MEMORANDUM

Entrepreneurial School Dropouts: A Model on Signalling, Education and Entrepreneurship

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Last 10 Memoranda

ENTREPRENEURIAL SCHOOL DROPOUTS

- A MODEL ON SIGNALLING, EDUCATION AND ENTREPRENEURSHIP

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Abstract

I present a theory on the relationship between educational choice and entrepreneurship in a labour market with asymmetric information. The model shows that, in a labour market where education is used as a signalling device, an imperfect relationship between productivity in education and in the labour market can lead to an equilibrium where a fraction of the high-ability individuals choose to quit school and become entrepreneurs. Using a comprehensive set of Norwegian register data, I find that this is prediction is confirmed empirically: Individuals combining low education with high ability have the highest entrepreneurship rates in the population.

Keywords: Entrepreneurship, self-employment, education, ability

JEL Classification: L26, M13, J24

1   Introduction

In this paper I propose a theory explaining the choice between entrepreneurship and regular employment based on heterogeneous education costs, asymmetric information and signalling through education. I explore the possibility of a world where education is used for signalling, but where some individuals choose not to obtain the signal in spite of being high ability individuals. This is done by modifying a classic signalling model such that it incorporates an effort-cost of education which is not perfectly correlated with ability. In addition, I extend the signalling model by including a sector of entrepreneurs who, at the cost of an insurance, are remunerated according to their ability without having to signal it through education. I show that a proportion of the high ability individuals will find it too costly to signal their ability and choose to become entrepreneurs instead of pursuing regular employment. Thus, the model predicts that individuals with a low level of education relative to their ability level have a higher probability of being entrepreneurs than others, and that the probability is rising with the degree of mismatch between education and ability. This theoretical prediction is tested on a comprehensive set of Norwegian register data with information on education, ability, labour market status and business ownership for the universe of male Norwegian citizens. My findings support the theoretical predictions with high entrepreneurship rates among "under-signaled" workers and low rates amongst workers with an education level that matches their ability.

There are few theories explicitly linking education and entrepreneurship. Apart from Lazear (2005) the theoretical postulations are typically derived from general models of educational choice. Important strands of this literature are the human

capital theory (Becker, 1975; Lucas, 1978) and the signalling or screening theory (Spence, 1973). Van der Sluis et al. (2008) provide a survey of the empirical literature on returns from education among entrepreneurs. When they discuss the theoretical background for the empirical literature, they mainly separate between a human capital and a signalling explanation of returns to education. Thus, the main theoretical foundations build on general models of educational choice.

Le (1999) divided the impact of education on entrepreneurship into two channels. On the one hand, education increases managerial abilities and thus the propensity to become an entrepreneur (Lucas, 1978). On the other, it also increases outside options through higher earnings as employed and therefore lowers the propensity to become an entrepreneur. In a typical signalling model extended to include entrepreneurs, there is no income gain from education for entrepreneurs since there is no employer-employee relationship and thus no need for a signal. Within this framework, education would lower the propensity to become an entrepreneur due to better outside options (Harmon et al., 2003). To my knowledge, there are no theories regarding the interacted effect of ability and education on entrepreneurship.

Empirical studies show mixed results on the relationship between and entrepreneurship. Berglann et al. (2011) analysed entrepreneurship by looking at Norwegian register data and found that entrepreneurship rates were higher among individuals with low levels of education than among individuals with higher levels of education. Based on OECD-data, Blanchflower (2000) found that: "self-employment is highest for individuals at the tails of the education distribution. Individuals with the least education have the highest probability of being self-employed which is

consistent with the recent findings of Reardon (1998) for the USA. The main exception is the UK where the reverse is the case."

The aim of this paper is to show that there exists another link between the labour market, education and entrepreneurship. In a labour market with information asymmetries, an imperfect correlation between ability and the effort cost of education may cause some individuals to become entrepreneurs because it is too costly for them to signal their true ability. A key feature of the standard signalling model (Spence, 1973) is that the effort cost of education is perfectly correlated with ability. In equilibrium, education is affordable to the high-ability individuals but too costly for the low-ability individuals. This ensures that the individual´s level of ability is recognizable to the employer. If, on the other hand, the effort cost of education is not perfectly correlated with ability, some individuals will have a high effort-cost of education even though they are of the high-ability type. Since education is too costly, these individuals do not find it optimal to signal their ability and end up in a low-wage job. In a world where employment is the only option, one can say that these individuals are mismatched. Which factors, uncorrelated with ability, can be thought to affect the effort cost of education? Some possible interpretations are learning disabilities, lack of parental support and distance to educational institutions, but these are by far all possible interpretations.

What if the mismatched individuals could apply their ability in another way? If they become entrepreneurs they would not have to signal their ability to an employer and would be remunerated according to ability-level. Of course, if they need large amounts of capital they would have to signal their ability to banks and other lending institutions or investors, but they would have the opportunity to

signal their ability through other means than education. They can, for instance, signal their ability through the amount of capital they are willing to put up for a loan. In many cases, the entrepreneur does not need large amounts of capital to start up a business. Think of a carpenter, painter or decorator, who with some tools and a leased van has everything he or she needs to work and generate income. By being business-savvy, a good salesperson and a good leader it is possible to generate a much higher income as a self-employed than in any job obtainable without a college-degree. In this case, the entrepreneur will not need to signal his or her ability, but faces some insurance cost since self-employment is more risky than employment.

Dyslexia is used as an example of imperfect correlation between ability and effort cost of education and there is indeed some evidence that dyslexia is much more common among entrepreneurs than similar controls. In a survey of British and American entrepreneurs and managers, Logan (2009) finds that 35 percent of the responding entrepreneurs in the US survey have dyslexic traits against 1 percent of the managers. For the UK data the figures are 19 percent of the entrepreneurs versus 3 percent of the managers. In a study of long-term outcomes of children with an ADHD-diagnosis, Mannuzza et al. (1993) find that: "A large proportion of probands were owners of small businesses (18% vs 5%, $P < .01$)." They also find that the educational attainment of individuals with ADHD is significantly lower than the controls. These studies show that there is a positive relationship between traits that inhibit school performance and the probability of starting ones own business.

I continue by presenting the theory, deriving empirical predictions and test these predictions on a comprehensive set of Norwegian register data. The results give support to the theory by identifying groups of high-ability/low education individuals with high entrepreneurship rates compared to the population in general.

2   Theory

The proposed theory is based on the standard signalling model by Spence (1973) where signalling through education can be used to communicate ability or productivity to employers in a world where ability is not directly observable. In this framework, the sole purpose of education is to communicate a certain level of ability, and education has no effect on productivity. I have extended this standard signalling model in two ways; first, I have introduced an imperfect correlation between ability and effort cost of education, second, I have introduced a sector of entrepreneurs.

Like in the original signalling model, I assume that the individual's ability translates directly to labour market productivity. If the workers choose to seek regular employment, they can signal their ability through education. Unlike the original model, where productivity in education is perfectly correlated with ability, ability and effort cost of schooling is imperfectly correlated in this model. This is achieved by introducing a group of high ability individuals who perform as low ability individuals in school. These individuals will, although they are high ability individuals, have the same effort cost of education as the low ability individuals. The second extension to the original model is to include a sector of entrepreneurs. The absence of an employer-employee relationship eliminates any information

asymmetries and the entrepreneur does not have to signal his or her ability. The entrepreneur is remunerated according to ability, but since entrepreneurship is intrinsically more risky than regular employment, the entrepreneur faces an additional insurance cost.

The individuals have the choice between three different strategies: First, obtaining the signal and becoming employed at a high wage. Second, not obtaining the signal and becoming employed at a low wage. Third, not obtaining the signal and becoming an entrepreneur at a wage determined by the individual's ability level. I show that in a separating equilibrium, low ability individuals choose the first strategy, high ability individuals with high effort cost of education choose the second strategy and high ability individuals with low effort cost of education choose the third strategy. Therefore, in this separating equilibrium, the individuals with high ability and high effort cost of education are the ones who choose to become entrepreneurs.

2.1 Assumptions

All agents know the possible levels of ability and their distribution, the distribution of the education cost component c and the insurance cost of entrepreneurship i. Neither ability nor effort cost of education is directly observable at the individual level. Workers know their ability $\bar{a}$ or $\underline{a}$ and their effort cost of education.

1. Workers choose education $s = \{0, s^*\}^1$ and whether to enter the regular labour market or become an entrepreneur.

2. Firms observe signals s and make simultaneous wage offers.

3. Workers accept or refuse offers.

2.2 Utility

The model contains three types of individuals grouped according to ability and effort cost of schooling. The non-disadvantaged high ability individuals are characterized by the high ability level $\bar{a}$ and have a low effort cost of education. Effort cost of schooling is normalized so that the non-disadvantaged high ability individuals face effort cost s. The low ability individuals have ability level $\underline{a}$ and a higher effort cost of education compared to the non-disadvantaged high ability individuals, namely sc where $c > 1$. So far the model follows along the lines of the standard signalling model, with two groups of different ability levels and a

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[1]For simplicity education has been restricted to two possible values, no education and the optimal signal. Education can also be modelled as a choice along a continuous variable without changing the results of the model. In that case, the high ability individuals will choose the lowest education level that separates them from the low ability individuals, resulting in only two levels of education (Cho and Kreps, 1987).

negative relationship between ability level and effort cost of education. This is extended by including a third group, the disadvantaged high ability individuals, who have a high ability level $\bar{a}$ but also a high effort cost of education *sc*. For simplicity, I assume that there are only two possible values of the effort cost of education and that the disadvantaged high ability individuals have the same effort cost of education as the low ability individuals[2]. The effort cost of schooling is distributed such that a share π_c of the high ability individuals are disadvantaged and have a high effort cost of schooling and a share $1 - \pi_c$ of the high ability individuals have a low effort cost of schooling. Low ability individuals all have the high effort cost of schooling[3]. All types of individuals face the same choice:

- Either obtain the signal through schooling and become employed at a high wage $\bar{a}$.

- Or quit school and become employed at the low wage $\underline{w}$.

- Or quit school and become an entrepreneur with a wage determined by the ability level. Due to a higher risk of income loss, this strategy entails an insurance cost *i*.

2.2.1 Utility for low ability individuals

Utility sending no signal and pursuing regular employment:

$$u = \underline{w} \tag{1}$$

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[2]This is not crucial, but is included to simplify the notation.

[3]One could imagine that low ability individuals could be disadvantaged and have high effort cost of schooling, but this group is excluded since their existence does not affect the models results or add anything of conceptual interest.

Utility sending signal s^* and pursuing regular employment:

$$u = \bar{a} - s^* c \tag{2}$$

Utility sending no signal and pursuing entrepreneurship:

$$u = \underline{a} - i \tag{3}$$

2.2.2 Utility for non-disadvantaged high-ability individuals

Utility sending no signal and pursuing regular employment:

$$u = \underline{w} \tag{4}$$

Utility sending signal s^* and pursuing regular employment:

$$u = \bar{a} - s^* \tag{5}$$

Utility sending no signal and pursuing entrepreneurship:

$$u = \bar{a} - i \tag{6}$$

2.2.3 Utility for disadvantaged high-ability individuals

Utility sending no signal and pursuing regular employment:

$$u = \underline{w} \tag{7}$$

Utility sending signal s^* and pursuing regular employment:

$$u = \bar{a} - s^* c \tag{8}$$

Utility sending no signal and pursuing entrepreneurship:

$$u = \bar{a} - i \tag{9}$$

9

2.3 Separating equilibrium

Assume there exists a separating equilibrium where low ability individuals quit school and become employed at a low wage, non-disadvantaged high ability individuals invest in education and become employed at a high wage and disadvantaged high ability individuals quit school and become entrepreneurs.

Assume a free entry condition for employers and a share π_h of high ability individuals in the population.

High ability non-disadvantaged individuals The non-disadvantaged high ability individuals set the education level s^* such that non-disadvantaged individuals find it too costly to invest in the signal[4]. The condition for the optimal signal is therefore:

$$\bar{a} - cs^* \leq \underline{w} \tag{10}$$

giving the optimal signal

$$s^* \geq \frac{\bar{a} - \underline{w}}{c} \tag{11}$$

The non-signal wage $\underline{w}$ is determined by the average ability among the individuals working in the low wage jobs. In the separating equilibrium, the average ability level is the low ability level and the low wage therefore becomes[5]:

$$\underline{w} = \underline{a} \tag{12}$$

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[4]They set the signal to the lowest level that makes education too costly for the low ability individuals(Cho and Kreps, 1987)

[5]Please see the appendix for a discussion of the uniqueness of the separating equilibrium and the wage in pooling equilibrium.

In order for the equilibrium to be separating, it must not be optimal for the non-disadvantaged high ability individuals to become entrepreneurs. This is the case if the insurance cost of entrepreneurship is greater than the effort cost of education:

$$i > s^* \tag{13}$$

Low ability individuals With the signal set to s^*, it is optimal for the low ability individuals to quit school and start to work for the low wage $\underline{w}$. As long as entrepreneurs face some insurance cost($i > 0$), the low ability individuals will not choose to become entrepreneurs because they reap the same returns in the low wage job without the insurance cost.

Disadvantaged high ability individuals For the disadvantaged high ability individuals, who have the same effort cost of education as the low ability individuals, signalling their ability in the labour market is too costly with the signal set at s^*. They therefore choose to quit school and, assuming that $i \leq s^* c$ for $c > 1$ and $\bar{a} - i > \underline{w}$, choose to become entrepreneurs instead of pursuing regular employment.

With these assumptions in place, we have a separating equilibrium were all the disadvantaged high ability individuals choose to become entrepreneurs, and these are the only ones choosing entrepreneurship. The non-disadvantaged high ability individuals obtain the signal and become employed with the high wage and the low ability individuals choose employment at the low wage.

In the presentation of this model, I have chosen to restrict the effort cost of education to two possible values. This is not necessary, but simplifies the pre-

11

sentation. One can easily imagine a situation with a continuous cost component. The difference will be that some disadvantaged individuals will still choose to invest in the signal and that the disadvantaged individuals with a c lower than some threshold will choose to become entrepreneurs.

A crucial assumption that has to be made, is that entrepreneurship cannot function as a signal in it self. In this simple form of the model, where only high ability individuals become entrepreneurs, one can easily imagine that employers would recognize the entrepreneurs as high ability individuals and offer them a job with the high wage. In a more complex setting, where individuals become entrepreneurs for a number of other reasons, the possible signal would be diluted by low ability entrepreneurs. This setting could easily be introduced formally by adding a random component to the utility function of entrepreneurship.

2.4 Empirical predictions

The model offers some clear predictions on the relationship between ability, education and entrepreneurship. In the simplest form of the model, we would expect to observe three types of individuals:

- High-ability, educated individuals in regular employment

- Low-ability, uneducated individuals in regular employment

- High-ability, uneducated entrepreneurs.

Acknowledging that there are additional reasons for choosing entrepreneurship, the predictions above can be interpreted in a less stringent manner. Some

12

individuals are spurred by a great idea to start a business, while some individuals are too risk averse to become entrepreneurs no matter how large their gain from entrepreneurship is. However, a testable implication of the model is that the entrepreneurship propensity rises with ability for a given education level, and that the gradient in this relationship gets steeper as one looks at lower education levels. The model predicts that the ones with the largest gain from entrepreneurship are the high ability individuals who for some reason find that the effort cost of education is too high and choose to quit school. Therefore, when taking the theory to the data, one would expect the share of entrepreneurs to be increasing with the discrepancy between ability and education. The share of entrepreneurs should be the highest among the individuals with high levels of ability relative to their education. The lowest shares should be found in groups with the highest levels of education and in the groups with the lowest levels of ability.

3 Empirical Analysis

As shown in the previous section, the model offers some clear predictions on the relationship between ability, schooling and entrepreneurship. The data allows me to test for the predicted patterns and I will do this in two steps. First, I will offer a graphical presentation of the simultaneous distribution of the relevant variables and show that the predicted pattern is present in the data. Second, I will offer a simple statistical test of the existence of this pattern.

3.1 Data

In order to test the model's empirical predictions, I rely on a comprehensive dataset with information about labour market status, detailed schooling information, ability tests from the Norwegian armed forces and detailed demographic data. The data consists of three blocks of administrative register data merged at the individual level.

In short, the first block contains comprehensive information on economic activities for all residents in Norway as well as detailed demographic information and schooling records. Schooling information is collected from the National Education Database (NUDB) (Statistics Norway, 2005) and enables us to identify the individual's highest completed education level and a course category. I only consider individuals who have completed the mandatory 10-year schooling or more. The education level is divided into seven groups, from mandatory schooling to PhD-level. In addition, the data contains grades for the 10th level for education completed in the years 2002-2007.

The second block contains annual audited accounts for the majority of Norwegian firms and ownership information and board members for all limited liability firms in the years 2001 to 2005. Using this information, the ownership structure of the firm can be disentangled, and employed individuals who are also owners can be identified. Together with tax-records on business income, this information can be used to identify the entrepreneurs. The high level of detail in the data enables me to separate between entrepreneurs running limited liability firms and single-person firms. Although there are exceptions to the rule, the former type of en-

trepreneur is generally an active owner of a firm with employees, where the latter is generally considered self-employed and runs a small firm without employees. My definition of the entrepreneur follows the one used in Berglann et al. (2011), where the entrepreneur is defined as fitting one of the following two descriptions:

- Owner of, and employed in, a limited liability firm. Owns at least 30% of the shares, or owns at least 10% and is a member of the board or a chief executive.

- The main source of income is business(non-wage) income.

For a more detailed description of this data and the definition of entrepreneurship, see Berglann et al. (2011).

The third block of data consists of results from a general ability test taken at a mandatory recruitment session for the Norwegian armed forces. The test, generally taken during the last year of high-school or at an age of 18-20, is a three-part ability test with a summarized stanine ability score. The stanine (Standard Nine) score is a nine point scale, from 1 to 9, with a mean of 5 and standard deviation of 2. The three parts are arithmetic, word- and figure-recognition problems. For a more detailed description of the Norwegian test-data, see Sundet et al. (2004), Sundet et al. (2005) and Black et al. (2010). The recruitment session is mandatory for all men, but is also taken by women enlisting for all the branches of the armed forces. To avoid selection issues, I only use data for the male population. The stanine ability scores are merged onto the previously described register data with a unique person identifier.

The data contains the entire population of Norwegian males in 2005, but only a relevant selection will be used for the empirical analysis. As I am interested in the choice between employment and entrepreneurship, only individuals who are in one of these categories are chosen for the analysis. In addition, I have also excluded age groups where a large proportion of the population is either enrolled in education or retired. The analysis is therefore restricted to the cohorts born 1950-1975. Thus, individuals younger than 30 years old, or older than 55, are excluded. Individuals without education-records or individuals with less than mandatory school are also dropped from the dataset.

After these restrictions the dataset consists of 624,166 observations. The records containing the ability scores do not cover the entire population. Some individuals were not required to show up for the recruitment sessions and others some were given a score because of a missing test. This group, which amounts to 14.9 percent of the individuals in the data, are dropped from the dataset. The number of individuals in the final dataset therefore amounts to 531,138.

3.2 A simple graphical analysis

In essence, we are interested in the simultaneous distribution of ability, education-level and entrepreneurship. As discussed earlier, the theory presented above suggests that the probability of being an entrepreneur should be rising with ability but falling with education-level. To capture the described interaction and the predicted pattern, the individuals are sorted into groups according to their ability-level interacted with their education-level. The seven education levels and nine ability levels results in 63 groups and the share of entrepreneurs is measured within each

group.

FIGURE I AROUND HERE

In figure I, the share of entrepreneurs[6] in each group is plotted in a three-dimensional graph, where the share of entrepreneurs is measured along the z-axis, the education level along the x-axis and the education level along the y-axis. [7] Figure I displays the following pattern: The highest shares of entrepreneurs are found among the individuals with high levels of ability and low levels of education. The lowest shares are found among the individuals with the highest education level(a PhD or equivalent) and lowest ability levels.

The observed pattern is in line with the presented theory, where a simple model predicted different shares of entrepreneurs in three different groups of individuals. The type of individual that the model predicted to choose entrepreneurship is the high ability, low education type. This type is found in the upper left corner of the figures, where the share of entrepreneurs are indeed the highest with around 20 percent. The two other groups are the high ability, high education individuals found in the upper right corner, and the low ability, low education individuals in the lower left corner. These two regions are the ones where the lowest shares of entrepreneurship are found with shares around 5 percent for the former and 9 percent for the latter group.

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[6]I have chosen to exclude physicians from the entrepreneurship definition. Please see the appendix, section 6.2.

[7]Groups of individuals with less than 100 observations are dropped due to very noisy results. See the appendix for a table of the number of observations

3.3 A simple statistical analysis

Table I presents the results from a simple statistical analysis of the data. A probit model has been estimated and the average marginal effects reported have been estimated by the use of the Margeff add-on for STATA (Bartus, 2009). The analysis has been performed using three different specifications: First, ability and education interacted and specified as dummy variables, second, ability and education as continuous variables, and third, ability, education, and ability and education interacted as continuous variables. Age group dummy variables are included to control for age.

In the first specification, ability is interacted with education to mimic the grouping in the graphical analysis, but the number of groups is reduced for simpler interpretation of the results. Education is divided into three categories, higher, medium and lower education. Three years of university and more is considered higher education. Mandatory schooling, high-school and vocational training are considered lower education and anything between the two mentioned categories is considered a medium education level. This includes one-year courses after high-school and additional schooling for individuals with vocational training. Education is interacted with three ability-levels: Low(Stanine 1-3), medium(Stanine 4-6) and high(Stanine 7-9).

The second specification is included in order to illustrate the effect of education and ability when not interacted, while the third specification is included to show how the coefficients of ability and education change when the interacted variable is included. The data used, and the restrictions posed on the definition

18

of the entrepreneur, is the same as in the graphical analysis. Thus, in table I the entrepreneur is defined in the same way as in table figure I.

TABLE I AROUND HERE

The aim of the statistical analysis is to determine if the observed pattern is different than the pattern the standard theory suggests, and if the difference is statistically significant. The results from the probit-estimation confirm the results from the graphical analysis. In both cases, the results are completely in line with the empirical predictions stated earlier. In table I we get the following results: Not only is entrepreneurship falling with education and increasing with ability, the interaction effects confirm the models prediction. Increased ability strongly increases the probability of being an entrepreneur for individuals with low levels of education. Furthermore, high education has a negative impact in itself, and more interestingly, ability has no significant effect on the probability of being an entrepreneur for individuals with high levels of education. This is in line with the model, since individuals with high levels of education have signalled their abilities to the fullest and have no additional pecuniary gain from starting a business. Thus we see that the individuals who would profit from entrepreneurship in the model, the severely undersignaled individuals, are indeed the ones with the highest rates in the data. With medium ability and medium education as the omitted category, the average marginal effect of having low education and a high level of ability on the propensity to be an entrepreneur is 5.72 percentage points. The average marginal effect of having the same ability level and a high level of education is

0.62 percentage points. As the share of entrepreneurs is 14.1% in the data, this difference is not only statistically significant, but also large enough to indicate that the models empirical prediction seems to have a good deal of explanatory power.

A concern would be that the results presented above follow from certain groups of individuals, only apply to small, or single person, firms or that they follow from the socio-economic background of the individuals. In an attempt to address this concern, I have repeated the main part of the analysis in table I[8]. The pattern is the same as in table I if the entrepreneurship definition is restricted to owners of limited liability companies. Even when restricting the definition to active owners of firms of a certain size[9], the pattern remains the same. The analysis was also performed on subsets of the data, restricting the data on age and background through parents' education and entrepreneurship status. The only subset that displayed a different pattern was when only children of entrepreneurs were analysed. They seemed to choose entrepreneurship regardless of ability level, but they also seemed to drop out of education when pursuing a career as an entrepreneur. What we see is that the observed pattern is not a result of parents education or entrepreneurship status, it is not a result of the age or cohort of the entrepreneur and it is not dependent on the size of the company that the entrepreneur owns and runs.

4 Discussion

The results presented in the previous section are consistent with hypothesis that some high ability individuals, because they have higher effort cost of education

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[8]See tables 6.4 and 6.4 in the appendix, section 6.3

[9]Three definitions were tested: active owners of firms with two or more employees, five or more and ten or more employees.

than others, choose not to signal their ability in the labour market and become entrepreneurs instead.

On the one hand, the results are not consistent with the theory that human capital increases managerial abilities (Lucas, 1978) and therefore the probability of succeeding as an entrepreneur. If this was the case, entrepreneurship rates should be increasing with education. On the other, the results are consistent with the theory that human capital increases the alternative cost of entrepreneurship. This, however, requires the additional assumption that human capital has higher returns for employed than for entrepreneurs and that entrepreneurial types therefore opt out of education (Le, 1999). Another interpretation of the results is that individuals choose occupation according to their comparative advantages (Roy, 1951) and that only high ability individuals succeed as entrepreneurs (Jovanovic, 1982). If one assumes that entrepreneurs have no need for education, this hypothesis is consistent with the results presented in this paper. One has to assume, however, that education has no positive impact on selection into entrepreneurship or the survival as an entrepreneur; i.e. that education either acts as a signalling device and therefore has no impact on earnings for entrepreneurs, or that the human capital accumulated through education has no positive impact on earnings or the survival of the firm.

Hence, all the theories rest on the same underlying assumption, that the returns to education are lower for entrepreneurs than for individuals in regular employment. What separates the theory presented in this paper from the others is that the individuals choose between entrepreneurship and regular employment while taking their effort cost of education into consideration in addition to the relative

21

returns to education in the different sectors. It is in no way necessary to use the signalling model; any model of educational choice with heterogeneous effort cost and different returns to education across sectors will generate the same empirical predictions. The key point is that it is variations in the effort cost of education relative to labour market ability that determines the choice of entrepreneurship versus employment.

5   Summary and conclusion

I present a theory on the relationship between educational choice and entrepreneurship in a labour market with asymmetric information. The model shows that, in a labour market where education is used as a signalling device, an imperfect relationship between productivity in education and in the labour market can lead to an equilibrium where a fraction of the high-ability individuals choose not to acquire the signal. I show that undersignaled individuals have incentives to start their own business rather than pursuing regular employment. The model predicts that entrepreneurship rates should be increasing in ability and decreasing in education. Specifically, individuals with high levels of ability and low levels of education should have the highest entrepreneurship rates. These are the most severely undersignaled individuals and therefore the ones who will profit the most from starting their own business. Conversely, individuals with low levels of ability or high levels of education have nothing to gain from starting a business since they signal their true productivity and are paid accordingly. The model therefore predicts low rates among these individuals. Using a comprehensive set of Norwegian register

data, including an ability-measure and detailed schooling information, I am able to test the models predictions. The results are strong, significant and consistent with the models predictions. Although a more detailed investigation of exogenous schooling cost is needed, the results indicate that a significant fraction of Norwegian entrepreneurs have chosen this state because they are not able to signal their productivity through education and therefore gain more from starting their own business than pursuing a regular career.

6 Appendix

6.1 Uniqueness of separating equilibrium

In a pooling equilibrium where the disadvantaged high ability individuals choose to become employed at a low wage, they mix in with the low ability individuals and the low wage $\underline{w}$ is determined by the average ability in the group. In this case, the low wage is the following:

$$\underline{w} = \frac{\pi_h \pi_c \bar{a} + (1 - \pi_h)\underline{a}}{(1 - \pi_h) + \pi_h \pi_c} \tag{14}$$

$$\pi_c = Pr(a = \bar{a}|c > 1) \tag{15}$$

The high ability individuals in the group increase the average productivity and therefore the wage offered by the employers. In order for the separating equilibrium to bee unique, the gains from self-employment must be higher than the gains from the low wage job for the disadvantaged high ability individuals. We therefore have the following criterion that must be met:

$$\bar{a} - i > \frac{\pi_h \pi_c \bar{a} + (1 - \pi_h)\underline{a}}{(1 - \pi_h) + \pi_h \pi_c} \tag{16}$$

This criterion above is met if the fraction of disadvantaged high ability individuals is sufficiently small.

6.2 Physicians and my definition of entrepreneurship

I have chosen to exclude doctors from my definition of the entrepreneur and treat them as employed. This is due to both the nature of their business and how physicians are organized in the Norwegian health care system. It is hard to argue that self-employed doctors, who are not running large clinics, are entrepreneurial or

face greater risk than their employed counterparts. The majority of private practitioners are a part of the comprehensive official health care system and, although they are registered as single person firms, obtain most of their revenues from the government. Although patients can choose their doctor, they have to choose from a regulated list of physicians, and when they have to visit the doctor they only have to pay a small fee. The rest is paid for by government transfers. On this basis I treat the self-employed doctors as employed as I consider them to be self-employed because of the way the Norwegian health-care system is designed. Hamilton (2000) treat doctors in a similar fashion in a study about income gains from entrepreneurship. Headen (1990) finds that 16% of physicians net income is attributable to entrepreneurship in the much less regulated US-market. This lends support to the treatment of physicians as employed rather than entrepreneurs.

6.3   Additional analysis and results from section 3.3

The following section contains results from robustness checks of the analysis in section 3.3. In all, ten different models has been estimated with the following deviations from the original analysis. The results are, like in section 3.3, reported in average marginal effects and can be found in tables 6.4 and 6.4.

1. Only active owners of limited liability companies are considered entrepreneurs. Other entrepreneurs are taken out of the dataset.

2. The original definition of the entrepreneur is used, but the dataset has been limited to individuals aged 30 to 39.

3. The original definition of the entrepreneur is used, but the dataset has been limited to individuals aged 40 to 55.

4. The original definition of the entrepreneur is used, but the dataset has been limited to individuals where at least one parent is an entrepreneur in 2000. By using the parents' state in 2000 I are able to identify their entrepreneurship status at the earliest possible time. This ensures that I capture those that have retired or transferred the business to their children in 2005 and makes us able to identify the parent status for older entrepreneurs.

5. The original definition of the entrepreneur is used, but the dataset has been limited to individuals where no parent is an entrepreneur in 2000.

6. The original definition of the entrepreneur is used, but the dataset has been limited to individuals where no parent has higher education than high-school or equivalent.

7. The original definition of the entrepreneur is used, but the dataset has been limited to individuals where at least one parent has completed education at a level higher than high-school.

8. Only active owners of limited liability companies with two or more employees are considered entrepreneurs. Other entrepreneurs are taken out of the dataset.

9. Only active owners of limited liability companies with five or more employees are considered entrepreneurs. Other entrepreneurs are taken out of the dataset.

10. Only active owners of limited liability companies with ten or more employees are considered entrepreneurs. Other entrepreneurs are taken out of the dataset.

TABLE A.I AROUND HERE

TABLE A.II AROUND HERE

6.4 Additional figures and tables for section 3.2

TABLE A.III AROUND HERE

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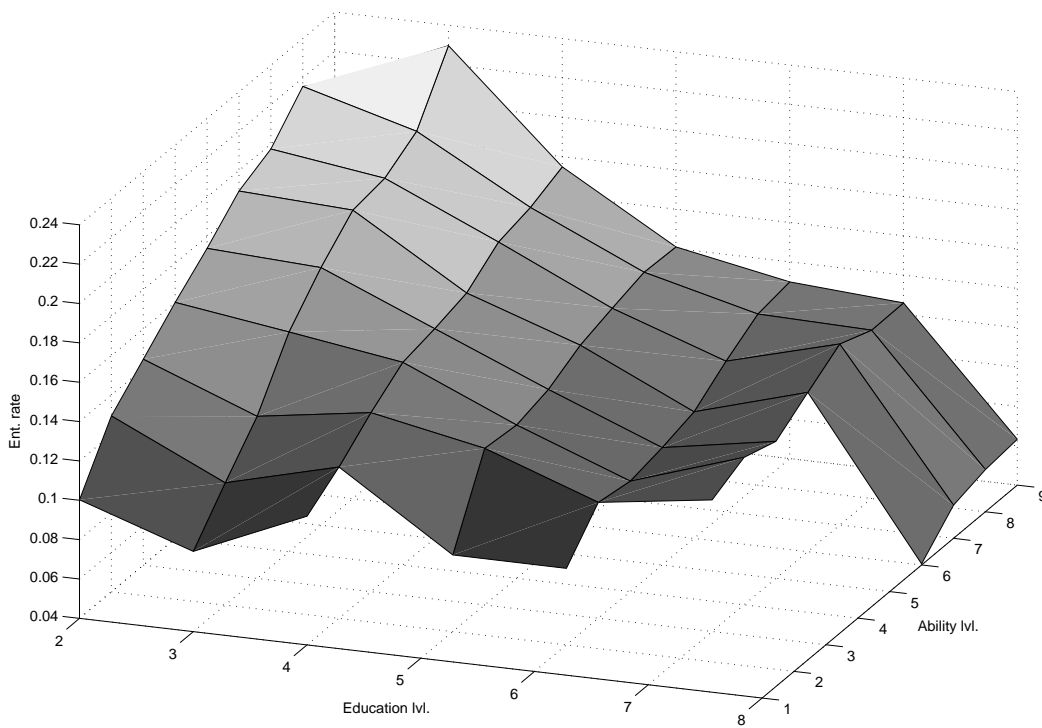
Share of entrepreneurs by ability and education group. Physicians are defined as employed

Table I: Probability of being and entrepreneur in 2005

	Coeff.(pp)		SE.	Coeff.(pp)		SE.	Coeff.(pp)		SE.
High edu. high ability	0.62	***	0.21						
High edu. med. ability	0.45		0.32						
High edu. low ability	1.76		4.85						
Med. edu. High ability	1.06	***	0.18						
Med. edu. med. ability	Ref.								
Med. edu. Low ability	-0.17		0.54						
Low edu. high ability	5.72	***	0.22						
Low edu. med. ability	4.51	***	0.17						
Low edu. low ability	2.04	***	0.19						
Ability level				0.73	***	0.03	1.59	***	0.08
Education level				-1.53	***	0.04	-0.26	**	0.11
Ability x Education							-0.21	***	0.02
Age 30-34	-3.21	***	0.12	-3.39	***	0.13	-3.42	***	0.13
Age 35-39	Ref.								
Age 40-44	2.18	***	0.15	2.14	***	0.16	2.17	***	0.16
Age 45-49	2.36	***	0.16	2.01	***	0.16	2.03	***	0.16
Age 50-55	2.87	***	0.16	2.50	***	0.16	2.55	***	0.16
Log-likelihood	-213769.74			-213781.07			-213703.8		
Share				14.09					
N				531138					

Probit, average percentage points. Physicians are defined as employed

*=.1 **=.05 ***=.01

Table A.I: Robustness; Prob. of being and entrepreneur in 2005

	1) Coeff.(pp)	SE.	2) Coeff.(pp)	SE.	3) Coeff.(pp)	SE.	4) Coeff.(pp)	SE.	5) Coeff.(pp)	SE.
High edu. high ability	-0.11	0.17	-1.45 ***	0.27	0.53	0.34	-3.84 ***	0.95	-1.22 ***	0.27
High edu. med. ability	-1.30 ***	0.25	-0.37	0.38	0.93 *	0.54	-0.96	1.38	-0.46	0.38
High edu. low ability	-2.72	1.78	2.76	3.07	-2.23	4.08	12.02	12.10	1.37	2.97
Med. edu. High ability	0.79 ***	0.15	0.08	0.23	1.57 ***	0.30	-1.14	0.83	0.21	0.24
Med. edu. med. ability	Ref.		Ref.		Ref.		Ref.		Ref.	
Med. edu. Low ability	-0.84 *	0.45	-0.43	0.62	-0.20	0.92	-1.63	2.45	-0.13	0.63
Low edu. high ability	3.18 ***	0.19	5.32 ***	0.34	5.80 ***	0.35	6.58 ***	1.16	5.12 ***	0.35
Low edu. med. ability	1.50 ***	0.13	4.67 ***	0.23	4.25 ***	0.28	8.01 ***	0.82	4.30 ***	0.23
Low edu. low ability	-1.27 ***	0.13	2.66 ***	0.25	1.40 ***	0.31	6.76 ***	1.00	2.48 ***	0.25
Age 30-34	-2.49 ***	0.09	-3.20 ***	0.12			-6.48 ***	0.46	-3.21 ***	0.12
Age 35-39	Ref.		Ref.		Ref.		Ref.		Ref.	
Age 40-44	1.60 ***	0.13								
Age 45-49	1.71 ***	0.14			0.11	0.17				
Age 50-55	2.11 ***	0.14			0.40	0.30				
Log-likelihood	-143191.59		-79099		-98152.903		-12761.799		-65211.745	
Share	8.52		11.6		15.68		20.79		10.41	
N	497309		222840		226722		25407		197433	

1) – 2a
2) 30-39
3) 40-55
4) Parent ent
5) Parent no ent
6) Parent kun vgs
7) One parent mer enn vgs
8) 2a 2 plus

Probability of being and entrepreneur in 2005. Probit, average percentage points.

*=.1 **=.05 ***=.01

Table A.II: Robustness; Prob. of being and entrepreneur in 2005

9) 2a 5 plus
10) 2a 10 plus

	6) Coeff.(pp)	SE.	7) Coeff.(pp)	SE.	8) Coeff.(pp)	SE.	9) Coeff.(pp)	SE.	10) Coeff.(pp)	SE.
High edu. high ability	-1.02 *	0.62	-1.76 ***	0.30	-0.83 ***	0.14	-0.93 ***	0.11	-0.78 ***	0.07
High edu. med. ability	-1.41 *	0.72	-0.26	0.45	-1.74 ***	0.19	-1.54 ***	0.16	-0.97 ***	0.11
High edu. low ability	-2.66	5.69	3.52	3.46	-2.60 *	1.39	-2.56 **	1.00		
Med. edu. High ability	-0.50	0.41	0.18	0.28	0.31 **	0.13	0.04	0.11	-0.12	0.08
Med. edu. med. ability	0.57	0.99	-1.00	0.79	-0.58	0.38	-0.22	0.34	-0.18	0.25
Med. edu. Low ability	Ref.		Ref.		Ref.		Ref.		Ref.	
Low edu. high ability	5.55 ***	0.57	5.22 ***	0.43	2.63 ***	0.17	1.93 ***	0.15	0.66 ***	0.10
Low edu. med. ability	5.39 ***	0.38	4.26 ***	0.29	1.46 ***	0.12	1.00 ***	0.10	0.17 **	0.07
Low edu. low ability	3.34 ***	0.38	2.28 ***	0.34	-0.76 ***	0.12	-0.69 ***	0.10	-0.64 ***	0.06
Age 30-34	-3.02 ***	0.20	-3.36 ***	0.16	-1.95 ***	0.08	-1.52 ***	0.07	-0.71 ***	0.04
Age 35-39	Ref.		Ref.		Ref.		Ref.		Ref.	
Age 40-44					1.10 ***	0.12	0.85 ***	0.10	0.50 ***	0.07
Age 45-49					0.95 ***	0.12	0.69 ***	0.10	0.53 ***	0.07
Age 50-55					1.32 ***	0.12	1.02 ***	0.11	0.68 ***	0.08
Log-likelihood	-32890.997		-46188.525		-111473.23		-85232.876		-44785.272	
Share	11.93		11.37		6.20		4.43		1.99	
N	90948		131892		485033		476023		464054	

Probability of being and entrepreneur in 2005. Probit, average percentage points.

*=.1 **=.05 ***=.01

34

Table A.III: Number of observations, data used in figure I

		Education level						
		2	**3**	**4**	**5**	**6**	**7**	**8**
Ability level	**9**	406	466	3605	568	10486	10448	1280
	8	1646	2515	11247	2184	21366	12601	1010
	7	4924	8073	25130	5136	29881	11934	651
	6	10664	14409	38584	7502	28456	7530	296
	5	18254	16279	45539	7389	17915	3239	84
	4	21489	11773	35347	4435	6636	748	12
	3	16501	5597	17433	1505	1396	131	2
	2	10303	2233	6374	342	279	34	0
	1	4508	619	1603	51	81	8	1

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Table A.IV: Number of observations by cell. Basis for figure I.

		Education level						
		2	**3**	**4**	**5**	**6**	**7**	**8**
Ability level	**9**	364	423	3374	544	9972	9470	1243
	8	1492	2303	10532	2104	20390	11554	985
	7	4475	7447	23530	4941	28755	10916	639
	6	9654	13266	36328	7185	27435	6993	290
	5	16573	14945	42701	7100	17282	3039	82
	4	19563	10856	33056	4236	6391	690	12
	3	15069	5210	16361	1432	1336	121	2
	2	9477	2128	5996	332	265	28	0
	1	4194	589	1502	51	79	6	1

2a-entreprenører