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The Effects of Entrepreneurship Education

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Abstract

Entrepreneurship education ranks highly on policy agendas in Europe and the US, but little research is available to assess its impacts. In this context it is of primary importance to understand whether entrepreneurship education raises intentions to be entrepreneurial generally or whether it helps students determine how well suited they are for entrepreneurship. We develop a theoretical model of Bayesian learning in which entrepreneurship education generates signals which help students to evaluate their own aptitude for entrepreneurial tasks. We derive predictions from the model and test them using data from a compulsory entrepreneurship course at a German university. Using survey responses from 189 students ex ante and ex post, we find that entrepreneurial propensity declined somewhat in spite of generally good evaluations of the class. Our tests of Bayesian updating provide support for the notion that students receive valuable signals and learn about their own type in the entrepreneurship course.

JEL Classification: D83, J24, L26, M13

Keywords: entrepreneurship, entrepreneurship education, Bayes' Rule, learning, signals

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1 Introduction

New venture formation is of considerable importance for economic growth and technological progress (Birch, 1979; Reynolds et al., 1994; Sheshinski et al., 2007). The economic impact of new businesses founded by university faculty, graduates and alumni is particularly significant. Academic entrepreneurs are likely to employ more people than their non-academic counterparts (Dietrich, 1999), and founders with university education apparently make higher investments in their business than non-academic entrepreneurs (Reynolds et al., 1994) and their firms are disproportionately high performing (Shane, 2004). Additionally, university spinoffs create important spillover effects for the local economy (Harhoff, 1999; Shane, 2004). For Germany, Audretsch and Fritsch (2002) find that entrepreneurship has become a source of growth. In awareness of these findings, many governments declare the sensitization and advancement of potential founders at tertiary educational institutions a primary goal of innovation policies.

Entrepreneurial education is frequently considered an effective strategy (Lin, 2004) towards more innovation. Universities in many countries have followed the example of US institutions and have instituted a wide range of entrepreneurship education efforts (Fayolle, 2000; Lin, 2004). Nonetheless, the impact of such education is poorly understood at present. In this paper we investigate the effects of entrepreneurship education on students' entrepreneurial intentions. Using a model of Bayesian updating we show that if students differ in their aptitude for entrepreneurship and if entrepreneurship education helps them uncover these differences, entrepreneurship training may not always lead to stronger entrepreneurial intentions. In our empirical study we find confirmation for the prediction that entrepreneurship education has heterogeneous effects, and that some students graduate from the course with stronger, and some with weaker entrepreneurial intentions.

Research on the impact and effects of entrepreneurship education has not kept pace with the growth of teaching capacity. The assertion that entrepreneurship education leads to increased entrepreneurial intentions and therefore to more new venture formation may seem intuitive. However, despite the recognition that education and prior entrepreneurial experiences influence people's attitudes towards starting their own business, the impact of entrepreneurship education on intentions to found a business has remained relatively untested (Donckels, 1991; Kruegel Jr and Brazeal, 1994). Moreover, on closer inspection the claim turns out to be less than trivial. Some studies have suggested that the average entrepreneur may expect

her life-time earnings to be considerably below those of a salaried employee (Astebro and Thompson, 2007). Hence, if entrepreneurship training confers a realistic assessment of future career options, entrepreneurial intentions may very well decline. This need not be a detrimental effect, if those who have misjudged themselves as fit or well-suited for entrepreneurship learn to avoid a career that would leave the would-be entrepreneurs and their financiers and other stake-holders unhappy. But any normative discussion of what entrepreneurship training is supposed to achieve may be premature as long as we do not have a robust characterization of the learning processes which students experience in such a setting.

Several previous studies have found a positive impact of entrepreneurship education courses or programs at universities on perceived attractiveness and perceived feasibility of new venture initiation (Tkachev and Kolvereid, 1999; Peterman and Kennedy, 2003; Fayolle and Lassas-Clerc, 2006; Souitaris et al., 2007). Many of these studies tend to have methodological limitations. For example, few studies employ a pre-post design, and even fewer involve a control group (Block and Stumpf, 1992). Most of the studies have considered self-selected participants with some existing predisposition towards entrepreneurship, thus biasing the results in favor of educational interventions (Gorman et al., 1997). Finally, only very few findings exist for the German language area (Franke and Lüthje, 2000). Regarding the impact of entrepreneurship education, there is still a major research gap.

In order to overcome some of the above mentioned limitations, we conducted a study of a large-scale compulsory entrepreneurship course at a major German university, using a pre-test–post-test design. The focus of this paper is to explore if students used this course to learn about their own entrepreneurial aptitude. We provide a descriptive analysis of students' intentions to become entrepreneurs before the course and after the course. This analysis indicates that the course induces sorting and that especially students who are initially uncertain about their entrepreneurial ability are able to determine more clearly whether or not they are positively inclined towards entrepreneurship after the course.

To provide firmer support to these descriptive results we test implications from a simple model of Bayesian updating using the survey data we have collected. Bayes' Rule is frequently used to describe how people update their beliefs under uncertainty in economics. Recent research by behavioral economists demonstrates that people do not always update their beliefs according to Bayes' Rule (Rabin and Schrag, 1999; Charness and Levin, 2005; Charness et al., 2007). However, the experiments undertaken by Charness et al. (2007) demonstrate

that Bayes' Rule describes learning behavior better if subjects update their beliefs after interaction with people in larger groups, which applies to the course setting we investigate here.

Our paper consists of seven sections. Next, we review the literature on entrepreneurship as intentionally planned behavior. Then, we develop a formal model of learning which employs the notion of Bayesian updating in Section 3. Section 4 describes the setting of our study, Section 5 contains a descriptive analysis of the data. In Section 6, we test the predictions from our theoretical model. Section 7 concludes and discusses future research.

2 Entrepreneurial Intentions and Entrepreneurship Education

The link between entrepreneurship education and entrepreneurial activity may seem somewhat tenuous. Successful entrepreneurs do not necessarily set up their companies directly after or even before graduation, although there are notable exceptions. In this section we survey literature that shows why students' entrepreneurial intentions matter for entrepreneurship and how entrepreneurship education impacts entrepreneurial intentions. We also briefly review other major determinants of entrepreneurial intentions.

2.1 Entrepreneurship as Intentionally Planned Behavior

Intentionality is a state of mind directing a person's attention (and therefore experience and action) toward a specific object (goal) or a path in order to achieve something (means) (Bird, 1988). Any planned behavior is best predicted by observing intentions toward that behavior, not by attitudes, beliefs,personality or demographics (Bagozzi and Yi, 1989). Thus, according to social psychology literature, intentions are the single best predictor of planned behavior, especially when the target behavior is rare, hard to observe or when it involves unpredictable time lags (Ajzen, 1991). When the target behavior affords a person complete control over behavioral performance, intentions alone should be sufficient to predict behavior, as explained in the theory of planned behavior (Ajzen, 1991). Intentions have been found to be an unbiased predictor of action, even where time lags exist, for example in career choices (Lent et al., 1994). Hence, intentions predict behavior, while in turn certain specific attitudes predict intention. Attitudes, again, derive from exogenous influences (Ajzen, 1987). Thus, intentions

are indirectly affected by exogenous influences: Either they drive attitudes or they moderate the relationship between intentions and behavior (i.e. facilitate or inhibit the realization of intentions). And intentions serve as a mediator or catalyst for action: intention-based models describe how exogenous influences change intentions and, in the end, actual behavior.

This is confirmed by meta-analytic studies (Kim and Hunter, 1993). Across a wide variety of target behaviors and related intentions, attitudes explain over 50% of the variance in intentions, intentions in turn explain over 30% of the variance in behavior. This compares to 10% usually explained by trait measures or attitudes alone (Ajzen, 1987). Many researchers see entrepreneurship as a typical example of planned intentional behavior (Bird, 1988; Katz and Gartner, 1988; Kruegel Jr and Brazeal, 1994). Having an entrepreneurial intention means that one is committed to starting a new business (Krueger, 1993). The attitude towards entrepreneurship may be influenced by educational measures. However, despite the recognition that education and prior entrepreneurial experiences may influence people's attitudes towards starting their own business, the impact of entrepreneurship education, as distinct from general education, on intentions towards entrepreneurship has remained largely unexplored (Donckels, 1991; Kruegel Jr and Brazeal, 1994).

2.2 Research on Entrepreneurship Education Effects

Research about the effects of entrepreneurship education is still its infancy (Gorman et al., 1997). Most studies up to date aim at simply describing entrepreneurship courses (Vesper and Gartner, 1997), at discussing the contents of good entrepreneurship education (Fiet, 2001) or at evaluating the economic impacts of courses by comparing takers and non-takers (Chrisman, 1997). Some researchers have proposed a positive link between entrepreneurship education and entrepreneurial attitudes, intention or action, but the evidence is still slim (Gibb Dyer, 1994; Robinson et al., 1991; Kruegel Jr and Brazeal, 1994). There has been little rigorous research on the effects of entrepreneurship education (Gorman et al., 1997). Some empirical studies do confirm that there is a positive impact of entrepreneurship education courses or programs at universities on perceived attractiveness and perceived feasibility of new venture initiation (Tkachev and Kolvereid, 1999; Fayolle and Lassas-Clerc, 2006). Reviews of literature on enterprise and entrepreneurship education (Dainow, 1986; Gorman et al., 1997)

and of particular entrepreneurship programs (McMullan et al., 2002) give evidence that these programs encourage entrepreneurs to start a business. But usually, there are serious methodological limitations. For example, studies rarely involve control groups or a form of stochastic matching (Block and Stumpf, 1992), basic controls as pre- and post-testing are not employed and most studies survey participants with an existing predisposition towards entrepreneurship, biasing the results in favor of educational interventions (Gorman et al., 1997).

The studies by Peterman and Kennedy (2003), Souitaris et al. (2007) and Oosterbeek et al. (2008) are three remarkable exceptions, using pre-test-post-test control group designs. The first study finds that exposure to enterprise education affects entrepreneurial intentions of high-school students. Souitaris et al. find that sensitization through a semester-long (January-May) entrepreneurship program leads to a stronger entrepreneurial intentions. They employed a pre-test-post-test control group-design and conducted their survey at two major European universities asking science and engineering students. They received 124 matched questionnaires from the program group and 126 from the control group. The students of the program group took an entrepreneurship course as an elective module within their curriculum. Hence, the allocation of students to the program group was not random, and different classes were taught by different academic instructors so that the treatment might have differed across classes. Finally, Oosterbeek et al. (2008) study the impact of entrepreneurship education in a compulsory course, using an instrumental variables approach in a difference-in-differences framework. Since students may have self-selected into different school locations, location choice (and thus treatment) is instrumented. Their results show that the effect on students' self-assessed entrepreneurial skills is insignificant. Moreover, the effect on entrepreneurial intentions is significantly negative. None of the studies attempts to investigate the nature of learning processes that are taking place during the respective courses.

Several researchers have called for more research to answer the question if entrepreneurship education can influence entrepreneurial perceptions and intentions (Donckels, 1991; Kantor, 1988; Kruegel Jr and Brazeal, 1994; McMullan et al., 2002). Descriptive and retrospective studies are not appropriate to provide convincing evidence for the above mentioned theoretical claims (Alberti, 1999; Gorman et al., 1997; Matthews and Moser, 1996). Peterman and Kennedy (2003) call for the development of credible methods of testing preconceived hypotheses, using large sample sizes and control groups, in order to move this young field of research beyond its exploratory stage (Alberti, 1999).

2.3 Prior Exposure to Entrepreneurship

Entrepreneurship education will not have homogeneous effects on all participating students (Lüthje and Franke, 2002), depending for example on their personality structure (Brockhaus Sr and Horwitz, 1986) or to an even greater extent on their prior exposure to entrepreneurship. Role models have been found to be a strong determinant of career choices (Katz, 1992). Role modeling occurs when social behavior is informally observed and then adopted by a learner who has learned by example rather than by direct experience (Bandura, 1977). According to social learning theory, role models are important environmental factors for career intentions (Mitchell, 1996). According to Shapero and Sokol (1982), the immediate family, and in particular father or mother, play the most powerful role in forming a notion of desirability and credibility of entrepreneurial actions. Empirical evidence for a relationship between the presence of parental entrepreneurial role models and the preference for a self-employment career has been repeatedly reported (Scott and Twomey, 1988; Scherer et al., 1989; Matthews and Moser, 1996; Peterman and Kennedy, 2003). Boyd and Vozikis (1994) show that entrepreneurial intentions are stronger with a growing degree of entrepreneurial self-efficacy due to the presence of entrepreneurial role models in close relatives.

These insights lead to a hypothesis already stated by Lüthje and Franke (2002) who assume that the effects of entrepreneurship education will differ across students, because students have received signals of their entrepreneurial ability prior to the entrepreneurship courses taken at a university. Hence, we need to study how intentions develop given prior assessments. Moreover, we argue that investigating the variable which most studies have focused on - average entrepreneurial intentions - is not satisfactory if one seeks to analyze the nature of learning processes. Towards that objective, we also need an assessment of the distribution of intentions, and of changes in the distribution.

3 Model

This section sets out a theoretical model of the effects of an entrepreneurship course on students' beliefs about their entrepreneurial ability. We model the evolution of students' beliefs about their own entrepreneurial ability when they receive signals of this ability.

We distinguish between e**n**trepreneurs and e**m**ployees. Being (truly) an entrepreneur means that one's own utility from being in an entrepreneurial function is greater than the

utility from being in an employee function. Conversely, we label employees all students who are better suited to non-entrepreneurial work. The label "employee" is not intended to be pejorative. An important function of entrepreneurship education is to help students self-select into activities which they are most suited to. Our model shows when this type of sorting is supported by entrepreneurship education.

Initially, both types of student are ill-informed about their true type and form beliefs about themselves. If we allow for heterogeneity in the strength of previous signals about entrepreneurship in the student population, then it might be expected that students who have stronger priors about their entrepreneurial ability are less likely to receive information that leads them to revise their beliefs about their entrepreneurial ability, and vice versa. Our theoretical model identifies conditions under which this intuition holds. We derive empirical tests from the model to test whether students update their beliefs about their entrepreneurial ability as a consequence of entrepreneurship education.

3.1 Setting and Assumptions

We assume that there are two types of student: e**n**trepreneurs ($\mathbf{n}$) and employees ($\mathbf{m}$). Students know that these two types exist and have information about the proportion of entrepreneurs ϕ, but they do not know their own type.

We distinguish between signals that entrepreneurs and employees receive about entrepreneurial ability. Depending on the culture they live in, entrepreneurs may have stronger or weaker information about their type than employees. In a culture in which entrepreneurship is not a predominant feature we might expect formal education to help students discover and develop mainly those talents suited to being employees. In contrast, a culture which accentuates entrepreneurship is less likely to provide strong signals and training for talented employees and more signals for talented entrepreneurs.[1]

In our model students receive information about their ability as entrepreneurs and as employees in two successive periods: periods one and two. Period one takes place before students go to university. Here students receive a signal σ_1 of their entrepreneurial ability which could

[1] Diamond (1997) discusses the reactions of neighboring stone age cultures in New Guinea when exposed to western civilization. He provides examples of cultures with an entrepreneurial bent which have embraced modern technologies and more conservative cultures which still observe traditions they have upheld for millenia. This shows that cultural openness towards entrepreneurship varies considerably. We might expect formal entrepreneurship education to be particularly effective in cultures that are not entrepreneurial.

be due to interaction with entrepreneurs, be they parents or acquaintances. Period two takes place once students go to university. Here students receive a signal $\boldsymbol{\sigma}_2$ of entrepreneurial ability from formal entrepreneurship education.

Students' beliefs about their own entrepreneurial ability are distributed on the interval $[0, 1]$. A belief of 0 implies that the student believes absolutely that they are an employee, a belief of 1 implies that they believe they are certainly an entrepreneur. Each type of student will receive a positive signal of entrepreneurial ability in each period with probability ψ^k where $\psi \in [0, 1]$ and $k \in \{n, m\}$. Define the precision of these positive signals as ς_i where $i \in \{1, 2\}$.

We assume that entrepreneurial ability either exists or it does not. Further, we assume that the signaling process is informative. This assumption has two components:

$$(i) \quad 1 \geq \psi^n > \psi^m \geq 0 \qquad\qquad (ii) \quad 1 \geq \varsigma_i > 0. \tag{I}$$

Part (i) implies that the probability that an entrepreneur-type receives a positive signal that they are an entrepreneur is greater than the probability that an employee-type receives such a signal. Part (ii) implies that signals always contain some information.

Next, we assume that students update their beliefs about their own type according to Bayes' Rule. We define the strength of positive signals that students receive as:

$$\sigma_i^k \equiv \psi^k \cdot \varsigma_i \tag{S}$$

Assumption (I) implies that the belief of an entrepreneur-type student who receives a positive signal of entrepreneurial ability (σ_i^n) that they are an entrepreneur will not decline as a result of the signal. Similarly an employee-type receiving a positive signal that they are an employee (σ_i^m) will not revise their belief that they are an entrepreneur upwards.

Assumption (I) also implies that there are strictly more entrepreneur-types in the population of students than employee-types who receive the incorrect signal.

3.2 Definitions

Initially students only know that a proportion ϕ of people in the population around them are entrepreneurs. Hence their prior of the probability that they are an entrepreneur is ϕ. Then, in the

course of their pre university life they receive the first signal about their own entrepreneurial ability. This signal will generally differ depending on their type.

Beliefs after period one By Bayes' rule the strength of the beliefs of entrepreneurs that they are entrepreneurs after period one is:

$$B_n^n \equiv \frac{\sigma_1^n \phi}{\sigma_1^n \phi + \sigma_1^m (1-\phi)} \qquad \text{and} \qquad B_m^n \equiv \frac{(1-\sigma_1^n)\,\phi}{(1-\sigma_1^n)\,\phi + (1-\sigma_1^m)\,(1-\phi)} \quad , \qquad (1)$$

where B_n^n is the strength of the first period belief of an entrepreneur ^{n} that they are an entrepreneur $_n$ if they receive a positive signal, while B_m^n is the strength of the entrepreneur's first period belief that they are an entrepreneur if they receive a negative signal. The expressions in (1) show that the first period signal divides the group of entrepreneurs into two sets, one of which believes more firmly that they are entrepreneurs (B_n^n) and one of whom no longer believes very strongly that they are entrepreneurs (B_m^n).

We define the strength of the beliefs of the employees that they are employees after period one as:

$$B_n^m \equiv \frac{\sigma_1^m (1-\phi)}{\sigma_1^m (1-\phi) + \sigma_1^n \phi} \qquad \text{and} \qquad B_m^m \equiv \frac{(1-\sigma_1^m)\,(1-\phi)}{(1-\sigma_1^n)\,\phi + (1-\sigma_1^m)\,(1-\phi)} \quad . \qquad (2)$$

These expressions show that employees who receive a misleading signal (B_n^m) that they are not employees (Type II error) will falsely infer that they are entrepreneurs. Similarly those who receive the correct signal (B_m^m) will have a high level of belief that they are employees.

Beliefs after period two Applying Bayes' rule once more the strength of beliefs of the entrepreneurs that they are entrepreneurs after period two is given by:

$$B_{n|n}^n = \frac{\sigma_2^n B_n^n}{\sigma_2^n B_n^n + \sigma_2^m B_n^m} \qquad \text{and} \qquad B_{n|m}^n = \frac{\sigma_2^n B_m^n}{\sigma_2^n B_m^n + \sigma_2^m B_m^m} \qquad (3)$$

$$B_{m|n}^n = \frac{(1-\sigma_2^n)\,B_n^n}{(1-\sigma_2^n) B_n^n + (1-\sigma_2^m) B_n^m} \qquad \text{and} \qquad B_{m|m}^n = \frac{(1-\sigma_2^n) B_m^n}{(1-\sigma_2^n)\,B_m^n + (1-\sigma_2^m)\,B_m^m}$$

where $B_{n|n}^n$ is the strength of the entrepreneur-type student's belief that she is an *entrepreneur* after receiving a second period signal that she is an entrepreneur and a first period signal that she is an entrepreneur $(_{n|n})$. $B_{m|n}^n$ is the student's second period belief that she is an entrepreneur if she received a second period signal that she is an *employee* and a first period

signal that she is an entrepreneur $(_{n|n})$ given that she is an entrepreneur $(^{n})$.

After period two there are four groups of students each with a distinct level of belief about their entrepreneurial ability. These beliefs are a function of the history of signals that students have received. Two groups of students have received signals going in the same direction and they now have the strongest $(B^n_{n|n})$ and the weakest $(B^n_{m|m})$ beliefs that they are entrepreneurs. In contrast the other two groups have received countervailing signals. These groups revise their belief about being entrepreneurs upwards $(B^n_{n|m})$ and downwards $(B^n_{m|n})$ after period two.

Analogously there are four groups of employees with different levels of beliefs that they are employees after period two:

$$\begin{aligned} B^m_{n|n} &= \frac{\sigma_2^m B_n^m}{\sigma_2^m B_n^m + \sigma_2^n B_n^n} \qquad \text{and} \qquad B^m_{n|m} = \frac{\sigma_2^m B_m^m}{\sigma_2^m B_m^m + \sigma_2^n B_m^n} \\ B^m_{m|n} &= \frac{(1-\sigma_2^m)\, B_n^m}{(1-\sigma_2^m) B_n^m + (1-\sigma_2^n) B_n^n} \qquad \text{and} \qquad B^m_{m|m} = \frac{(1-\sigma_2^m) B_m^m}{(1-\sigma_2^m)\, B_m^m + (1-\sigma_2^n)\, B_m^n} \end{aligned} \tag{4}$$

There are those employees who are truly employee-types and have received a series of consistent signals, leading them to believe quite strongly that they are employees $(B^m_{m|m})$ or quite strongly that they are not $(B^m_{n|n})$. Also, those employees who receive inconsistent signals will revise their beliefs that they are entrepreneurs upwards $(B^m_{n|m})$ and downwards $(B^m_{m|n})$.

Given these definitions we can characterize the size of the change in students' beliefs about their entrepreneurial ability after students update their period one beliefs on the basis of their period two signals. In the following section we derive a number of propositions about the changes in students' beliefs.

3.3 Results

In this section we derive two sets of results: first we focus on students' beliefs about their entrepreneurial ability in period two; second we analyze the change in beliefs between periods one and two. In each case we focus on the strength of students' beliefs. Stronger beliefs are beliefs that are further away from students' initial prior that they are entrepreneurs: ϕ. Similarly, stronger signals are signals that are further away from uninformative signals. A signal is uninformative if it is $1/2$.

Analyzing second stage beliefs we show that stronger signals in the first period lead to stronger beliefs about being an entrepreneur or an employee if both signals are consistent. In

contrast, beliefs become weaker if signals are not consistent. Additionally, it is shown that changes in beliefs about being an entrepreneur also depend on the consistency of signals and on the strength of first period signals. If first period signals are sufficiently strong, changes in beliefs will be greater for those receiving consistent signals. Both predictions can be tested empirically, as we do in Section 5 below.

Beliefs after Entrepreneurship Education

We begin with the most obvious implication of updating of beliefs: If there are entrepreneurs and employees in the population of students, if these all receive informative signals as defined in Assumption (I), if entrepreneurs' first period signals that they are entrepreneurs are not too strong ($\sigma_1^n < 0.5$) and if students update their beliefs according to Bayes' Rule, then we can show that:

Proposition 1

The distribution of beliefs after period two will have greater variance than the distribution of beliefs after period one.

We prove this proposition in Appendix 7.1. There we derive the expectation and the variance of students' beliefs that they are entrepreneurs for each period. A comparison of the variances for periods one and two shows that the variance of beliefs after students' have received the signals provided by entrepreneurship education is always greater than the variance of beliefs after period one, if $\sigma_1^n < 0.5$. [2]

We test whether Proposition 1 holds by testing the following hypothesis:

Hypothesis 1

The variance of beliefs in period two is greater than the variance of beliefs in period one.

We test this hypothesis using a robust difference of variances test. This test is robust to non-normality of error terms.

Now consider the effects of first period signals on the second period beliefs of entrepreneurs and employees. As is almost obvious, consistency of signals in period one and two will lead to stronger beliefs. Also, greater strength of signals to either type in the first period will make second period beliefs more distinct.

[2] This result may also hold for greater values of σ_1^n but we have not pursued the exact bound as we are quite confident that in the population we study the strength of the signal is weak.

Proposition 2

If the signals received by students in period one and two are consistent, then beliefs in period two will be stronger, than if signals are inconsistent.
Stronger first period signals lead to stronger beliefs after period two.

As noted above stronger beliefs are closer to certainty ($B = 1$ or $B = 0$) and weaker beliefs are closer to the prior of uninformed students ($B = \phi$).

In Appendix 7.2 Proposition 2 is proved. In Section 6 we test whether Proposition 2 holds by testing the following hypothesis:

Hypothesis 2

i) If signals are consistent then second period beliefs are stronger.
ii) Stronger first period signals lead to stronger second period beliefs.

To test this hypothesis we regress a measure of strong first period signals ($SFPS$) and of consistent signals (CS) on the variance of second period beliefs ($\bar{B}$) around their mean. The dependent variable is defined such that stronger beliefs increase the level of the dependent variable. It does not matter whether the belief that one is an entrepreneur is close to one or close to zero. In both cases students have strong beliefs and in both cases the level of the dependent variable is high.

Hypothesis 2 implies that the coefficients on the measure of extreme signals, the measure of consistent signals and their interaction are all positive. Our empirical model is:

$$\bar{B} = \beta_0 + \beta_1 CS + \beta_2 SFPS + \beta_3 CSX + \boldsymbol{\beta_4}' \boldsymbol{X} + \epsilon \quad , \tag{5}$$

where $\bar{B} \equiv (B[2] - \mu(B[2]))^2$ captures the squared deviation of students' second period beliefs ($B[2]$) from the overall mean, CS is a measure of consistent signals, $SFPS$ is a measure of the strength of the first period signal and CSX is the interaction of the latter two variables. $\boldsymbol{X}$ represents a vector of control variables. Hypothesis 2 predicts that $\beta_1 > 0, \beta_2 > 0$ and $\beta_3 > 0$.

The Change in Beliefs after Entrepreneurship Education

Now consider changes in the students' beliefs between the two periods. These changes characterize the impact of the course. We find that it is quite difficult to characterize the relationship

between the size of the change in students' beliefs about their aptitude for entrepreneurial tasks and the strength of first period signals they receive.

However, if we may assume that the signaling process is informative and also reliable then we may derive an additional prediction. We have already assumed that signals are informative above (Assumption I). If signals are also reliable that means students have a probability greater than $1/2$ of receiving the correct signal for their type. In such a setting there will be more students with correct and consistent signals than students with misleading and consistent signals. Then it is possible to prove the following additional result:

Proposition 3

If students receive sufficiently precise and reliable first period signals then those who receive consistent signals will change their beliefs **less** *as first period signals become stronger.*

Here a change of beliefs is the difference between the second and the first period beliefs. Signals are precise if they are far away from the uninformative levels around $1/2$, i.e. if $\sigma_1^n \to 1$ and $\sigma_1^m \to 0$. Note that we do not have a clear prediction for those individuals receiving inconsistent signals.

In Appendix 7.3 Proposition 3 is proved.

Proposition 3 can by tested by the following hypothesis:

Hypothesis 3

If students receive consistent signals, then those among them who have received stronger signals in period one will change their beliefs less.

To test this hypothesis we will regress the square of the change in beliefs on a measure of the strength of signals in period one and of consistent signals. We predict a negative coefficient on the interaction of strong and consistent signals. The dependent variable is squared, since our model makes predictions about the extent of a change in beliefs, not about their direction.

The empirical model in this case is:

$$\bar{\triangle} = \gamma_0 + \gamma_1 CS + \gamma_2 SFPS + \gamma_3 CSX + \boldsymbol{\gamma_4}' \boldsymbol{X} + \epsilon \quad , \tag{6}$$

where $\bar{\triangle} \equiv (\triangle - \mu(\triangle))^2$ captures the squared change in students' beliefs. The remaining variables are defined as above. Hypothesis 3 predicts that $\gamma_3 < 0$.

Proposition 3 is weaker than Proposition 2. It relies on the additional assumption that the signaling process is reliable. Additionally, it is weaker because our model predicts that in the counterfactual case in which students receive inconsistent signals there are two groups with different reactions to more precise first period signals. Our model predicts that these two groups will be of equal size, in which case these reactions cancel out in aggregate. In smaller populations we may see deviations from this prediction.

4 Institutional Background and Data Collection

This section discusses the "Business Planning" course we survey and the way in which we collected our data.

Institutional Background The setting for data collection is the Department of Business Administration, in the Munich School of Management, at Ludwig-Maximilians-Universität (LMU) Munich, one of Germany's largest universities. At the time of the course we study, over 3.000 business administration students were enrolled at this department. The Bachelor curriculum at the department is somewhat untypical due to its obligatory entrepreneurship education course "Business Planning". This course is comprised of several lectures and integrated exercises. Every business administration student in the Bachelor of Science curriculum at LMU has to enroll in this course in the third semester of their study program.

The objectives of the "Business Planning" course are threefold: i) to teach students basic capabilities needed in the planning and management of a startup enterprise, in particular to convey the necessary knowledge and skills for crafting a complete business plan; ii) to sensitize students for entrepreneurship according to the classification by Liñan (2004): students are supposed to acquire knowledge about small enterprises, self-employment and entrepreneurship so that they can make a rational career decisions; iii) to allow students to gain practical experience by interaction with real-world entrepreneurs; and iv) the training of key qualifications such as teamwork and presentation skills. It is important to realize that the course objectives do not encompass any notion of convincing students to become entrepreneurs or to describe entrepreneurship as a particularly desirable option. While the economic importance of entrepreneurship is clearly signaled, students are not meant to be indoctrinated.

The course took place from October 2008 to February 2009 and was obligatory for the

third semester business administration students. The students were working in groups of five to develop a full business plan based on an idea developed by an entrepreneur from the Munich region. More than 40 entrepreneurs were thus supported by 80 student teams, where each entrepreneur was consulted by two student teams. The two teams supporting an entrepreneur initially shared basic information that they have obtained on the business concept, but are then competing against each other. At the end of the course, the students have to deliver the business plan to the teaching staff as well as to their entrepreneur together with a presentation in front of hypothetical investors.

The students had to take part in eight lectures conveying the principles of business planning. These lectures were held by LMU faculty, supported by experts on financial planning and entrepreneurial marketing as well as experienced entrepreneurs and investors giving a first-hand insight into their businesses. The students also attended tutorials with 25 students each, i.e., five teams per exercise group. In these exercises the students repeated the contents of the lectures and presented their progress in their business-planning project, receiving feedback from their fellow students as well as from the respective teaching assistant and a tutor.

As far as we know, the seminar concept and the obligatory character of the course, are unique in German university entrepreneurship education. The setting presents a particularly suitable framework for our study since students do not self-select into the "Business Planning" course. Moreover, given that students interact with real-world entrepreneurs we believe that they receive informative and important signals of their own ability as entrepreneurs.

Data Collection Students were surveyed (either using a written or an online survey) directly after the kickoff session of the course and immediately before the time when the students received their grades at the end of the semester. The survey instruments used had been reviewed by three academics and 12 non-participating students to ensure clarity of wording and face validity of the constructs. Out of ethical concerns, we did not attempt to enforce full participation in the two surveys. The two survey instruments were largely identical. However, the second survey also contained items used in the course evaluation.[3] The survey forms were anonymized in both rounds, and matching was achieved by employing a voluntary structured identification code.[4]

[3] The survey forms are available upon request.

[4] The code consisted of the first letter of the first name of the student's mother, the last letter of the student's name, the first digit of the student's month of birth, and the first letter of the student's place of birth.

5 Descriptive Analysis of the Data

In this section we provide descriptive information on the composition of our sample, the way in which students in the sample evaluated the "Business Planning" course and on the effects which the course had on students' intentions to become entrepreneurs. We show that sample selection biases are not of concern and that the course was perceived as informative by students. We document that 17.9% of students taking the course who responded to both the pre and post surveys change their minds about wanting to become founders of an enterprise. $5/7$ of these moved from a positive to a negative response, while only $2/7$ change their minds in the opposite direction. Finally, we provide descriptive evidence consistent with Bayesian updating of beliefs about entrepreneurial ability.

5.1 Participation in the Surveys and Possible Selection Biases

We collected responses from 357 students who either participated the the *ex ante* or the *ex post* survey. They represent 97.8 percent of the total enrollment in the "Business Planning" course. 265 students participated in the first, 274 students responded to the second survey. For 196 students we were able to match the two survey responses. While our research design has the advantage that students cannot self-select into the course itself, we may still face selection issues due to differential propensities to respond to our surveys.

Table 1: Demographic Characteristics

subgroup	age (years)	female (%)	protestant (%)	non-German (%)	parents self-employed (%)
pre-survey only (N=69)	22.3*	52.8	30.1	29.2*	47.8
both surveys (N=196)	21.7	55.1	22.2	18.4	40.3
post-survey only (N=78)	22.9*	48.8	24.4	22.5	50.0

Note: *-$p < 0.10$, **-$p < 0.05$

Differences significant between students who participated in both surveys and pre- or post-group only.

Post-survey age was corrected by 0.30 years to correct for calendar time of survey.

A first suggestion that we are not facing major (or possibly not any) selection issues can be taken from Table 1 where we display several demographic variables for three groups of

respondents: those who only responded in the first survey, those who participated in both data collections, and those who only responded in the *ex post* survey. Participants in both surveys were significantly younger than those who responded to only one survey round. This may reflect students' behavior - older students are likely to feel more pressure to focus on their studies and may therefore be less willing to "waste" time on survey responses. Moreover, students not participating in both surveys were more likely to have self-employed parents (in the pre- and post-survey group) or self-employed friends (in the post-survey group).

However, given that we have some information about non-respondents for both of the two surveys, we can use a multivariate test whether the likelihood of responding in the *ex ante* (*ex post*) survey is systematically related to characteristics revealed in the second (first) data collection. We therefore ran two probit regressions in which we predict response behavior as a function of sex, age, religion, nationality and the employment status of parents and friends. Moreover, we included scale variables for the students' attitude towards entrepreneurship, the perceived social norms in favor of entrepreneurship, the perceived entrepreneurial self-efficacy, and the perceived feasibility of a startup project. Both probit regressions contained 11 regressors and were either largely or totally uninformative (p=0.089, n=251 in the case of participation in the post-survey as a function of ex ante data, and p=0.267, n=263 in the case of ex ante participation as a function of data collected in the second round). The marginal explanatory power in the ex post survey participation is due to non-German participants and students with self-employed parents. The non-participation of these students is likely to introduce a conservative (if any) bias in our results.[5] The subsequent discussion focuses on the matched sample with *ex ante* and *ex post* information from 196 students.

5.2 Overall Course Assessment and Impact on Attitudes and Skills

We now turn to a first exploration of the impact of the course. Table 2 summarizes evidence about the ex ante and ex post assessments of several classical attitudinal measures. First, we use a scale comprised of five items to measure students' attitude towards entrepreneurship. We tested the scale based on the inter-item correlation. Scale reliability is high for both surveys (Cronbach's alpha=0.886 and 0.924 in the first and the second survey, respectively). To maintain the scale information, we do not standardize the two measures. We also

[5] The detailed results of these probit regressions are available upon request.

obtain a scale measure of entrepreneurial self-efficacy based on 20 items (Cronbach's alpha 0.935 and 0.942), an assessment of the perceived feasibility of handling a startup project (six items, Cronbach's alpha 0.750 and 0.747) and finally a measure of perceived social norms. The latter is based on four items asking for an assessment whether parents, siblings or friends thought that the respondents ought to become entrepreneurs. These were transformed to yield a symmetric scale, which was then multiplied by a weight obtained in a survey item in which respondents indicated to which extent they cared about the particular opinion. This measure is best considered a formative variable since the social influence of parents, siblings and friends may be additive in nature.

Table 2: Attitudinal Measures and Assessments

	Ex ante	S.E.	Ex post	S.E.	Difference	p-value
Attitude towards entrepreneurship *(scale, 5 items)*	4.319	(0.100)	4.389	(0.110)	0.070	$p = 0.357$
Risk preference (*scale, 6 items)*	4.774	(0.111)	4.841	0.114	0.068	$p = 0.452$
Entrepreneurial self-efficacy (*scale, 20 items)*	6.466	(0.094)	6.513	(0.096)	0.047	$p = 0.617$
Feasibility of start-up project (*scale, 6 items)*	1.551	(0.060)	1.656	(0.065)	0.106	$\boldsymbol{p = 0.028}$
Perceived social norms (*weighted sum of 4 items)*	-2.413	(2.178)	-4.163	(2.057)	1.75	$p = 0.261$

Note: N=196. Responses from matched surveys of LMU students.

Table 2 summarizes the mean values of these measures and their differences. Only the perceived feasibility of handling a startup project has seen a statistically significant change of about 7 percent of its ex ante value. An even larger change is apparent in a confidence measure summarized in Table 3.

Ex post students agree less to the statement "I can always conclude my projects successfully" than ex ante, and the change is marginally significant (p=0.087). The confrontation with a real-world problem may have led to an adjustment of assessments. A large and significant improvement is apparent in the response to the statement "I know everything that is needed to

start a new enterprise." The ex ante average response to that statement was between "do not agree" and "rather not agree" (mean value 2.50) and shifts to a mean value of 3.87 (between "rather not agree" and "neither agree nor disagree").

Table 3: Confidence Assessments

	Ex ante	Ex post	Difference	p-value
1. I can always conclude my projects successfully.	5.43	5.31	-0.12	$p = 0.087$
2. I know everything that is needed to start a new enterprise.	2.5	3.87	1.37	$\boldsymbol{p < 0.001}$
3. I am very self-confident	4.88	4.98	0.1	$\boldsymbol{p = 0.028}$

Note: N=196. Responses measured on rating scales from 1 to 7 in matched surveys of LMU students.

Moreover, the measure of general self-confidence has risen significantly, but much less than the response to the entrepreneurship-specific question. We conclude from these answers that the training has had a significant positive effect on students' skills and self-confidence, and that it may have led to a reduced, and possibly more realistic assessment of project success.

Now we turn to the assessment of the course. We discuss this here to exclude the possibility that students disliked the course, leading them to dislike entrepreneurship.

An overall positive assessment of the course emerges from course evaluation questions available for 274 students participating in the course evaluation. These are tabulated in Table 4. 81.4% (9.1%) percent of the students agreed (were neutral) to the statement that they "better understand the steps that one has to take to found a firm." The cooperation with real-world entrepreneurs yielded a smaller effect. 57.5% (25.1%) agreed (were neutral) that they "better understand the attitudes, values and motivation of entrepreneurs."[6] An improvement of practical management skills for founding a firm was confirmed by 66.8% percent of students, 19.7% were neutral, 13.5% percent did not see an improvement. Asked whether the course has had the effect that "I will consider founding or taking over an enterprise" 41.6% responded positively, and 38.3% negatively. 20.1% percent of students gave a neutral response. 34.7%

[6] The somewhat smaller effect is probably due to the fact that student teams engaged in considerable division of labor, and that only some students within the respective teams directly interacted with the cooperating entrepreneurs.

percents stated that as an effect of the course, they would tend to prefer an employee position, 41.2% disagreed with that statement, and 24.1% were neutral.

Table 4: Students' Assessments of Course Impact

Statement	Agreement to the statement		
	negative	neutral	positive
The course has had the effect			
... that I understand the attitudes, values and motivation of entrepreneurs better.	17.5%	25.1%	57.5%
... that I understand the steps that one has to take to found a firm better.	9.5%	9.1%	81.4%
... of improving my practical management skills for founding a firm.	13.5%	19.7%	66.8%
... of improving my networking skills.	27.0%	26.3%	46.7%
... of improving my skills to recognize business ideas.	24.8%	22.6%	52.6%
... that I will consider founding or taking over an enterprise.	38.3%	20.1%	41.6%
... that I will tend to prefer an employee position.	41.2%	24.1%	34.7%

Note: N=196 - data from the ex post survey and course evaluation.

Data were originally coded on a 1 to 7 rating scale and have been recoded to 1/3=negative, 4=neutral, 5/7=positive.

Cross-tabulating the last two responses shows that at the end of the course, about 40% percent of students indicated that they have entrepreneurial intentions (and a dislike of an employee position), and about 35% have the opposite preference.

5.3 Changes in Entrepreneurial Intentions

Entrepreneurial intentions were surveyed with two items in the questionnaires. First, we asked a direct question "Would you like to found your own enterprise at some point?" requesting a yes or no-response. Second, we asked for an indication of agreement regarding the statement "I intend to found my own enterprise within the next five to ten years" with responses on a seven-point rating scale. The results are presented in Tables 5 and 6.

Table 5: Ex ante and ex post Entrepreneurial Intentions

Would you like to found your own enterprise at some point?

		Ex post response			
		no	yes	Total	
Ex ante	no	46	10	56	28.6%
response	yes	25	115	140	71.4%
	Total	71	125	196	100.0%
		36.2%	63.8&	100.0%	

Note: N=274 - data from the ex post survey and course evaluation.

Table 5 shows that the share of students indicating that they want to found their own business at some point has decreased at the conclusion of the course. In the pre-course survey, 71.4% of the 196 students indicated entrepreneurial intentions. At the conclusion of the course, this share has decreased to 63.8%. The differences are highly significant in a chi-square test (Pearson's chi-squared=$71.6,\ p < 0.001$).

Table 6: Ex ante and ex post Entrepreneurial Intentions

I intend to start my own enterprise within the next five to ten years.

		Ex post response								
		1	2	3	4	5	6	7	Total	
	strongly disagree	8	4	3	0	0	1	0	16	8.2%
	disagree	10	13	3	1	0	0	0	27	13.8%
	somewhat disagree	4	8	12	3	6	2	1	36	18.4%
Ex ante	neutral	2	3	10	11	8	4	0	38	19.4%
response	somewhat agree	1	1	0	7	14	5	1	29	14.8%
	agree	0	2	0	3	5	12	4	26	13.3%
	strongly agree	1	0	2	1	2	6	12	24	12.2%
	Total	26	31	30	26	35	30	18	196	100.0%
		13.3%	15.8%	15.3%	13.3%	17.9%	15.3%	9.2%	100.0%	

Note: N=196. Responses from matched surveys of LMU students.

Table 6 contains the results for the more detailed measure of entrepreneurial intentions. Consistent with the results in Table 5, the average score (interpreting the scale as metric) has decreased from 4.08 to 3.89 (p=0.069 in a two-tailed test, N=196). However, the distribution itself is quite informative. The share of neutral responses has declined from 19.4 to 13.3%. The neutral overall balance in the ex ante survey (40.2 vs. 40.2% with negative vs. positive assessments) has given way to a slightly more negative result (44.4 vs. 42.3%). These changes are small, but they appear to indicate that the course helps students to develop a more precise idea of their future plans. The number of students with neutral assessments declines, opinions become stronger.

Table 7: Changes in Entrepreneurial Intention by ex ante Intention

		Change in ex post response				
		Change		No change		Total
Ex ante response	strongly disagree	8	50.0%	8	50.0%	16
	disagree	14	51.9%	13	48.1%	27
	somewhat disagree	24	66.7%	12	33.3%	36
	neutral	27	71.1%	11	28.9%	38
	somewhat agree	15	51.7%	14	48.3%	29
	agree	14	53.8%	12	46.2%	26
	strongly agree	12	50.0%	12	50.0%	24
	Total	114	58.2%	82	41.8%	196

Note: N=196. Responses from matched surveys of LMU students.

This result is also apparent in Table 7 where we cross-tabulate a discrete measure of changes in entrepreneurial intentions with the ex ante intention. This table shows that students with strong ex ante opinions were less likely to change their intentions than students with more indifferent intentions. Changes in intentions occur mostly for the group of the undecided, as one would expect in a world with Bayesian updating during the course.

If students update their beliefs about themselves, some of them should also revise opinions that they have held before. Table 8 contains interesting evidence regarding this process. In the upper panel of the table, we display which percentage of students who had indicated a

particular level of entrepreneurial intentions have parents or friends who are self-employed. For example, while only 12.5% of those who disagreed strongly with the statement "I intend to found my own enterprise within the next five to ten years" had self-employed parents, the share of students with self-employed parents was 58.3% for those in the highest response category. There is a clear bivariate relationship between parental self-employment and students' intentions. This is even more clearly visible once we condition parental self-employment on positive experience. The relationship is less pronounced for self-employment of friends, but again clearer once one requires self-employment to have been a positive experience.

Table 8: Ex ante and ex post Entrepreneurial Intentions

Ex ante statement: "I intend to found my own enterprise within the next five to ten years."

Level of agreement	parent self-employed	... and positive experience	friends self-employed	... and positive experience	N
strongly disagree	12.5%	6.3%	68.6%	31.3%	16
disagree	29.6%	22.2%	66.7%	55.6%	27
somewhat disagree	36.1%	30.6%	77.8%	58.3%	36
neutral	43.2%	35.1%	83.8%	75.7%	37
somewhat agree	41.4%	34.5%	82.8%	65.5%	29
agree	53.8%	53.8%	69.2%	65.4%	26
strongly agree	58.3%	54.2%	91.7%	87.5%	24
Total	40.5%	54.2%	77.9%	64.6%	195

Ex post statement: "I intend to found my own enterprise within the next five to ten years."

Level of agreement	parent self-employed	... and positive experience	friends self-employed	... and positive experience	N
strongly disagree	23.1%	15.4%	69.2%	46.2%	26
disagree	32.3%	29.0%	71.0%	51.6%	31
somewhat disagree	40.0%	36.7%	86.7%	70.0%	30
neutral	53.8%	34.6%	84.6%	73.1%	26
somewhat agree	29.4%	26.5%	76.5%	64.7%	34
agree	50.0%	46.7%	73.3%	66.7%	30
strongly agree	66.7%	66.7%	88.9%	88.9%	18
Total	40.5%	54.2%	77.9%	64.6%	195

Note: parental and friends' self-employment is taken from the ex-ante survey in both panels.

Note: N=195. Responses from matched surveys of LMU students.

While these results are not surprising, the second panel of Table 8 yields a helpful insight. When we tabulate the results again using the *ex post* responses, we find that the share of self-employed parents or friends has become much more higher in the lower *ex post* response categories. The share of students with self-employed parents has almost doubled now in the lower response category, and it has increased somewhat in the upper one. This shows that students get detached from some signals that affected their *ex ante* entrepreneurial intentions.

At the end of this section we are left with an interesting puzzle. The course has apparently led to somewhat diminished entrepreneurial intentions among students.[7] However, it has also led students to develop less ambiguous ideas about their future plans. Students state that they feel more assured regarding the capabilities needed to found a new enterprise (see Table 3 and Table 4). Moreover, we find interesting evidence that students reshape their intentions and opinions regarding entrepreneurship during the course. "Weak" opinions become more defined, and students become detached from previous convictions as determined by parental background and former personal environment. At the same time, the information that students have received has led to reduced entrepreneurial intentions. We consider these descriptive results quite important since they cast new light on the learning process itself, rather than the level of entrepreneurial intentions. In the next section we test the predictions of our formal model to see whether Bayesian updating provides an explanation for what we observe.

6 Testing Bayesian Updating

We now proceed to test the hypotheses that were developed in section 3.3. We begin by presenting the variables which enter our regressions and tests. Then we present results of a differences of variances test and two regressions.

[7] We have to sound a warning here - the sentiment of students regarding entrepreneurship may also have been affected by the financial crises that began to impact the economy at the end of 2009 - exactly the time when students enrolled in this class. Our control group data will allow us to compute the actual treatment effect. In the current analysis we focus on changes in entrepreneurial intentions using data from the pre-post comparison.

6.1 Description of Variables

As noted in Section 3.3 above we investigate how consistent and strong signals before and during the course affect the strength of students' beliefs after the course (period two). Students could have strong beliefs that they are entrepreneurs or that they are employees after period two. Similarly they could have received strong signals that they are either employees or entrepreneurs before and during the course.

Table 9: Descriptive Statistics

Variable	**Mean**	**Median**	**Std. Deviation**	**Minimum**	**Maximum**
$\bar{B}$	3.497	3.771	3.236	0.003	9.351
$\bar{\triangle}$	2.000	1.000	4.335	0.000	36.000
Perceived social norms	-4.404	0.000	28.063	-78.000	84.000
Scale: entrepreneurial self efficacy	6.552	6.600	1.338	1.950	10.000
Scale: risk preference	4.818	4.857	1.537	1.143	8.571
Scale: feasibility assessment period one	1.582	1.500	0.831	-0.333	4.333
Change in feasibility assessment scales	0.106	0.167	0.657	-2.000	2.200
Strong signals period one	0.680	0.250	1.042	0.000	8.028
Strong signals period two	0.433	0.111	0.651	0.000	4.694
Consistent signals	0.471	0.000	–	0.000	1.000
Parents self-employed	0.424	0.000	–	0.000	1.000
Friends self-employed	0.771	1.000	–	0.000	1.000
non- German	0.213	0.000	–	0.000	1.000
Female	0.545	1.000	–	0.000	1.000
Protestant	0.254	0.000	–	0.000	1.000

We measure the strength of beliefs and signals by constructing the squared deviation of students' signals and beliefs from the means of these measures. In this way extreme beliefs and signals that one is an entrepreneur or that one is an employee have the same effect.

The dependent variables We use detailed measures of students' intentions to found an enterprise within the next five to ten years as our dependent variable in the empirical test of Hypothesis 2. In order to capture the strength of students' beliefs that they are (are not) entrepreneurs we transformed the measure of students' intentions to found. The squared deviation from the mean of students' second period intentions to found ($\bar{B}$) forms our measure of the strength of students' second period intentions.

Hypothesis 3 is based on the change in students' intentions resulting from entrepreneurship education. The dependent measure here is the squared *change* of intentions to found ($\bar{\triangle}$). This variable is clearly skewed. Regressions in which we use its logarithm as the dependent variable produce qualitatively identical results to those reported below.

Signals and their strength We measure the level of students' pre course signals of their type using the questions on students' assessment of the feasibility of founding and running an independent and own company. We construct a scale from six questions on feasibility to capture the signals students receive before the course.

The level of the signals students receive from the course is measured by the difference between the ex-post responses to the feasibility questions aggregated to a scale and the ex-ante responses to the same questions aggregated to a scale.

The strength of both the first period and the second period signals was measured by taking the squared deviation from the means of the signal measures. These variables indicate whether a student received particularly strong signals about their type, regardless of whether they believe themselves to be entrepreneurs or employees.

Consistency of signals We define a sequence of signals as consistent if the first and the second period signals were both high or the first period signals were both low.

Control variables We employ a number of control variables such as gender, nationality and confession as well the scales for self efficacy, risk and control which were discussed previously.

6.2 Test of Hypothesis 1

We have shown that Bayesian updating has the effect that students' beliefs about their entrepreneurial ability will have greater variance after students receive an informative signal of their ability. Table 10 sets out the standard deviations of students' beliefs about their entrepreneurial ability for the pre- and post-course samples. We provide these for the full set of students who responded to at least one survey and for the restricted sample of students that took part in both surveys. We also consider the latter sample excluding all those students whose first period intentions to become entrepreneurs were in a range indicating indecision (neutral or somewhat agree / disagree) and whose intentions had not changed in period two. This indicates that these students did not receive sufficiently strong signals from the course or that they do not update beliefs as predicted by Bayes' Rule.

Table 10: Comparing the Variances of ex ante and ex post Beliefs

		Standard Deviation of Beliefs by Sample		
		Full	Estimation	Restricted - Estimation
N		541	392	318
Response time	ex ante	1.821	1.806	1.965
	ex post	1.873	1.898	2.068
			p-value	
Test statistic	F-test	0.323	0.243	0.260
	Levene's robust test	0.455	0.357	0.117
	Brown and Forsythe's median test	0.394	0.365	0.113

Table 10 shows that the variance of beliefs about entrepreneurial ability increases in all three samples: beliefs after entrepreneurship education have greater variance than beliefs before. However, we are unable to reject the hypothesis that the two variances are statistically identical, although the results are close to significant in the restricted sample. Therefore, we are not able to provide much support for Bayesian updating on the basis of this test alone. Note however, that the test also provides no grounds to reject Bayesian updating. We include the test as it is narrowly inconclusive and may prove useful in larger samples.

Table 11: Regressions for Strength of Intentions in Period Two

Dependent Variable:	(1) $\bar{B}$	(2) $\bar{B}$	(3) $\bar{B}$	(4) $\bar{B}$
Strong first period		0.625***	0.764***	0.770***
signals		(0.236)	(0.254)	(0.249)
Consistent signals		1.959**	2.339***	2.351***
		(0.773)	(0.816)	(0.791)
Consistent and strong		3.343***	3.263***	3.166**
signals		(1.254)	(1.252)	(1.226)
Strong second period			-0.550	-0.506
signals			(0.388)	(0.382)
non - German	0.363	0.602	0.604	
	(0.661)	(0.613)	(0.611)	
Female	-0.032	-0.034	-0.021	
	(0.532)	(0.492)	(0.490)	
Protestant	0.707	0.871	0.885	0.738
	(0.600)	(0.555)	(0.554)	(0.536)
Parents self-employed	0.284	-0.106	-0.094	
	(0.519)	(0.482)	(0.481)	
Friends self-employed	-0.355	-0.377	-0.378	
	(0.612)	(0.564)	(0.563)	
Scale: feasibility	-0.544	-0.897**	-0.943**	-0.715**
assessment period one	(0.456)	(0.426)	(0.426)	(0.286)
Scale: feasibility	-0.221	-0.163	-0.126	0.044
assessment period two	(0.436)	(0.403)	(0.403)	(0.350)
Scale: entrepreneurial	0.315	0.173	0.178	
self efficacy	(0.247)	(0.229)	(0.228)	
Scale: risk preference	-0.299*	-0.171	-0.172	
	(0.177)	(0.164)	(0.164)	
Perceived social norm	0.004	0.008	0.009	
	(0.011)	(0.010)	(0.010)	
Constant	3.848**	3.926***	4.050***	3.736***
	(1.599)	(1.476)	(1.474)	(0.513)
Adjusted R-squared	-0.015	0.143	0.148	0.162
N	189	189	189	189

Standard errors are shown in parentheses: *** (**, *) denotes a 1% (5%,10%) level of significance.

6.3 Test of Hypothesis 2

Table 11 sets out results from regressions performed to test Hypothesis 2. Note that the dependent variable in this regression is a continuous variable, so that we use OLS. There are 189 observations as we do not have responses on all questions contained in the feasibility scale from all those students who took part in the first and second round surveys. We set out four regressions. The first contains only control variables and shows that none of these is able to explain the strength of students' intentions to become entrepreneurs or to avoid entrepreneurship after the course. This is interesting because several of these variables do provide information about the level of students' intentions before and after the course.[8]

Next we include the three measures suggested by Hypothesis 2: a measure of the strength of first period beliefs, a measure of consistent beliefs and the interaction of these two measures. Our results show that all three measures have positive sign and are significant at the 1% and 5% levels respectively. In the regressions reported in Columns 2 and 3 of Table 11 we use the same large set of control variables as in Column 1. We find that apart from the feasibility assessment scale non of these variables is significant. Not even the strength of the second period signal has any effects. In the regression reported in Column 4 we drop all those controls that are insignificant above the 20% level. We arrived at the specification reported there by iteratively removing the least significant controls one by one. While the adjusted R-squared measure of this last regression is clearly highest we find that the coefficients we estimate are not much affected by the procedure. We conclude that the effects we identify are robust.

These results indicate that the strength and consistency of students' signals affect intentions to become entrepreneurs as predicted in Hypothesis 2.

6.4 Test of Hypothesis 3

To test Hypothesis 3 we seek to establish whether students who have received consistent signals and who have a stronger signal in the first period are less likely to adjust their beliefs in the second period. Table 12 shows that we are unable to reject the Hypothesis 3.

[8] We do not report regressions on the intentions ex ante and ex post here as our model makes no predictions about these. The regressions are available from the authors upon request.

Table 12: Regressions for Extent of Changes in Intentions

Dependent Variable:	(1) $\bar{\triangle}$	(2) $\bar{\triangle}$	(3) $\bar{\triangle}$
Strong first period	-0.567*	-0.690**	-0.662**
signals	(0.330)	(0.332)	(0.328)
Consistent signals	2.240**	2.295**	2.368**
	(1.100)	(1.107)	(1.094)
Consistent and strong	-3.585**	-3.614**	-3.693**
first period signals	(1.692)	(1.708)	(1.677)
Strong second period	0.983*	0.917*	0.923*
signals	(0.529)	(0.525)	(0.523)
non - German		-0.957	
		(0.831)	
Female		0.706	
		(0.665)	
Protestant		0.275	
		(0.751)	
Parents self-employed		-1.315**	-1.152*
		(0.646)	(0.627)
Friends self-employed		0.385	
		(0.763)	
Scale: entrepreneurial		0.417	0.347
self efficacy		(0.270)	(0.264)
Scale: risk preference		-0.445**	-0.455**
		(0.223)	(0.218)
Perceived social norm		0.025**	0.022*
		(0.012)	(0.012)
Constant	1.782***	1.389	2.363
	(0.409)	(1.976)	(1.772)
Adjusted R-squared	0.056	0.078	0.086
N	189	189	189

Standard errors are shown in parentheses: *** (**, *) denotes a 1% (5%, 10%) level of significance.

Table 12 provides three OLS regressions. In column (1) we just regress the main variables of interest on the dependent variable. We find that the strength of first and second period

signals significantly affects changes in intentions as do consistent signals and the interaction of consistent and strong first period signals. The interaction term has the sign predicted in Proposition 3. It is also not surprising that strong second period signals change intentions more while strong first period beliefs make it less likely that intentions change.

In column (2) we introduce a large set of control variables. This does not affect the significance of the four main variables of interest, nor are the coefficients significantly altered. Column (3) provides a regression in which we test down, iteratively removing the least significant regressors. Once more this has no significant effect on the signs or coefficients of regressors we are most interested in.

These results indicate that the strength and consistency of students' signals affect changes in students' intentions to become entrepreneurs as predicted in Hypothesis 3.

7 Conclusion

This paper provides an analysis of learning processes in entrepreneurship education. While entrepreneurship education has been introduced and promoted in many countries and at many institutions of tertiary education, little is known at this point about the effect of these courses. In particular, it is largely unknown how the courses impact students' willingness to engage in entrepreneurial activity and what kind of learning processes are responsible for these effects.

In the context of funding of entrepreneurial ventures it has been argued that subsidizing finance for new entrepreneurs could be socially wasteful (de Meza and Southey, 1996; de Meza, 2002). By analogy, one might expect that entrepreneurship education could have negative effects if it succeeded in convincing those not suited to entrepreneurship that they should become entrepreneurs. Alternatively, and more positively, it could be that such education actually informs students and allows them to discover where their abilities lie.

In this paper we analyze the effects of entrepreneurship education on a group of students who are not selected for their interest in entrepreneurship. We postulate that student behavior is largely be driven by Bayesian updating - students enter entrepreneurship courses with prior beliefs about their own "type", but update their beliefs in the course of entrepreneurship training. Based on a simple theoretical model we derived three hypotheses that link ex post intentions as well as changes in intentions to the strength and consistency of signals received by students prior to and during the entrepreneurship course. Data were collected in a compulsory

entrepreneurship class at a large German university.

In our descriptive analysis, we find evidence that students update their beliefs, and that initially undecided students are particularly likely to change their entrepreneurial intentions. We are not able to show (Hypothesis 1) that the variance of beliefs increased significantly during the course, but the result may have been due to a lack of power of the test. Our two other hypothesis tests yield the predicted result, however. We show that strong ex ante beliefs and consistency of signals lead to stronger ex post intentions, and that changes in intentions due to the course tend to be smaller if ex ante signals are strong and if the signals received by students are consistent.

A number of caveats apply. The current study does not employ data from a control group.[9] Hence, we cannot exclude the possibility that students updated their beliefs based on information that was extraneous to the course. We consider this unlikely, since the course contents were very specific and not duplicated in other courses. Nor do we know if particular content characteristics of this course have led to the described outcomes.

In our overall assessment, the results can be read as confirmation for educational policies that view entrepreneurship training as a way of informing students about career options, and of creating learning opportunities for calibrating and refining their assessments of which career is most suitable. We have no means to assess how costly the mistakes of choosing the "wrong" career would be to the students and to society at large. Hence, we cannot quantify the true economic and societal impact of entrepreneurship training. But it seems worthwhile to consider that a simple increase in entrepreneurial activity may neither be a good objective, nor the most likely outcome for including entrepreneurship in the curriculum.

In future work we intend to further test the theoretical framework describing the effects of entrepreneurship education that has been developed in this paper. We will reapply the framework to other entrepreneurship courses and seek to establish whether the framework also describes effects of other types of education, which are intended to help students discover their proclivity for a specific type of work.

[9] In addition to the data collection for the course studied, we also obtained data on a small sample of students at another Munich university. However, with 44 observations the sample is to small for setting up a fully developed pre-post control group design. Entrepreneurial intentions declined in the control group as well and more strongly than in our treatment group.

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Appendix

Here we present the calculations which underpin Propositions 1- 3.

7.1 Expectation and variance of first and second period beliefs

This section sets out the proof of Proposition 1. First, we derive the expectations of first and second period beliefs. Then we derive the variances of first and second stage beliefs. Finally, we show when the variance of second stage beliefs exceeds that of first stage beliefs.

The expectation of first period beliefs

$$\mu_1 = \phi\Big(\psi^n B_n^n + (1-\psi^n)B_m^n\Big) + (1-\phi)\left(\psi^m(1-B_n^m) + (1-\psi^m)(1-B_m^m)\right) \quad . \quad (7)$$

Given that $B_n^n = 1 - B_n^m$ and $B_m^m = 1 - B_m^n$ we can show that:

$$\mu_1 = \Big(B_n^n - B_m^n\Big)\Big(\phi\psi^n + \psi^m(1-\phi)\Big) + B_m^n \quad . \tag{8}$$

We define $\lambda \equiv \Big(\phi\psi^n + \psi^m(1-\phi)\Big)$ to simplify calculations further below. Note that it must be true that $1 \geq \lambda \geq 0$. Now we reexpress the expectation of first stage beliefs as:

$$\mu_1 = \lambda B_n^n + (1-\lambda)B_m^n \quad . \tag{9}$$

The variance of first period beliefs Given the definition of the expectation of first stage beliefs the variance of first stage beliefs may be written as:

$$V_1 = \lambda\left(B_n^n - \mu_1\right)^2 + (1-\lambda)\left(B_m^n - \mu_1\right)^2 \quad . \tag{10}$$

Substituting out the expectation and simplifying we obtain:

$$V_1 = \lambda(1-\lambda)\left(B_n^n - B_m^n\right)^2 \quad . \tag{11}$$

The expectation of second period beliefs

$$\mu_2 = B_{n|n}^n\Big(\phi(\psi^n)^2 + (1-\phi)(\psi^m)^2\Big) + \left[B_{n|m}^n + B_{m|n}^n\right]\Big(\phi(1-\psi^n)\psi^n + (1-\phi)\psi^m(1-\psi^m)\Big) + B_{m|m}^n\Big(\phi(1-\psi^n)^2 + (1-\phi)(1-\psi^m)^2\Big), \tag{12}$$

where we have already taken into account that $B_{i|k}^n = 1 - B_{i|k}^m$ for $k \wedge i \in \{m, n\}$. Now define $\Lambda = \phi(\psi^n)^2 + (1-\phi)(\psi^m)^2$. We can then simplify the above expression to:

$$\mu_2 = \Big(B_{n|n}^n - B_{m|m}^n\Big)\Lambda + \Big(B_{n|m}^n + B_{m|n}^n\Big)\Big[\lambda - \Lambda\Big] + B_{m|m}^n\Big[1 - 2\lambda\Big] \quad . \tag{13}$$

This leads us to:

$$\mu_2 \;=\; \Big(B_{n|n}^n + B_{m|m}^n - \big(B_{m|n}^n + B_{n|m}^n\big)\Big)\Big[\Lambda - \lambda\Big] + \Big(B_{n|n}^n\lambda + B_{m|m}^n(1-\lambda)\Big) \quad . \tag{14}$$

To simplify further calculations we define $R \equiv \Big(B_{n|n}^n + B_{m|m}^n - \Big(B_{m|n}^n + B_{n|m}^n\Big)\Big)$ and $S \equiv \Big(B_{n|n}^n - B_{m|m}^n\Big)$. Then we can express the expectation of second stage beliefs as: $\mu_2 =$

$R\Big[\Lambda-\lambda\Big]+S\lambda+B^n_{m|m}$.

The variance of second period beliefs

$$V_2=\Big(\big(B^n_{n|m}-\mu_2\big)^2+\big(B^n_{m|n}-\mu_2\big)^2-\Big(\big(B^n_{n|n}-\mu_2\big)^2+\big(B^n_{m|m}-\mu_2\big)^2\Big)\Big)\left[\lambda-\Lambda\right] + \big(B^n_{n|n}-\mu_2\big)^2\lambda+\big(B^n_{m|m}-\mu_2\big)^2\left[1-\lambda\right] \quad (15)$$

where as above we take into account that $B^n_{i|k}=1-B^m_{i|k}$ for $k\wedge i\in\{m,n\}$. If we substitute out the expected value of second period beliefs using the definitions given above we have:

$$\begin{aligned}V_2=&\left[\Big(R\Big[\lambda-\Lambda\Big]-S\lambda+B^n_{n|m}-B^n_{m|m}\Big)^2+\Big(R\Big[\lambda-\Lambda\Big]-S\lambda+B^n_{m|n}-B^n_{m|m}\Big)^2\right]\left[\lambda-\Lambda\right]\\ &-\left[\Big(R\Big[\lambda-\Lambda\Big]+S\left(1-\lambda\right)\Big)^2+\Big(R\Big[\lambda-\Lambda\Big]-S\lambda\Big)^2\right]\left[\lambda-\Lambda\right]\\ &+R^2\Big[\lambda-\Lambda\Big]^2+S^2\left(1-\lambda\right)\lambda \quad (16)\end{aligned}$$

Defining $Z\equiv R\Big[\lambda-\Lambda\Big]-S\lambda$ this may be further simplified to:

$$\begin{aligned}V_2=&\left[\big(Z+(B^n_{n|m}-B^n_{m|m})\big)^2+\big(Z+(B^n_{m|n}-B^n_{m|m})\big)^2-(Z+S)^2-Z^2\right]\left[\lambda-\Lambda\right]\\ &+R^2\Big[\lambda-\Lambda\Big]^2+S^2\left(1-\lambda\right)\lambda \quad (17)\\ =&\left[\big(B^n_{n|m}-B^n_{m|m}\big)^2+\big(B^n_{m|n}-B^n_{m|m}\big)^2-S^2-2ZR\right]\left[\lambda-\Lambda\right]+R^2\Big[\lambda-\Lambda\Big]^2+S^2\left(1-\lambda\right)\lambda\\ =&\left[\big(B^n_{n|m}-B^n_{m|m}\big)^2+\big(B^n_{m|n}-B^n_{m|m}\big)^2+R^2\Lambda+R\lambda(2S-R)\right]\left[\lambda-\Lambda\right]+S^2\left(\Lambda-\lambda^2\right)\end{aligned}$$

The difference of first and second period variance of beliefs Here we show that the variance of second stage beliefs (V_2) is greater than the variance of first stage beliefs (V_1).

Note that:

$$\begin{aligned}V_2-V_1=&\left[\overbrace{\Big(B^n_{n|m}-B^n_{m|m}\Big)^2+\Big(B^n_{m|n}-B^n_{m|m}\Big)^2-\Big(B^n_n-B^n_m\Big)^2}^{Z}+R^2\Lambda+R\lambda\Big(2S-R\Big)\right]\left[\lambda-\Lambda\right]\\ &+\left[S^2-\Big(B^n_n-B^n_m\Big)^2\right]\Big(\Lambda-\lambda^2\Big). \quad (18)\end{aligned}$$

Given that $S = B^n_{n|n} - B^n_{m|m}$ it is easily shown that $S = (B^n_{n|n} - B^n_n) + (B^n_n - B^n_m) + (B^n_m - B^n_{m|m})$. Each of the differences in this sum is non-negative if Assumption (I) holds. Therefore, it must be the case that $S > (B^n_n - B^n_m)$. Note also that $(\lambda - \Lambda)$ and $(\Lambda - \lambda^2)$ are always non-negative if Assumption (I) holds.

It remains to show that $Z = \left(B^n_{n|m} - B^n_{m|m}\right)^2 + \left(B^n_{m|n} - B^n_{m|m}\right)^2 - \left(B^n_n - B^n_m\right)^2 > 0$. A change of variables will simplify the argument here. Define $a \equiv (B^n_{n|m} - B^n_m)$, $b \equiv (B^n_m - B^n_{m|m})$ and $c \equiv (B^n_{m|n} - B^n_m)$. Then we can reexpress the problem as:

$$\begin{aligned} Z =& (a+b)^2 + (c + (B^n_n - B^n_m) + b)^2 - (B^n_n - B^n_m)^2 > 0 \\ =& a^2 + 2b^2 + 2ab + c^2 + 2bc + 2b(B^n_n - B^n_m) + 2c(B^n_n - B^n_m) > 0 \\ =& a^2 + c^2 + 2ab + 2(B^n_n - B^n_{m|m})(b+c) \quad . \end{aligned} \tag{19}$$

This expression is positive as long as $b + c > 0$. We show below that this corresponds to the requirement that $-\triangle^n_{m|m} > -\triangle^n_{m|n}$ which is the case if $1/2 \geq \sigma^n_1$ and if Assumption (I) holds.

7.2 Second period beliefs

Here we derive results on levels and changes in second period beliefs as first period beliefs change. We focus on beliefs of entrepreneurs as those of employees can be derived by relabeling. We comment on this below.

Consistent and inconsistent signals Here we show that beliefs of students that they are entrepreneurs if they receive consistent signals that they are entrepreneurs are higher than beliefs of all other students. We also show that beliefs of students that they are entrepreneurs if they receive consistent signals that they are not entrepreneurs are lower than beliefs of all other students. This is the first part of Proposition 2.

We show that: $B^n_{n|n} > B^n_{m|n}, B^n_{n|n} > B^n_{n|m}$. We also show that: $B^n_{m|m} < B^n_{m|n}, B^n_{m|m} < B^n_{n|m}$. The corresponding relationships for employees hold by symmetry: $B^m_{n|n} < B^m_{m|n}, B^m_{n|n} < B^n_{n|m}$ and $B^m_{m|m} > B^m_{m|n}, B^m_{m|m} > B^n_{n|m}$.

It is easily shown that:

$$B^n_{n|n} - B^n_{n|m} = \frac{\sigma^n_2 B^n_n}{\sigma^n_2 B^n_n + \sigma^m_2 B^m_n} - \frac{\sigma^n_2 B^n_m}{\sigma^n_2 B^n_m + \sigma^m_2 B^m_m} =$$

$$\frac{\sigma_2^n \sigma_2^m \phi(1-\phi)\left(\sigma_1^n - \sigma_1^m\right)}{\left[\sigma_2^n \sigma_1^n \phi + \sigma_2^m \sigma_1^m (1-\phi)\right]\left[\sigma_2^n (1-\sigma_1^n)\phi + \sigma_2^m (1-\sigma_1^m)(1-\phi)\right]} > 0 \tag{20}$$

$$B_{n|n}^n - B_{m|n}^n = \frac{\sigma_2^n B_n^n}{\sigma_2^n B_n^n + \sigma_2^m B_n^m} - \frac{(1-\sigma_2^n) B_n^n}{(1-\sigma_2^n) B_n^n + (1-\sigma_2^m) B_n^m} =$$

$$\frac{(\sigma_2^n - \sigma_2^m) B_n^n B_n^m}{\left[\sigma_2^n B_n^n + \sigma_2^m B_n^m\right]\left[(1-\sigma_2^n) B_n^n + (1-\sigma_2^m) B_n^m\right]} > 0 \tag{21}$$

$$B_{m|m}^n - B_{n|m}^n = \frac{(1-\sigma_2^n) B_m^n}{(1-\sigma_2^n) B_m^n + (1-\sigma_2^m) B_m^m} - \frac{\sigma_2^n B_m^n}{\sigma_2^n B_m^n + \sigma_2^m B_m^m} =$$

$$\frac{(\sigma_2^m - \sigma_2^n) B_m^n B_m^m}{\left[\sigma_2^n B_m^n + \sigma_2^m B_m^m\right]\left[(1-\sigma_2^n) B_m^n + (1-\sigma_2^m) B_m^m\right]} < 0 \tag{22}$$

$$B_{m|m}^n - B_{n|m}^n = \frac{(1-\sigma_2^n) B_m^n}{(1-\sigma_2^n) B_m^n + (1-\sigma_2^m) B_m^m} - \frac{\sigma_2^n B_m^n}{\sigma_2^n B_m^n + \sigma_2^m B_m^m} =$$

$$\frac{(1-\sigma_1^n)(1-\sigma_1^m)(1-\phi)\phi\left[\sigma_2^m - \sigma_2^n\right]}{\left[(1-\sigma_2^n)(1-\sigma_1^n)\phi + (1-\sigma_2^m)(1-\sigma_1^m)(1-\phi)\right]\left[\sigma_2^n (1-\sigma_1^n)\phi + \sigma_2^m (1-\sigma_1^m)(1-\phi)\right]} < 0 \tag{23}$$

These expressions imply that students receiving consistent signals hold stronger second period beliefs than students receiving inconsistent signals.

Comparative statics of consistent signals We investigate how the strength of first period signals affects the strength of second period beliefs where strength is defined as in Section 3.3.

$$\frac{\partial B_{n|n}^n}{\partial \sigma_1^n} = \frac{\partial}{\partial \sigma_1^n} \frac{\sigma_2^n \sigma_1^n \phi}{\sigma_2^n \sigma_1^n \phi + \sigma_2^m \sigma_1^m (1-\phi)} = \frac{\sigma_2^n \sigma_2^m \sigma_1^m \phi (1-\phi)}{\left(\sigma_2^n \sigma_1^n \phi + \sigma_2^m \sigma_1^m (1-\phi)\right)^2} > 0 \tag{24}$$

$$\frac{\partial B_{n|n}^n}{\partial \sigma_1^m} = \frac{\partial}{\partial \sigma_1^m} \frac{\sigma_2^n \sigma_1^n \phi}{\sigma_2^n \sigma_1^n \phi + \sigma_2^m \sigma_1^m (1-\phi)} = -\frac{\sigma_2^n \sigma_1^n \sigma_2^m \phi (1-\phi)}{\left(\sigma_2^n \sigma_1^n \phi + \sigma_2^m \sigma_1^m (1-\phi)\right)^2} < 0 \tag{25}$$

These derivatives demonstrate that second period beliefs of entrepreneurs who receive consistent signals that they are entrepreneurs increase as first period signals for entrepreneurs and for employees become stronger. Note that signals are stronger if ($\sigma_1^n \to 1$) or ($\sigma_1^m \to 0$).

$$\frac{\partial B_{m|m}^n}{\partial \sigma_1^n} = \frac{\partial}{\partial \sigma_1^n} \frac{(1-\sigma_2^n)(1-\sigma_1^n)\phi}{(1-\sigma_2^n)(1-\sigma_1^n)\phi + (1-\sigma_2^m)(1-\sigma_1^m)(1-\phi)}$$

$$= -\frac{(1-\sigma_2^n)(1-\sigma_2^m)(1-\sigma_1^m)\phi(1-\phi)}{\left((1-\sigma_2^n)(1-\sigma_1^n)\phi + (1-\sigma_2^m)(1-\sigma_1^m)(1-\phi)\right)^2} < 0 \tag{26}$$

$$\frac{\partial B_{m|m}^n}{\partial \sigma_1^m} = \frac{\partial}{\partial \sigma_1^m} \frac{(1-\sigma_2^n)(1-\sigma_1^n)\phi}{(1-\sigma_2^n)(1-\sigma_1^n)\phi + (1-\sigma_2^m)(1-\sigma_1^m)(1-\phi)}$$

$$= \frac{(1-\sigma_2^n)(1-\sigma_1^n)(1-\sigma_2^m)\phi\,(1-\phi)}{((1-\sigma_2^n)(1-\sigma_1^n)\phi + (1-\sigma_2^m)(1-\sigma_1^m)\,(1-\phi))^2} > 0 \tag{27}$$

These derivatives demonstrate that second period beliefs of entrepreneurs who receive consistent signals that they are employees decrease as first period signals for entrepreneurs and for employees become more precise.

Comparative statics of inconsistent signals

$$\frac{\partial B^n_{m|n}}{\partial \sigma_1^n} = \frac{\partial}{\partial \sigma_1^n}\frac{(1-\sigma_2^n)\sigma_1^n\phi}{(1-\sigma_2^n)\sigma_1^n\phi + (1-\sigma_2^m)\sigma_1^m\,(1-\phi)} = \frac{(1-\sigma_2^n)(1-\sigma_2^m)\sigma_1^m\phi\,(1-\phi)}{((1-\sigma_2^n)\sigma_1^n\phi + (1-\sigma_2^m)\sigma_1^m\,(1-\phi))^2} > 0 \tag{28}$$

$$\frac{\partial B^n_{m|n}}{\partial \sigma_1^m} = \frac{\partial}{\partial \sigma_1^m}\frac{(1-\sigma_2^n)\sigma_1^n\phi}{(1-\sigma_2^n)\sigma_1^n\phi + (1-\sigma_2^m)\sigma_1^m\,(1-\phi)} = -\frac{(1-\sigma_2^n)\sigma_1^n(1-\sigma_2^m)\phi\,(1-\phi)}{((1-\sigma_2^n)\sigma_1^n\phi + (1-\sigma_2^m)\sigma_1^m\,(1-\phi))^2} < 0 \tag{29}$$

These derivatives demonstrate that second period beliefs of entrepreneurs who receive first a correct and then an incorrect signal will tend to be closer to entrepreneurship $\left(B^n_{m|n} \to 1\right)$ as first period signals for entrepreneurs and employees become more precise.

$$\begin{aligned}\frac{\partial B^n_{n|m}}{\partial \sigma_1^n} &= \frac{\partial}{\partial \sigma_1^n}\frac{\sigma_2^n(1-\sigma_1^n)\phi}{\sigma_2^n(1-\sigma_1^n)\phi + \sigma_2^m(1-\sigma_1^m)\,(1-\phi)} \\ &= -\frac{\sigma_2^n\sigma_2^m(1-\sigma_1^m)\phi\,(1-\phi)}{(\sigma_2^n(1-\sigma_1^n)\phi + \sigma_2^m(1-\sigma_1^m)\,(1-\phi))^2} < 0 \end{aligned} \tag{30}$$

$$\begin{aligned}\frac{\partial B^n_{n|m}}{\partial \sigma_1^m} &= \frac{\partial}{\partial \sigma_1^m}\frac{(1-\sigma_2^n)(1-\sigma_1^n)\phi}{(1-\sigma_2^n)(1-\sigma_1^n)\phi + \sigma_2^m(1-\sigma_1^m)\,(1-\phi)} \\ &= \frac{\sigma_2^n(1-\sigma_1^n)\sigma_2^m\phi\,(1-\phi)}{(\sigma_2^n(1-\sigma_1^n)\phi + \sigma_2^m(1-\sigma_1^m)\,(1-\phi))^2} > 0 \end{aligned} \tag{31}$$

These derivatives demonstrate that second period beliefs of entrepreneurs who receive first an incorrect and then a correct signal will tend to be further from entrepreneurship $\left(B^n_{n|m} \to 0\right)$ as first period signals for entrepreneurs and employees become more precise.

7.3 Changes in Beliefs

This section sets out the proofs of Proposition 3. We define changes in beliefs as follows:

$$\triangle^n_{n,n} = B^n_{n|n} - B^n_n \qquad \triangle^n_{m,m} = B^n_{m|m} - B^n_m \quad \triangle^m_{n,n} = B^m_{n|n} - B^m_n \qquad \triangle^m_{m,m} = B^n_{m|m} - B^m_m \tag{32}$$

$$\triangle^n_{n,m} = B^n_{n|m} - B^n_m \qquad \triangle^n_{m,n} = B^n_{m|n} - B^n_n \quad \triangle^m_{n,m} = B^m_{n|m} - B^m_m \qquad \triangle^m_{m,n} = B^m_{m|n} - B^m_n \tag{33}$$

Here the first set of changes in beliefs describes students receiving consistent signals and the second describes students receiving inconsistent signals.

To simplify the following analysis we introduce a change of variables:

$$\zeta \equiv (1-\sigma^n_1)\phi \qquad \upsilon = (1-\sigma^m_1)(1-\phi) \qquad \nu = \sigma^n_1\phi \qquad \omega = \sigma^m_1(1-\phi) \tag{34}$$

Then we can simplify the expressions for changes in beliefs to:

$$\begin{aligned}
\triangle^n_{n,n} &= \frac{\nu\omega(\sigma^n_2 - \sigma^m_2)}{[\nu+\omega][\sigma^n_2\nu + \sigma^m_2\omega]} & \triangle^n_{m,m} &= \frac{\zeta\upsilon(\sigma^m_2 - \sigma^n_2)}{[\zeta+\upsilon][\zeta(1-\sigma^n_2) + \upsilon(1-\sigma^m_2)]} \\
\triangle^m_{n,n} &= \frac{\nu\omega(\sigma^m_2 - \sigma^n_2)}{[\nu+\omega][\sigma^n_2\nu + \sigma^m_2\omega]} & \triangle^m_{m,m} &= \frac{\zeta\upsilon(\sigma^n_2 - \sigma^m_2)}{[\zeta+\upsilon][\zeta(1-\sigma^n_2) + \upsilon(1-\sigma^m_2)]} \\
\triangle^n_{n,m} &= \frac{\zeta\upsilon(\sigma^n_2 - \sigma^m_2)}{[\zeta+\upsilon][\sigma^n_2\zeta + \sigma^m_2\upsilon]} & \triangle^n_{m,n} &= \frac{\nu\omega(\sigma^m_2 - \sigma^n_2)}{[\nu+\omega][\nu(1-\sigma^n_2) + \omega(1-\sigma^m_2)]} \\
\triangle^m_{n,m} &= \frac{\zeta\upsilon(\sigma^m_2 - \sigma^n_2)}{[\zeta+\upsilon][\sigma^n_2\zeta + \sigma^m_2\upsilon]} & \triangle^m_{m,n} &= \frac{\nu\omega(\sigma^m_2 - \sigma^n_2)}{[\nu+\omega][\nu(1-\sigma^n_2) + \omega(1-\sigma^m_2)]}
\end{aligned} \tag{35}$$

Consistent Signals Begin first with changes in the beliefs of those receiving consistent signals. There are two groups here: those receiving correct and those receiving incorrect signals.

Correct signals:

$$\frac{\partial \triangle^n_{n,n}}{\partial \sigma^n_1} = \frac{\omega(\sigma^n_2 - \sigma^m_2)\left[\sigma^m_2\omega^2 - \sigma^n_2\nu^2\right]}{[\nu+\omega]^2[\sigma^n_2\nu + \sigma^m_2\omega]^2}\overbrace{\frac{\partial\nu}{\partial\sigma^n_1}}^{+} \tag{36}$$

$$\frac{\partial \triangle^m_{m,m}}{\partial \sigma^n_1} = \frac{\upsilon(\sigma^n_2 - \sigma^m_2)\left[(1-\sigma^m_2)\upsilon^2 - (1-\sigma^n_2)\zeta^2\right]}{[\zeta+\upsilon]^2[\zeta(1-\sigma^n_2) + \upsilon(1-\sigma^m_2)]^2}\overbrace{\frac{\partial\zeta}{\partial\sigma^n_1}}^{-} \tag{37}$$

By definition we know that $\sigma_2^n \geq \sigma_2^m$. If the signals students receive in periods one and two are not completely uninformative and there are approximately as many entrepreneurs as employees in the population ($\phi/(1-\phi) \approx 1$), then the change in beliefs of those receiving correct signals in both periods is *decreasing* in the precision of the first period signal . To see this note that in this case the overall sign of equations (36) and (37) is negative as the following analysis of the terms in square brackets in the numerators shows:

$$\sigma_2^m\omega^2 - \sigma_2^n\nu^2 = \sigma_2^m\omega^2\left(1 - \frac{\sigma_2^n\sigma_1^{n2}\phi^2}{\sigma_2^m\sigma_1^{m2}(1-\phi)^2)}\right) \tag{38}$$

$$(1-\sigma_2^m)\upsilon^2 - (1-\sigma_2^n)\zeta^2 = (1-\sigma_2^m)\upsilon^2\left(1 - \frac{(1-\sigma_2^n)}{(1-\sigma_2^m)}\frac{(1-\sigma_1^n)^2\phi^2}{(1-\sigma_1^m)^2(1-\phi)^2}\right) \tag{39}$$

The terms in square brackets in the numerators of equations (36) and (37) have the opposite sign to the signed terms at the end of each expression leading to an overall negative sign if *signals are sufficiently informative*. This means that $\sigma_1^n \to 1$ and $\sigma_1^m \to 0$. In this case expression (38) is negative and so is the derivative at (36). Equally, expression (39) is positive and the derivative at (37) is negative.

Note that, if there are very few entrepreneurs in the population ($\phi/(1-\phi) \to 0$) employees' changing beliefs will dominate those of the few remaining entrepreneurs. Employees' beliefs are still *decreasing* in the precision of the first period signal however.

If the proportion of entrepreneurs in the population is very high ($\phi/(1-\phi) \to \infty$), then the entrepreneurs' changing beliefs will dominate those of the few remaining employees. Entrepreneurs' beliefs in this case are also *decreasing* in the precision of the first period signal.

Note that the analysis for an increase in the precision of the employees' first period signal ($\sigma_1^m \to 0$) leads to the same conclusion. This is intuitive as nothing in the model prevents us from relabeling employees and entrepreneurs.

We have now shown that entrepreneurs and employees receiving correct and consistent signals will display *lower* changes in beliefs from period one to period two if their first period signals are more precise and these signals are sufficiently informative.

In contrast, if students receive uninformative signals then the effect of stronger first period information differs by the type of student and by the type of signal. We do not pursue this case here.

Misleading signals:

$$\frac{\partial \triangle^n_{m,m}}{\partial \sigma^n_1} = \frac{\upsilon(\sigma^m_2 - \sigma^n_2)\Big[\upsilon^2(1-\sigma^m_2) - \zeta^2(1-\sigma^n_2)\Big]}{[\zeta+\upsilon]^2[\zeta(1-\sigma^n_2)+\upsilon(1-\sigma^m_2)]^2}\overbrace{\frac{\partial \zeta}{\partial \sigma^n_1}}^{-} \tag{40}$$

$$\frac{\partial \triangle^m_{n,n}}{\partial \sigma^n_1} = \frac{\nu\omega(\sigma^m_2 - \sigma^n_2)\Big[\sigma^m_2\omega^2 - \sigma^n_2\nu^2\Big]}{[\nu+\omega]^2[\sigma^n_2\nu+\sigma^m_2\omega]^2}\overbrace{\frac{\partial \nu}{\partial \sigma^n_1}}^{+} \tag{41}$$

We can apply the same arguments as above to these two expressions. The common term $(\sigma^m_2 - \sigma^n_2)$, which is negative, now changes the signs of both expressions above.

We have now shown that entrepreneurs and employees receiving misleading and consistent signals will display *greater* changes in beliefs from period one to period two if their first period signals are more precise and these signals are sufficiently informative.

Conflicting Signals Now focus on those receiving contradictory signals. Here there are two groups to distinguish depending on the sequence in which the correct and the misleading signal arrive.

Sequence: misleading, correct We start with those who get a misleading signal and then a correct signal.

$$\frac{\partial \triangle^n_{n,m}}{\partial \sigma^n_1} = \frac{\upsilon(\sigma^n_2 - \sigma^m_2)\Big[\sigma^m_2\upsilon^2 - \sigma^n_2\zeta^2\Big]}{[\zeta+\upsilon]^2[\sigma^n_2\zeta+\sigma^m_2\upsilon]^2}\overbrace{\frac{\partial \zeta}{\partial \sigma^n_1}}^{-} \tag{42}$$

$$\frac{\partial \triangle^m_{m,n}}{\partial \sigma^n_1} = \frac{\omega(\sigma^n_2 - \sigma^m_2)\Big[(1-\sigma^m_2)\omega^2 - (1-\sigma^n_2)\nu^2\Big]}{[\nu+\omega]^2[\nu(1-\sigma^n_2)+\omega(1-\sigma^m_2)]^2}\overbrace{\frac{\partial \nu}{\partial \sigma^n_1}}^{+}$$

Again we can apply the same reasoning as above. This shows that those who receive a misleading signal first, will change their beliefs *less* as the precision of the first period signals increases if signals are sufficiently informative.

Sequence: correct, misleading

$$\frac{\partial \triangle^n_{m,n}}{\partial \sigma^n_1} = \frac{\nu\omega(\sigma^m_2 - \sigma^n_2)\Big[(1-\sigma^m_2)\omega^2 - (1-\sigma^n_2)\nu^2\Big]}{[\nu+\omega]^2[\nu(1-\sigma^n_2)+\omega(1-\sigma^m_2)]^2}\overbrace{\frac{\partial \nu}{\partial \sigma^n_1}}^{+} \tag{43}$$

$$\frac{\partial \triangle_{n,m}^{m}}{\partial \sigma_1^n} = \frac{\zeta \upsilon (\sigma_2^m - \sigma_2^n)\left[\sigma_2^m \upsilon^2 - \sigma_2^n \zeta^2\right]}{[\zeta + \upsilon]^2 [\sigma_2^n \zeta + \sigma_2^m \upsilon]^2} \overbrace{\frac{\partial \zeta}{\partial \sigma_1^n}}^{-} \tag{44}$$

Again we can apply the same reasoning as above. This shows that those who receive a correct signal first, will change their beliefs *more* as the precision of the first period signals increases.