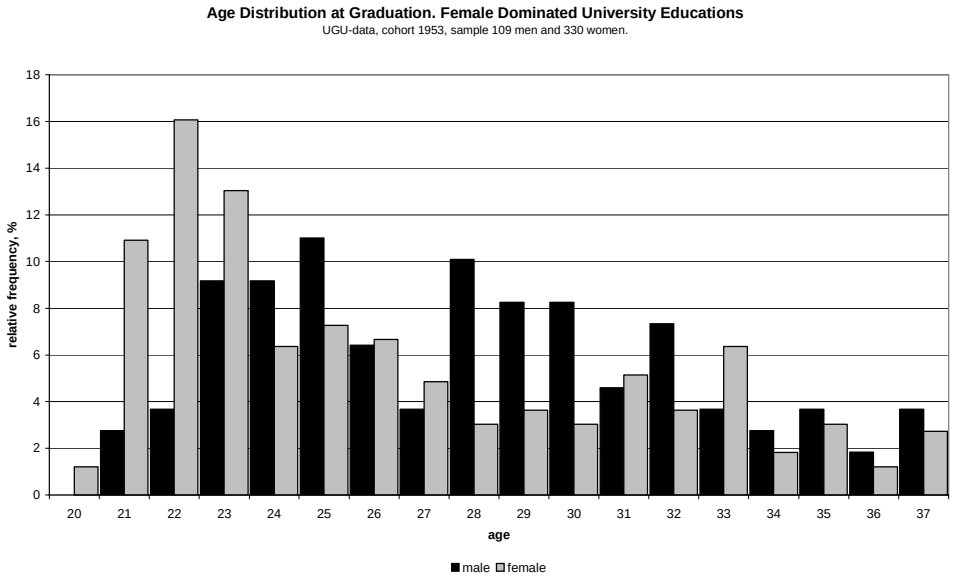

Figure 3

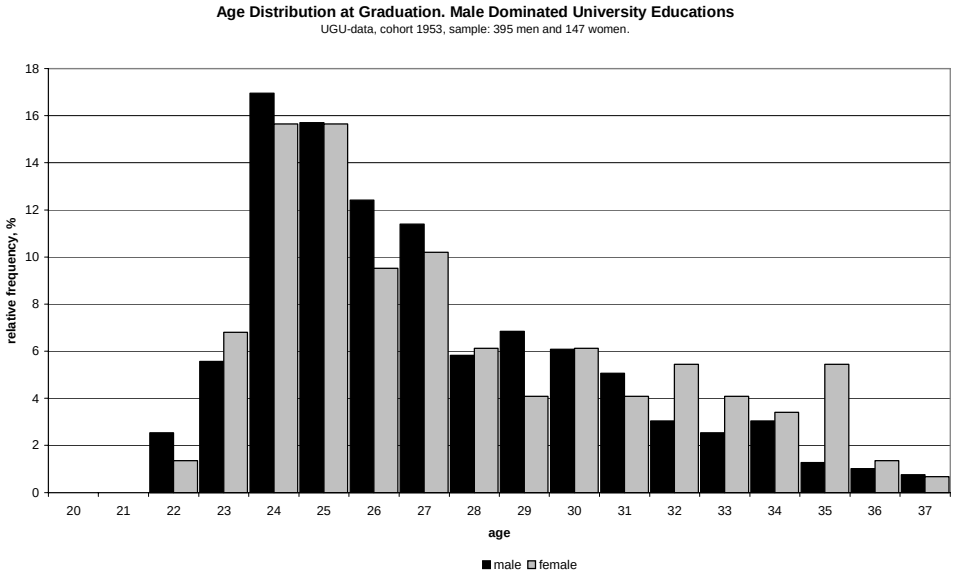

Figure 4

In figure 5, the average age of university freshmen between 1990 and 1998 shows a pattern which we interpret 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 an educationally disadvantaged family background are delayed in their decision to go to university is that they have relatively little knowledge about their academic abilities.

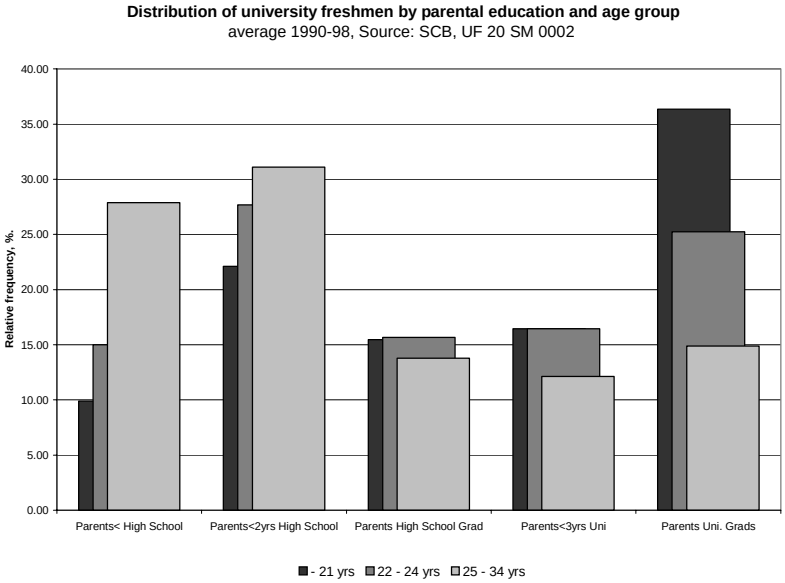

Figure 5

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 the 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 $r_1 > m_1 > 0$.[19] 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.[20] 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 gives no skills.

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

where

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

and

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

[19] The parameter c in a^c is $(1 - (\text{the ability elasticity of success}))$.

[20] We assume that this is the only effect of skills, hence, excluding that skills may also influence the probability of being successful on the job.

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 more productive skills. 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

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

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 in the presence of uncertainty.

Using Assumption 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 6. 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.

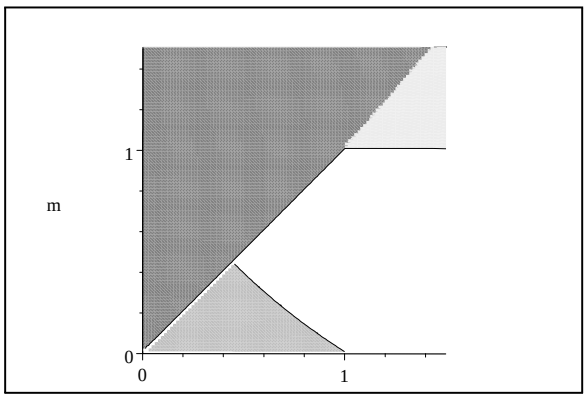

Figure 6. Optimal choices when $a = 1/2$.

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.[21]

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

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 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 , $T = 2$.

Assume that there are three possible occupations in working life, $C_2 \in \{R_1, M_1, O_1\}$,just as there is 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 productivity of the 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. 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 their perceived probability of success.

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 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 $\rho_1(a)$. Thus:

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

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

$$\begin{aligned} V_1(\rho_0) &= \max_{C_1 \in \{R,M,O\}} E[H] = h_{C_1} \int_0^1 \rho_0(a) P_{C_1}(a)da + E[V_2(\rho_1) \mid y], \text{ where} \\ V_2(\rho_1) &= \max_{C_2 \in \{R,M,O\}} E[H_{C_2}] \end{aligned} \tag{11}$$

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 blast. It is easily verified that the boost is increasing in c whereas the blast 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. With 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, choice behavior in the second period 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

$$\max_{C_1 \in \{R,M,O\}} E[H \mid C_1] = \frac{1}{1 + c_1}\left[h_{C_1} + h_{R_2}\frac{1 + c_1}{1 + c_1 + r2}\right] + \frac{c_1}{1 + c_1}h_{O_2}. \tag{16}$$

It will prove useful to highlight an important aspect of the behavior of the uncertain individual who has an 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 2 (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 :

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

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 3 (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:

$$I_M \lesseqgtr I_R \text{ if } m \lesseqgtr \frac{1 + r_2}{r_1}.^{22} \tag{18}$$

■

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

[22] This margin in $(r - m)$-space is the DD-curve shown in figures 8 and 9 in appendix for the assumption that $r1 = r2$, and $h_{O_1} = h_{O_2} = 1$.

[23] 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.

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

Lemma 2 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 4 (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 $E[H_{\text{oneshot}}] = 2h_{O_2}$. It follows from lemma 2 that sequential skill accumulation gives ex ante expected productivity

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

If $E[H_{\text{sequential}}]$ exceeds $E[H_{\text{oneshot}}]$ 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.

Another consequence of uncertainty which follows directly from proposition 3 is what we call the *handicap of uncertainty,* which captures 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.

Corollary 5 (Handicap of Uncertainty) *Uncertain individuals who reach the top via the easy track have less productive skills than certain individuals.*

To see this, compare the certain and uncertain individual who is successful at the top. The certain will have productivity $h_{R_1} + h_{R_2} > h_{M_1} + h_{R_2}$ which is productivity of the uncertain individual who took the easy track. The *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 certain 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).[24]

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 6 (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.

[24] 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, Sjögren and Sällström (2001).

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

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

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 a less demanding 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 individuals 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 what is optimal behavior of Rationella's in a two period situation. 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. What about Perseveria?

Proposition 7 (stubbornness) *Smaller prior variance results in smaller boost/bust in self-image in case of success/failure and hence in more persistent behavior*

Proof. It is verified in the appendix that Perseveria's self-image, $\int_0^{R_1} a\rho_{1P}\,da$ after success (failure) in C_1 is lower(higher) than Rationella's. Given Perseveria's updated priors it is also shown that she does not necessarily opt for the risky (outside) option in case of success (failure). ■

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 people, i.e. the larger is c, the smaller will be the blow to self-perception of a failure. Certain enough people will, hence be able to endure failures without being discouraged. At the same time, certain enough 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/destroy self-image for an individual with low/high mean and variance. The reason is that this individual is likely to chose options resulting in weak signals of ability/inability in case of success/failure.

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.

The next step ahead is, of course, to take the implications of this framework to data. Preliminary tests using hazard functions, controlling for ability, field of study etc., of the pattern of delayed labor market entry of men and women in female/male dominated fields seem to confirm the pattern of delay already present in the raw data.[25]

Understanding the emergence of group differences in perceptions of self also requires attention. Absence of role models - individuals who can serve as points of reference when the individual forms his perception of self is one possible story.[26]

[25] Work in progress by the authors: Sjögren and Sällström (2001a).

[26] We invest this route in Sjögren and Sällström (2001c)

Another example of informational role-models is present in Chung (2000).[27]

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 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.[28] That more students from low 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

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

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

(2001b) 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.

References

Altonji, J. G., and R. M. Blank (1999): "Race and Gender in the Labor Market," in *Handbook of Labor Economics, Vol. 3c*, ed. by O. C. Ashenfelter, and D. Card, pp. 3143–3259. North Holland.

Bandura, A. (1977): "Self-Efficacy: Toward a Unifying Theory of Behavior Change," *Psycological Review*, vol. 84, 191–215.

Baumeister, R. F. (1999): "The Nature and Structure of the Self: An Overview," in *The Self in Social Psychology*, ed. by R. F. Baumeister, pp. 1–20. Psychology Press.

Benabou, R., and J. Tirole (2000): "Self-Confidence and Social Interactions," *NBER working Paper*, No. W7585.

——— (2001): "Self-Confidence and Personal Motivation," *forthcoming in Quarterly Journal of Economics*.

Blackaby, D., and J. Frank (2000): "Ethnic and Other Minority Representation in UK Academic Economics," *The Economic Journal*, 110(464), F293–F311.

Booth, A. L., and w. K. M. Jonathan Burton (2000): "The Position of Women in UK Academic Economics," *The Economic Journal*, 110(464), F312–F333.

Breen, R. (1999): "Beliefs, Rational Choice and Bayesian Learning," *Rationality and Society*, vol. 11, no. 4., 463–479.

Chung, K.-S. (2000): "Role Models and Arguments for Affirmative Action," *American Economic Review*, vol. 90, no. 3., 640–648.

Erikson, R., and J. O. Jonsson (1996): "Introduction. Explaining Class Inequality in Education: The Swedish Test Case," in *Can Education Be Equalized?*, ed. by R. Erikson, and J. O. Jonsson. Westview Press.

Frieze, I. H. e. a. (1978): *Women and Sex Roles*. New York: Norton.

Gecas, V. (1989): "The Social-Psychology of Self-Efficacy," *Annual Review of Sociology*, vol. 15, 291–316.

Gustafsson, Jan Eric, e. a. (2000): in *Välfärd Vid Vägskäl SOU 2000:3, F:IX*.

Kolpin, V. W., and L. D. Singell, Jr (1996): "The Gender Composition and Scholarly Performance of Economics Departments: A Test for Employment Discrimination," *Industrial Labor Relations Review*, vol. 46, no. 3, 408–423.

Lundberg, S. J., and R. Startz (2000): "Inequality and Race: Models and Policy," in *Meritocracy and Economic Inequality*, ed. by K. Arrow, S. Bowles, and S. Durlauf. Princeton University Press.

Meghir, C., and M. Palme (1999): "Assessing the Effect of Schooling on Earnings Using a Social Experiment," *Working Paper, Stockholm School of Economics*.

Prendergast, C., and L. Stole (1996): "Impetuous Youngsters and Jaded Old-Timers: Acquiring a Reputation for Learning.," *Journal of Political Economy*, vol. 104, no. 4., 1105–1135.

Pulford, B. D., and A. M. Colman (1997): "Overconfidence : Feedback and Item Difficulty Effects," *Personality and Individual Differences*, vol. 23, 125–133.

SCB (2000): "Universitet Och Högskolor. Grundutbildning: Social Bakgrund Bland Högskolenybörjare 1998/99," *Statistiska Meddelanden*, UF 20 SM 0002.

Singell, Larry D., J. M., and J. Ziliac (2000): "Gender and Promotion In the Economics Profession," *mimeo, Arizona State University and University of Oregon.*

Sjögren, A., and S. Sällström (2001a): "Finding One's Way: Delayed Labor Market Entry and Wage Gaps," *in progress.*

——— (2001b): "Negative Self-Selection and the Dynamics of Self-Confidence," *in progress.*

——— (2001c): "Signals, Role Models, and the Perception of Ability.," *in progress.*

Svensson, A. (1996): "NT-Resan," *Skolverket VHS: Not-häfte*, nr 6, 1996.

Tykocinsky, O., T. Pittman, and E. Tuttle (1995): "Inaction Inertia: Foregoing Future Benefits as a Result of an Initial Failure to Act," *Journal of Personality and Social Psychology*, vol. 68, 793–803.

UGU (1948,1953): "Evaluation Through Follow Up (U G U), Pupils Born in 1948, 1953: Code Books in Swedish.," www.ssd.gu.se/kid/indexval.html.

Weinberg, B. A. (2000): "A Model of Overconfidence," *mimeo, Ohio State University.*

A Appendix

A.1 Description of UGU 1953 -Data[29]

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.

[29]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 Stubborn self-image and behavior

Success in C_1 gives Perseveria an updated prior

$$\rho_{1P|s \text{ in } C_1} = \frac{a^{c_1}(a-a^2)}{\int_0^1 a^{c_1}(a-a^2)da} = (c_1+3)(c_1+2)a^{c_1}\left(a-a^2\right). \tag{20}$$

Perseveria's self-image is hence:

$$\int_0^1 a\rho_{1P|s \text{ in } C1}da = \frac{2+c_1}{4+c_1} < \int_0^1 a(1+c_1)a^{c_1}da = \frac{1+c_1}{2+c_1}, \tag{21}$$

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

$$\rho_{1P|\text{f in C1}} = \frac{(1-a^{c_1})6(a-a^2)}{\int_0^1 (1-a^{c_1})6(a-a^2)da} = 6\,(1-a^{c_1})\left(a-a^2\right)\frac{(c_1+3)\,(2+c_1)}{c_1(5+c_1)}. \quad (22)$$

Perseveria's self-image is then:

$$\int_0^1 a\rho_{1P|\text{f in C1}}da = \frac{c_1^2+9c_1+14}{2\,(9c_1+c_1^2+20)} > \int_0^1 a\frac{(1+c_1)}{c_1}(1-a^{c_1})da = \frac{1+c_1}{2\,(2+c_1)}, \quad (23)$$

which is the self-image of Rationella's after failure in C_1.Given her updated prior, Perseveria's expected gain in productivity from choosing C_2 is:

$$\begin{aligned} E_P[H_{C_2} \mid C_1] &= h_{C_2}\int_0^1 (c_1+3)\,(c_1+2)a^{c_1}\left(a-a^2\right)a^{c_2}da \quad (24)\\ &= \frac{h_{C_2}\,(c_1^2+5c1+6)}{(c_1+c_2+3)\,(c_1+c_2+2)} = \frac{h_{O_2}(c_2+1)\,(c_1^2+5c1+6)}{(c_1+c_2+3)\,(c_1+c_2+2)}. \end{aligned}$$

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

$$\frac{d\,(E_P[H_{C_2} \mid C_1])}{d(c_2)} = h_{O_2}\left(5c_1+c_1^2+6\right)\frac{c_1^2+3c_1+1-2c_2-(c_2)^2}{(c_1+3+c_2)^2\,(c_1+2+c_2)^2} \quad (25)$$

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_2 such that M_2 is the preferred option.

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

$$\begin{aligned} E_P[H_{C_2} \mid C_1] &= h_{C_2}\int_0^1 6\,(1-a^{c_1})\left(a-a^2\right)(c_1+3)\frac{2+c_1}{c_1(5+c_1)}a^{c_2}da \quad (26)\\ &= 6\frac{h_{O_2}(1+c_2)\,(30c_1+31c_1^2+10c_2c_1^2+10c_1^3+12c_2c_1+2c_1^3c_2+c_1^4)}{(2+c_2)\,(c_2+3)\,(c_2+c_1+2)\,c_1\,(c_2c_1+15+8c_1+5c_2+c_1^2)}. \end{aligned}$$

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.