Subjective Completion Beliefs and the Demand for Post-Secondary Education*

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Abstract

The outcome of pursuing an upper or post-secondary education degree is uncertain. A student might not complete a chosen degree for a number of reasons, such as insufficient academic preparation or financial constraints. Thus, when considering whether to invest in post-secondary education, students must factor their probability of completing the degree into their decision. We study the role of this uncertainty in education choices using representative survey data from Germany. Students' subjective beliefs about this probability were elicited prior to them finishing their secondary education. Relating these beliefs to students' subsequent education choices and outcomes, we find that they are predictive of intentions to invest in education, actual subsequent investments in education, and degree completion. A structural choice model of sequential investment further reveals that the association between completion beliefs and investment choices is strongest for students with low academic skills and weak preferences for post-secondary education. We find robust evidence that the fear of dropping out of post-secondary education is related to leaving education early; a one standard deviation increase in the beliefs is associated with a reduction of not investing in any post-secondary education of about 20 percent.

Keywords: Subjective beliefs; Subjective probabilities; Completion uncertainty; Post-secondary education; Human capital investment.
JEL classification: I21, I26, J24

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1 Introduction

After finishing compulsory education, students have to decide whether to continue investing in education. This choice is one of the most important career decisions young adults have to make, and is made under partial information; beliefs held at this early stage are thus central to post-secondary education choices. In this paper, we focus on one major source of uncertainty: the probability of dropping out of a chosen education track. We incorporate a measure of the perceived or subjective probability of completing a post-secondary degree into simple models of education choice, using data from a large representative survey from Germany. This data offers at least two characteristics that contribute to our understanding of young adults' education decisions. First, subjective completion beliefs are elicited shortly *before* students finish their compulsory secondary education; the data track students up to 14 years, which allows us to observe their subsequent education outcomes. In contrast to the majority of the previous literature, which focuses on beliefs of students who are already enrolled in college, we are able to study the extensive margin demand for any post-secondary education. Moreover, beliefs of students already enrolled in college are likely to have been updated by new information, and are thus likely to be different from the original beliefs upon which investment decisions were based. Second, the representative population sample allows us to extend the previous literature to more vocational forms of post-secondary education, such as different types of apprenticeships. Since students from less advantaged economic backgrounds are more likely to invest in vocational education, it is necessary to take these education tracks into account when designing informational policy interventions.

We have three key objectives. First, we study the determinants of subjective completion beliefs. Specifically, we assess the relative importance that students assign to factors such as past academic performance, personality measures, risk attitudes, family background, and labor market characteristics. Second, we quantify the importance of subjective completion beliefs for three key outcomes: the intention to invest in education, the actual subsequent investment, and the actual completion of the chosen education track. In addition to estimating the persistence of these early beliefs as predictors of education outcomes, we can compare the actual influence of academic, personality, risk, family, and local labor and education market variables on degree completion vis-à-vis belief formation. Third, we delve deeper into the relationship between beliefs and education by incorporating subjective probabilities into a sequential model of human capital investment. The model combines the different post-secondary options of the German system with forward-looking behavior and unobserved tastes or preferences for education that are correlated across choices.

Our findings suggest that the most important determinants in the formation of completion beliefs are students' academic ability and personality. In contrast, subjective risk attitudes, family background variables (such as household income or parents' education), and local labor market variables (such as youth unemployment or various measures of education demand and supply) are given comparatively less weight by students. These determinants have similar effects on intentions to invest in education. However, actual investment and completion depend to a larger extent on family characteristics, the state of the local labor market, and regional supply and demand in the post-secondary education market. When we consider different post-secondary options separately, we find that academic ability is the main driver of subjective beliefs for those choosing a university education. In contrast, the subjective beliefs of those choosing a vocational education seem to be driven more by non-academic factors. We also find that beliefs are most decisive for youths with low academic ability and weak preferences for education, a group that has largely been ignored in the present literature.

Our results point to a strong persistence of early completion beliefs in post-secondary education choices and outcomes; beliefs are statistically significant predictors of intentions to invest, investments, and completion, even after accounting for a large set of background variables. The effects are also substantial in an economic sense. For instance, our models predict that an increase in completion beliefs by one standard deviation would be associated with a reduction in the number of youths who fail to invest in post-secondary education by about 20 to 30 percent, depending on the model specification. Although these estimates are correlational in nature, we show that they are robust in a bounding analysis which takes potential selection on unobservables into account.

Understanding the role of uncertainty in individuals' post-secondary education choices is essential for designing effective education policies. For instance, if students' expectations are misaligned, providing additional information can be a cost-effective measure to enhance education choices and eventual career success (e.g., Bettinger et al., 2012; Jensen, 2010).

1.1 Related literature

The incorporation of completion probabilities into theories of education choice has a long standing (e.g., Altonji 1993; Comay, Melnik and Pollatschek 1973; Manski 1989; see also Bound and Turner 2011). This literature emphasizes that "[d]ifferences in dropout probabilities may be more important than differences in *ex post* payoffs in determining the *ex ante* return to attending a particular school" (Altonji, 1993, p74). Empirical approaches based on structural assumptions that distinguish *ex ante* from *ex post* returns to education include Carneiro et al. (2003), Cunha, Heckman and Navarro (2005), Cunha and Heckman (2007), and Foley, Gallipoli and Green (2014). However, there is relatively little empirical work using completion probabilities directly; notable exceptions using predicted college completion probabilities include Hussey and Swinton (2011), Fossen and Glocker (2014), and Castex (2015). In general, when studying choice under uncertainty, researchers have to make assumptions about how expectations are formed (Manski, 2004), and, most commonly, such work relies on rational expectations, e.g., that individuals' predictions are unbiased. To avoid imposing rational expectations, the most widely used alternative, which we follow in this paper, is to apply direct measures of elicited subjective beliefs (Manski, 2004). Several studies have shown subjective beliefs to be meaningful in education choice models, and often superior to those constructed by rational expectations models (e.g., Attanasio and Kaufmann, 2014; Huntington-Klein, 2015*b*; Stinebrickner and Stinebrickner, 2012; Zafar, 2011*a*) and a growing literature on college major choice uses such subjective beliefs (e.g., Arcidiacono et al., 2014; Arcidiacono, Hotz and Kang, 2013; Hastings et al., 2016; Huntington-Klein, 2016; Stinebrickner and Stinebrickner, 2012, 2014*a*,*b*; Wiswall and Zafar, 2015*a*). In contrast to our paper, most of these studies assess beliefs about returns to or costs of education choices, rather than about the likelihood of completion.[1] In this respect, our analysis is most closely related to Wiswall and Zafar (2015*a*), who also use students' subjective completion beliefs. We contribute to this literature in various dimensions: Our paper is the first to study subjective completion beliefs formed before the end of secondary education in a population survey; we follow students over time until they complete their post-secondary education, and we integrate elicited subjective completion probabilities into a sequential model of education choice, as motivated by the theoretical literature. Most of the existing studies on the demand for post-secondary education focus solely on investment, rather than on intentions or completion;[2] we add to the literature by providing evidence on the relationship between subjective completion beliefs and each of these three outcomes in a unifying framework.

Besides beliefs about returns to education, beliefs about one's own academic ability have recently been highlighted as a key factor in college choice (Arcidiacono, Hotz and Kang, 2013; Bond et al., 2016; Bulman, 2015; Stange, 2012; Stinebrickner and Stinebrickner, 2012, 2014*b*; Zafar, 2011*b*): students learn about their own ability by observing their grade point averages [GPA], and this updated information on their own ability is a main determinant of college enrollment, college-major choice, and dropout decisions.[3] While belief updating is essential for staying in school, results in this literature also point towards preexisting beliefs as key determinants of later investment and success in education. For example, Bond et al. (2016, p2) find that belief updating in response to SAT scores is too modest to explain the variation in college application choices, and conclude that there is a substantial amount of "inertia" in college choices, in the sense that they are "predetermined by non-academic factors and preexisting beliefs". In a similar vein, Stinebrickner and Stinebrickner (2014*a*, p468) stress the importance of timing interventions to inform students about their own ability before college entrance. We add to the literature by studying the persistence in education choice due to the *ex ante* perceived probability of completing a post-secondary education, using a representative population survey.[4] Our evidence supports and extends Zafar's presumption that "prior belief[s] [at the start of college] continue[s] to be important. In attempting to understand the choice of college majors, it might be useful to focus on students at earlier stages of their schooling (for example, in high school) and analyze their subjective beliefs" (Zafar, 2011*b*, p339f).

[1] Completion uncertainty also has important consequences beyond aggravating wage uncertainty. For example, various non-pecuniary aspects have been shown to be relevant to education choice (see Oreopoulos and Salvanes, 2011, for a recent summary). In order to benefit from them, staying in the chosen education path and/or completing the degree might be crucial. Studies using elicited subjective beliefs about labor market prospects consistently find the (non-financial) consumption value of education or major-specific unobserved tastes to be the main drivers of education choices (i.e., Huntington-Klein, 2015*a*; Wiswall and Zafar, 2015*a*). Similar results are found in structural approaches that do not use subjective beliefs. For instance, D'Haultfoeuille and Maurel (2013) use a sophisticated Roy model and find non-pecuniary aspects to be predominant in education choice. Such preference-related factors are not affected by pure labor market uncertainty, but they can be affected by completion uncertainty.

[2] Notable exceptions are Turner (2004), Venti and Wise (1983) and Light and Strayer (2000) for completion. Similarly, the literature on intentions is still comparatively small, although it has been growing recently (e.g., Christofides et al., 2015; Wiswall and Zafar, 2015*b*; Zachary and Zafar, 2015).

[3] For evidence on students applying for college, see Bond et al. (2016); Bulman (2015), and for students enrolled in college, Stinebrickner and Stinebrickner (2012, 2014*a*,*b*); Zafar (2011*b*).

[4] Thus far, studies have focused mainly on single institutions rather than representative samples. Exceptions include Milla (2014) and Bond et al. (2016). Both assess students enrolled in college or who applied for college in representative samples. As opposed to us, they do not use an elicited measure of subjective beliefs, and focus on the selected population applying to, or enrolled in, college.

Our study is also closely related to the literature on non-cognitive determinants of education success (see, Almlund et al., 2011; Borghans et al., 2006): Subjective beliefs and the results presented in this study might itself be interpreted as a non-cognitive determinant. However, beliefs have a strong foundation in economic theory and, as we will show below, fit well in a human capital model with a clear economic interpretation. Related to this, we show how subjective completion beliefs differ from and relate to the Big Five personality measures, risk attitudes, and locus of control, all of which are now ubiquitous in economic applications (see, for example, Borghans et al., 2006; Caliendo, Cobb-Clark and Uhlendorff, 2015; Dohmen et al., 2010). Moreover, we use estimates from our structural model to decompose the effects of academic ability, locus of control, and parental background into their direct impact on investment and their indirect impact via subjective completion beliefs. Of special interest to our design is the locus of control. Coleman and DeLeire (2003) hypothesize that students with a more internal locus of control (i.e., students who believe their actions affect their outcomes) have higher subjective beliefs about their own returns to education, which leads them to exert more effort and to invest in their human capital (for a recent review on the locus of control, see Cobb-Clark, 2015). Our results support the hypothesis that one's locus of control affects education choices via subjective beliefs: We estimate that virtually the entire effect of locus of control is mediated through beliefs (for other variables, beliefs play only a partial role). Our framework might therefore prove useful in studying the mediating role of subjective beliefs, since it integrates investment in upper and post-secondary education jointly in both reduced-form and structural models.[5]

1.2 Outline of the paper

The remainder of this study proceeds as follows: In Section 2, we describe the institutional features of the education system in Germany and present the data. In Section 3, we assess determinants of subjective completion beliefs, relate these beliefs to education outcomes, and explain how the impact of subjective beliefs varies with selection on observables and unobservables. We develop and estimate a structural model of sequential human capital investment in Section 4. Section 5 concludes our paper by discussing and reviewing our key findings.

2 Institutional setting and data

2.1 Institutional setting

Our primary data source is the German Socio-Economic Panel [SOEP], a large-scale representative household panel data set (Wagner et al., 2007, 2008). We focus on youths, ages 16 to 17 years, who have newly entered the survey population by answering the youth questionnaire between 2000 and 2013. The SOEP is a yearly household panel that provides a rich set of parental background informa-

[5]Subjective beliefs have been studied as a mediator and a potential explanation of education differentials in parental unemployment (Pinger, 2015), family background (Keller and Neidhöfer, 2014), or gender and migration (Tolsma, Need and De Jong, 2010).

tion, and follows the young adults over time up to 14 years. Additionally, we combine the individual-level data with regional labor market information and education supply and demand measures based on 96 geographic regions, which we will refer to as Ror (for their German name *Raumordnungsregionen*).[6] All regional information is matched according to the individual's residency when answering the youth questionnaire, and lagged by one year to avoid endogeneity or reverse causality. We only use variables assessed in the youth questionnaire as covariates to avoid any biases from conditioning on (future) outcomes.[7]

At the time of entering the survey population, youths are in the midst of deciding about their enrollment in post-secondary education. We are interested in their extensive-margin decision whether or not to invest in any post-secondary education at all. In addition, Section 4 will consider an important intensive-margin dimension of this decision by further distinguishing between the three most commonly taken post-secondary education tracks in Germany: At the time of answering the youth questionnaire, apart from the option not to invest ($j = 0$), youths have the choice to invest directly in a profession-specific apprenticeship or vocational education ($j = 1$), or to continue high school. After completing high school, students can then decide whether to invest in an apprenticeship ($j = 2$) or in a university degree ($j = 3$).

Applying for an apprenticeship ($j = 1$) is similar to applying for a regular job; contracts are brokered by the German unemployment agency or by individual initiatives. While we do not model the supply side explicitly (see, e.g., Manski and Wise, 1983), our models account for regional and time-variation in the excess demand for apprenticeship positions by including the local number of apprenticeship positions by population and the local cyclical youth unemployment rate. Students with high school degrees who apply for apprenticeships ($j = 2$) typically have better chances at obtaining highly competitive apprenticeship positions. In fact, some apprenticeship positions are exclusively available to high school graduates. In 2010, 20.9 percent of the newly signed apprenticeship contracts went to students with high school degrees (Statistisches Bundesamt, 2011, p1004). Thus, we model this path separately and refer to it as *tertiary apprenticeship*. It is important to realize that, in Germany, some apprenticeship degrees have a high standing and a reputation similar to a university degree—especially apprenticeship degrees acquired after completing high school. A university education ($j = 3$) is open only to high school graduates. There is excess demand for prestigious universities and very selective majors, such as Law or Medicine. Yet, students can usually enroll in less selective regional universities. To capture supply-side features of the university market, our models control for the number of universities in a local area, and we control for the excess demand by the number of high school graduates and the number of university students in a region.

A simplified version of Germany's education system is depicted in Figure 1, which summarizes the key features that are relevant to our analysis (more information can be found in Wölfel and Heineck, 2012).

[6] A map of Ror is provided in Appendix, Figure B1. The data source is INKAR 2013 provided by the German Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR, 2013). For more information, see Pinger (2015) who also uses this additional data source. Moreover, we add the number of universities (higher learning institutions) as a proxy for distance to university provided by the statistical agency of Germany (Statistisches Bundesamt).

[7] One of the motivations for the structural model presented in Section 4 is to account for sequential decision-making and to avoid associated biases.

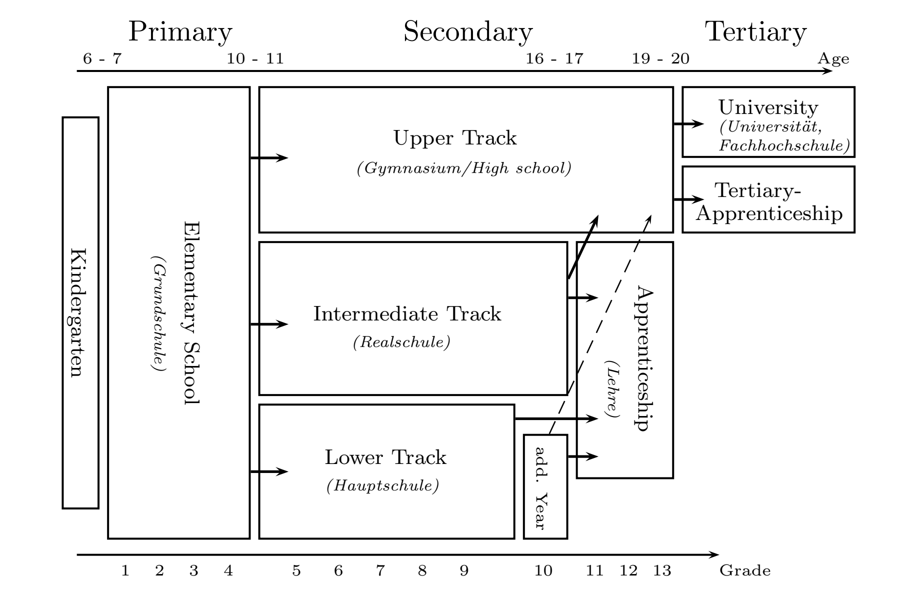


Figure 1: The German education system
Source: Adaptation and extension of the overview provided by Wölfel and Heineck (2012).

The system is characterized by early tracking: after elementary school, students are tracked into three streams according to their academic ability (that is, their grades and teachers' recommendations). The secondary school track affects the default choice of the investment in post-secondary education: While students in the lower and intermediate tracks need to make an active decision to apply for and enroll in a consecutive school-track if they want to obtain a high school degree, for students in the upper track the high school degree is the default outcome.[8] All our models control for this difference in secondary track by including the indicator variable "in high school with 17"; and robustness checks include estimations of the main results separately by school-type (Appendix, Table C4).

Our estimation sample includes all youth questionnaire respondents with non-missing information in the core variables: subjective belief, education outcomes, and grade point average [GPA]. Moreover, we excluded from the sample individuals who have already started an apprenticeship at the time of responding to the youth questionnaire.[9] Missing information in other variables (cf. Appendix, Table B3) is included along with corresponding indicator variables. We are interested in students' intentions to invest in post-secondary education, their actual investment, and actual completion. To assess their investment intention, we use a self-reported measure elicited in the youth questionnaire: Students are asked to indicate which further education degree, if any, they plan to complete ($j = 0, 1, 2, 3$). Our selection criteria result in a sample size of 3,610 observations. To assess actual education investment, we require at least two years of longitudinal information to record the end of secondary education and the start of a post-secondary education, which reduces the observations to 2,116. To assess actual completion, we restrict the sample to students who responded for at least five years of data collection, resulting in 1,372 observations. Note that these sample reductions are not attrition-based but simply

[8]As an example of the distribution of secondary school degrees obtained in Germany, in the 2011 cohort, four percent dropped out without a secondary degree, 17 percent completed the lower track, 36 percent the intermediary track, and 43 percent obtained high school degrees (Statistisches Bundesamt, 2013, p7).

[9]In our sample as well as in aggregate statistics, only 10.6 percent started an apprenticeship before the age of 17 years in 2011 (Statistisches Bundesamt, 2013, p17).

a result of the sampling period. For example, a student who answered the youth survey in 2010 would only be part of intentions and investment regressions but she would be too young to be observed graduating.

Our set of background variables include current GPA and prior secondary track recommendation (at the age of ten years) to account for academic ability; locus of control, risk attitudes, and the Big Five personality inventory, to assess youths' personalities;[10] and individual and family backgrounds are captured by individual's gender, number of siblings, whether they are second-generation immigrants (youths whose parents were both born in a foreign country), whether at least one parent has a college education, whether at least one parent is currently unemployed, and the logarithm of net household income. Finally, the background variables also include regional labor and education market (Ror) characteristics relevant for the students' choice sets, which we mentioned before and represent a mix of (exogenous) education supply and demand shifters, as well as region fixed effects and year-of-questioning (which is almost identical to students' age) fixed effects. More information on the institutional setting can be found in Kunz and Staub (2016); summary statistics as well as more details on variables are provided in Appendix B.

2.2 Subjective completion beliefs

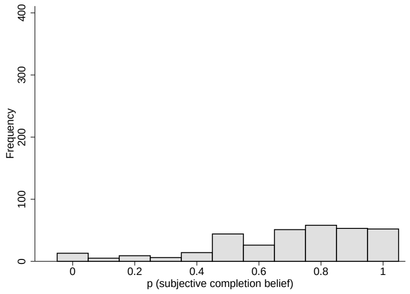
Our main variable of interest is subjective completion belief, p_i, which is assessed by the following question in the youth questionnaire:

> Think about your future in your job and private life: how probable is it, in your opinion, that the following events will occur?
>
> [Please check off a probability on the scale from 0 percent to 100 percent.]
>
> *You successfully finish your vocational training or university studies?*

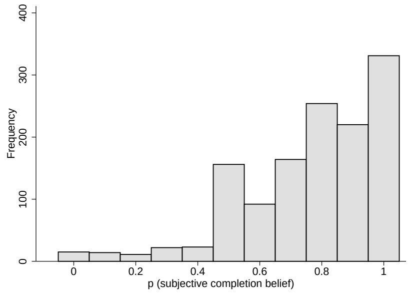
Students could answer on an eleven point scale, ranging from 0% to 100%. This belief could be interpreted as a non-cognitive skill capturing the confidence of the student. In contrast to other non-cognitive skills, p_i has a clear economic interpretation and is central to human capital theory (Altonji, 1993). Thus, although our results can be read with the interpretation of p_i as a non-cognitive skill in mind, we favor the interpretation of this belief as the probability of graduation from a post-secondary education track conditional on attendance—i.e., $p_i \equiv Pr_i(complete = 1|invest = 1)$ for student i.

Alternatively, p_i might be interpreted as the unconditional probability, entailing also the belief of investing, i.e. $Pr_i(complete = 1) = Pr_i(invest = 1)Pr_i(complete = 1|invest = 1)$. The exact way this measure should be incorporated into models of education choice will depend on its interpretation. However, the conditional interpretation seems more appropriate for at least two reasons: First, the question immediately preceding the subjective completion belief question in the survey directly assesses

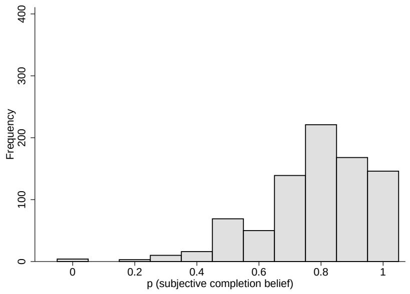
[10] We standardize all the principal components of the personality variables (all but risk attitudes, which are assessed by one question only). The locus of control has been developed by Rotter (1966), the Big Five inventory by Costa and McCrae (1992) and validated in the SOEP version by Hahn, Gottschling and Spinath (2012). Risk attitudes have been introduced and extensively studied by Dohmen et al. (2011).



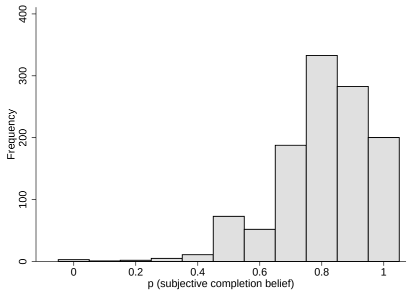
(A) No intentions (N=331)



(B) Apprenticeship (N=1'302)



(C) Tertiary apprenticeship (N=826)



(D) University (N=1'151)

Figure 2: Subjective completion beliefs by intentions to invest in post-secondary education
Source: SOEP 2000-2013 (v30), own calculations.

students' probability of investment in their preferred track, $Pr_i(invest = 1)$, framing students to think about p_i as the conditional probability. Second, the two subjective beliefs questions provide bounds on each other that can be used to check their coherency: If p_i referred to $Pr_i(complete = 1)$, it could not be larger than the self-reported $Pr_i(invest = 1)$. This interpretation of p_i as the unconditional probability is strongly rejected by the data.[11] Therefore, we interpret p_i as the conditional probability for the remainder of the paper. However, we present additional results in the appendix where we interpret p_i as the unconditional probability and suitably modify our models to control for intentions and the subjective investment probability; our findings are robust to this interpretation (cf. Appendix, Table C2).

In Figure 2, we plot histograms of p_i, the subjective beliefs, by students' education intentions. Overall, German students appear to be confident about finishing a post-secondary education, as most report a subjective probability above 50%. The distributions of students intending to invest in paths that first require a high school degree (tertiary apprenticeship and university, Panels C and D) are very similar in shape. Yet, the subjective beliefs of youths who intend to complete a university degree are more concentrated and slightly shifted to the right compared to their fellow high school students who aim for a tertiary apprenticeship position. The mode of the distribution of students who intend to start an apprenticeship without enrolling in high school lies at 100%. Finally, students with no intention to invest in further education display a much larger variance in their beliefs. The fact that positive beliefs are found among all intended investment levels, including the intention not to invest in further

[11] Following this reasoning, almost half the sample would be inconsistent and roughly 200 students would be strongly inconsistent, with an (unconditional) completion belief 50 percentage points larger than their (unconditional) investment belief. This could also be interpreted as students being unable to respond consistently to subjective beliefs questions or that their responses include some error. However, based on the prior literature, this inconsistency is too large to be reasonably interpreted as errors, and clearly points to p_i being understood as the conditional probability.

training or education, shows that students interpreted this question as a counterfactual, which is in line with p_i representing a conditional probability. For example, a student might believe to be able to complete post-secondary education once enrolled, but her expected utility from graduating might still be lower than leaving education immediately, be it due to a distaste for learning or due to expected individual returns from education which are lower than the forgone earnings.

3 Subjective completion beliefs and education outcomes

3.1 Determinants of subjective completion beliefs

The origin of beliefs is key to understand how beliefs can shape the education decisions from a policy perspective. So far the literature has concentrated on how beliefs mediate other covariates (e.g. low socio-economic status) or how beliefs are updated in response to new information. There is no standard model of belief formation or how information is processed and interpreted, other than in response to information shocks. In this section, we exploit the rich panel structure of the SOEP to present correlations between important predetermined characteristics and beliefs, to enhance our understanding of the belief formation process. To analyze how the variables we discussed in the previous section relate to subjective completion beliefs, we estimate OLS regressions of the model

$$p_i = x_i' \beta^p + \upsilon_i, \quad (1)$$

where i indexes individuals, p_i is subjective completion belief, x_i are varying sets of explanatory variables with corresponding vector of coefficients β^p, and υ_i is an unobserved error term. The estimates are presented in Table 1.[12] In Column (1), the beliefs are explained solely by academic ability, year, and region fixed effects. In Column (2), we add the personality measures; in Column (3), individual and family background characteristics; and, finally, in Column (4), regional labor market measures.

The explained variation, as measured by the adjusted R^2, increases substantially only when academic ability and personality measures are included in the regressions, but is relatively unaffected when adding individual and family characteristics or regional youth labor market variables.[13] The joint significance tests for subsets of variables reported at the bottom panel of the table paint a similar picture: Academic ability and personality characteristics are highly significant across all regressions, and their associated F statistics in Column (4) are 16.5 and 26.6, respectively. Individual and family characteristics are jointly significant, but at the five percent level with an F statistic of 2.5. The local youth labor market characteristics are insignificant and their F statistic is just 0.3. Since these coefficient estimates are neither jointly nor individually significant, we omitted them from the table. Thus, Table 1 indicates that youths' subjective completion probabilities reflect mainly their past academic record and personality traits. Youths' socio-economic family backgrounds are only mildly

[12] Note that our dependent variable is a fraction. In the Appendix, Table C1, we present quasi-likelihood fractional response regressions (as in Papke and Wooldridge, 1996, 2008). The results are virtually indistinguishable from the OLS estimates.

[13] These results are not affected by the order in which the sets of variables are included.

Table 1: Determinants of subjective completion beliefs, OLS regressions

Dependent variable: p_i, subjective completion belief (mean=0.776, standard deviation=0.198)				
	(1)	(2)	(3)	(4)
GPA (std)	0.037	0.028	0.028	0.029
	(0.003)	(0.003)	(0.003)	(0.003)
Rec: Lowest Track (yes/no)	0.029	0.027	0.029	0.029
	(0.015)	(0.015)	(0.015)	(0.015)
Rec: Intermediate Track (yes/no)	0.066	0.060	0.057	0.056
	(0.012)	(0.011)	(0.011)	(0.011)
Rec: High school (yes/no)	0.051	0.043	0.039	0.038
	(0.011)	(0.011)	(0.011)	(0.011)
In high school (yes/no)	0.004	0.002	-0.005	-0.005
	(0.008)	(0.008)	(0.008)	(0.008)
Locus of control (std)		0.024	0.023	0.023
		(0.004)	(0.004)	(0.004)
Risk attitudes (std)		0.006	0.005	0.005
		(0.004)	(0.004)	(0.004)
Openness (std)		0.005	0.005	0.004
		(0.004)	(0.004)	(0.004)
Agreeableness (std)		0.006	0.007	0.007
		(0.004)	(0.004)	(0.004)
Extraversion (std)		0.016	0.017	0.017
		(0.004)	(0.004)	(0.004)
Neuroticism (std)		-0.001	0.000	0.000
		(0.003)	(0.004)	(0.004)
Conscientiousness (std)		0.032	0.033	0.033
		(0.004)	(0.004)	(0.004)
Female (yes/no)			-0.011	-0.011
			(0.007)	(0.007)
Nr. siblings			-0.003	-0.003
			(0.002)	(0.003)
Second-generation migrant (yes/no)			-0.009	-0.009
			(0.013)	(0.013)
Parent college-educated (yes/no)			0.009	0.008
			(0.007)	(0.007)
Parent cur. unemployed (yes/no)			0.002	0.002
			(0.013)	(0.013)
Log. net household income			0.006	0.006
			(0.002)	(0.002)
N	3'610	3'610	3'610	3'610
adj. R^2	0.057	0.117	0.121	0.120
Fixed effects	✓	✓	✓	✓
Academic	✓	✓	✓	✓
F (p-value)	28.912 (0.000)	18.354 (0.000)	16.482 (0.000)	16.498 (0.000)
Personality		✓	✓	✓
F (p-value)		26.835 (0.000)	26.509 (0.000)	26.616 (0.000)
Family Background			✓	✓
F (p-value)			2.458 (0.016)	2.380 (0.020)
Labor market				✓
F (p-value)				0.310 (0.907)

Notes: Cells contain coefficients from linear regressions of subjective beliefs on varying sets of covariates, in (1) only on academic and region and time fixed effects (coefficients not presented), (2) adds personality, (3) family background and individual characteristics, and (4) local labor market characteristics. Robust standard errors in parentheses. All regressions include indicator variables for missing values in any of the covariates, and region and year fixed effects. F (p-value) are test statistics and p-values of tests of joint significance of corresponding groups of variables.
Source: SOEP 2000-2013 (v30), INKAR 2012, own calculations.

related to their completion beliefs, and the state of the local youth labor and education market seems not to affect their beliefs at this stage.

Looking at the determinants individually, all academic ability variables are consistently positive and significant. Somewhat surprisingly, already being enrolled in high school does not alter students' subjective completion beliefs, which might be a result of conditioning on prior track recommendations. As hypothesized by Coleman and DeLeire (2003), the locus of control is a very important determinant of subjective completion beliefs throughout the regressions, both in magnitude and significance.[14] Risk attitudes do not matter once family characteristics are accounted for. Our regressions indicate that among the Big Five measures of personality, conscientiousness is the most influential in shaping subjective beliefs. This finding highlights the importance of conscientiousness for education outcomes (see, *inter alia*, Borghans, Meijers and Ter Weel, 2006). While we find little evidence that openness or neuroticism influence completion beliefs, the effect of extraversion is about half as large as conscientiousness, and the effect of agreeableness, in turn, is about half as large as extraversion. On average, females seem to have lower subjective completion beliefs. This estimate is, however, only marginally significant (at least conditional on personality and academic ability). Household income is positively and significantly related to subjective completion beliefs. The remaining estimated coefficients are insignificant and mostly very small in magnitude.

3.2 Education choice with subjective completion beliefs

In this section, we turn to our central question of how subjective completion beliefs measured at age 17 years relate to education intentions, investments, and, finally, degree attainment. To fix ideas, let individual i's utility u_{ij} from choosing an uncertain post-secondary education track ($j \geq 1$) be

$$u_{ij} \quad = \quad \begin{cases} \mu_{ij} + \nu_{ij} & \text{with probability } p_{ij} \\ \bar{\mu}_{ij} + \nu_{ij} & \text{with probability } (1 - p_{ij}), \end{cases} \tag{2}$$

where p_{ij} is subjective completion belief, μ_{ij} and $\bar{\mu}_{ij}$ are the utilities from completing and dropping out, respectively, and ν_{ij} is a utility component unaffected by completion.[15] The associated expected utility is

$$U_{ij} \quad = \quad \bar{\mu}_{ij} + p_{ij}(\mu_{ij} - \bar{\mu}_{ij}) + \nu_{ij}. \tag{3}$$

Hence, adolescents get a baseline utility from attending a particular education track $\bar{\mu}_{ij}$. The subjective completion belief p_{ij} weights the utility differential between completing and not completing up or down.

[14] Related to this, Jaik and Wolter (2016) find that students with external locus of control have a higher intention to delay their education transition. Caliendo, Cobb-Clark and Uhlendorff (2015) also find a strong link between subjective beliefs and the locus of control in the realm of job search among the unemployed. However, for an opposing view see Cebi (2007).

[15] This assumption implies that preferences are additively separable. This excludes interactions between uncertainty and other covariates, which is, however, a promising line of future research.

Since not investing in education does not involve completion uncertainty, the utility is simply

$$U_{i0} \quad = \quad \mu_{i0} + \varepsilon_{i0}, \text{ with certainty.} \tag{4}$$

In this section, we assess the extensive margin of investment in any post-secondary education $U_{ij} = U_i$ for $j \geq 1$, against not investing U_{i0}, which directly relates to the survey question of p_i (which assesses any post-secondary education; we will assess the intensive margin between tracks and resulting comparative advantages in detail in the next section). A student prefers to invest in education if $U_i > U_{i0}$; where, by standard normalization, $\mu_{i0} = 0$. Taking averages across individuals, adding covariates that measure observed preferences and skills (i.e., $\nu_i = x_i'\beta^d + \varepsilon_i$), and assuming that $\epsilon_i = \varepsilon_i - \varepsilon_{i0}$ follows a standard normal distribution, we estimate probit models of the form

$$d_i \quad = \quad 1[\alpha p_i + x_i'\beta^d + \epsilon_i > 0]. \tag{5}$$

We consider three different binary outcomes d_i: First, whether a student intends to complete any post-secondary education, which is measured concurrently with subjective beliefs at age 17 years. Then, the expectation of (5) gives $P(U_i > 0)$, so that $\alpha = \mu - \bar{\mu}$. A similar interpretation is possible when d_i represents the second outcome – whether a student actually invests in any post-secondary education, i.e., whether the student started an apprenticeship, a tertiary apprenticeship, or a university degree. This event can be a few months or a few years away. It then corresponds to the revealed preferences of actual investment in post-secondary education. Finally, the interpretation is somewhat different when d_i stands for the third outcome—the completion of an apprenticeship or a university degree, an event that is at least a couple of years away. In this case, α gives an indication of the student's ability to incorporate information beyond that in x_i into his or her forecast of $d_i = 1$, an interpretation of subjective beliefs along the lines of Finkelstein and McGarry (2006). The students process all their available information in forming their beliefs, meaning that relevant information over and above their subjective beliefs is either not used, not used efficiently, or influences the decision through a different channel from subjective completion uncertainty.

Table 2 contains the estimation results. Panels (A) to (C) present the probit regressions of subjective completion beliefs on different education outcomes. In each panel, we report the estimated coefficients, robust standard errors (in parentheses), average marginal effects (in squared brackets), pseudo R_n^2 for models estimated without and with p_i, and sample statistics for the respective subsamples. Columns (1) to (4) contain simple probit estimates of education outcomes on subjective beliefs and varying sets of covariates: The specification in Column (1) contains, apart from p_i, only an indicator of whether the student is currently in high school, as well as region and year fixed effects. Thus, in this specification, any other variable acts on the intention to invest in education through its effect on p_i. The next Columns progressively control for sets of academic (Column 2), personality (Column 3), and family and labor market variables (Column 4). We turn to the results in Columns (5)-(7) in the next section.

Panel (A) contains results corresponding to the intention to invest in any post-secondary education. The uncertainty measured by p_i is an important predictor for investment intentions: The coefficients on subjective beliefs are large and highly significant throughout the probit regressions. The average

Table 2: Subjective completion beliefs and education outcomes

Dependent variables: Indicator variables for post-secondary education intentions (A), investment (B), or completion (C).

	probit				probit eev		
					$\rho = \hat{\rho}^o$	$\rho = .1$	$\rho = .3$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(A) Intentions							
p	0.921	0.809	0.716	0.704	0.538	0.600	0.371
	(0.142)	(0.146)	(0.149)	(0.151)	(0.149)	(0.150)	(0.144)
	[0.140]	[0.121]	[0.107]	[0.103]			
R^2_n	0.029	0.040	0.048	0.057			
$R^2_n(p)$	0.049	0.055	0.059	0.067			
Sample: $N = 3'610$, $\bar{d} = 0.91$, $\bar{p} = 0.78$, $SD(p) = 0.20$, $\hat{\rho}^o = 0.157$							
(B) Actual investment							
p	0.997	0.915	0.902	0.862	0.842	0.758	0.523
	(0.223)	(0.228)	(0.239)	(0.249)	(0.249)	(0.248)	(0.238)
	[0.069]	[0.062]	[0.056]	[0.044]			
R^2_n	0.087	0.100	0.120	0.182			
$R^2_n(p)$	0.113	0.121	0.138	0.197			
Sample: $N = 2'116$, $\bar{d} = 0.96$, $\bar{p} = 0.77$, $SD(p) = 0.20$, $\hat{\rho}^o = 0.020$							
(C) Actual completion							
p	0.434	0.410	0.387	0.373	0.374	0.272	0.056
	(0.181)	(0.185)	(0.190)	(0.192)	(0.192)	(0.191)	(0.183)
	[0.172]	[0.162]	[0.153]	[0.148]			
R^2_n	0.089	0.093	0.102	0.121			
$R^2_n(p)$	0.092	0.096	0.104	0.123			
Sample: $N = 1'372$, $\bar{d} = 0.54$, $\bar{p} = 0.77$, $SD(p) = 0.20$, $\hat{\rho}^o = 0.000$							
Fixed effects	✓	✓	✓	✓	✓	✓	✓
Academic		✓	✓	✓	✓	✓	✓
Personality			✓	✓	✓	✓	✓
Family Background				✓	✓	✓	✓
Labor market				✓	✓	✓	✓

Note: Table entries are coefficients (robust standard errors in parentheses; average marginal effects in squared brackets), from probit regressions (1)-(4) and probit regressions with endogenous explanatory variable (5)-(7). Variable p denotes the subjective completion beliefs. Other covariates: in column (1) in high school, region and time fixed effects, (2) adds academic, (3) adds personality, (4) to (7) family background, individual, and local labor market variables. In probit eev regressions the correlation between errors, ρ, is restricted as indicated in column headers: (5) $\hat{\rho}^o$, the estimated selection-on-observables; (6) 0.10; (7) 0.30. R^2 and $R^2(p)$ are McFadden's pseudo-R^2 excluding and including p, respectively; $\bar{d}$ is the mean of the dependent variable, $\bar{p}$ and $SD(p)$ are mean and std. deviation of p_i.
Source: SOEP 2000-2013 (v30), INKAR 2012, own calculations.

marginal effects are economically relevant. In the most parsimonious specification, increasing subjective beliefs in the population by one standard deviation increases intentions to invest in post-secondary education by 2.8 percentage points (0.140×0.2), which is quite large relative to the nine percent of students who do not intend to invest in a post-secondary education. These figures change little if we condition on increasing sets of background characteristics commonly considered in the literature. A one standard deviation change results in an increase of 2.1 percentage points using all background characteristics. Moreover, the increase in the R^2 when including subjective beliefs in the regression in Column (1) (from 2.9 to 4.9 precent) is similar to the increase when adding the full sets of both academic and personality variables (from 2.9 to 4.8 precent). Thus, the predictive power of subjective beliefs is equal to the one of academic and personality variables combined. In sum, subjective beliefs are strongly related to intended behavior (a result consistent with, for example, Huntington-Klein, 2015*b*), and very important relative to other choice determinants, such as GPA or personality skills.

Several explanations can account for this contemporaneous correlation between beliefs and intentions. Therefore, we examine whether the link from belief to intention carries over to revealed preferences in actual investments at least two years later. In Panel (B), our dependent variable is now an indicator that equals one if the student started any post-secondary education. Compared to the sample used in (A), the sample in (B) only excludes students who are still in school and students too young to have answered subsequent questionnaires. The average marginal effects are somewhat smaller in absolute value than for the intentions, ranging from 1.4 to 0.9 percentage points for a one standard deviation increase in subjective beliefs. The effects are of similar magnitude as before when considered relative to the group who fails to invest in post-secondary education, which comprises about four percent of youths: A one standard deviation increase in p_i is associated with a predicted reduction of this group by between 34 percent to 22 percent. This result suggests that subjective completion beliefs not only drive hypothetical, intended investment, but have real behavioral consequences. Compared to the previous results on students' intentions, the set of family background and labor market variables explain a somewhat larger fraction of the completion belief effect and exhibit more explanatory power.

Finally, we compare how subjective completion beliefs relate to actual completion at least five years later. This correlation can be interpreted as the degree to which students can predict their future outcomes.[16] The estimation results are given in Panels (C). The average completion rate is roughly 54 percent. Unconditionally, a one standard deviation increase in subjective beliefs increases completion rates in the population by 3.4 percentage points. This effect shrinks to 3.0 percentage points when including the full set of individual, family, and regional characteristics. Thus, a one standard deviation increase in p_i is predicted to reduce the group of students dropping out of post-secondary education by about 6.5 percent. For completing a post-secondary education, the explanatory power of family background and labor market characteristics is substantial relative to that of the other covariates.

[16]Since completing a program and graduating takes some time, we consider only students whom we see at least five years after they have taken the youth questionnaire. Students who were interviewed in earlier years are more likely to have completed their degrees simply by virtue of having been in the sample for a longer period of time. However, this mechanism is captured by the year fixed effects, and is therefore unlikely to bias our results. A second concern is that some of the observations are censored: As of the time we observe them, some students have not yet completed their degree, but they might do so in the future. In this sense, our results should be interpreted as representing the average effect of completion beliefs on completion within a given time frame.

For instance, relative to a baseline of only fixed effects, the inclusion of p_i, academic, and personality variables adds successively about three, three, and eight percent to the R^2, while family and labor market variables add another 18 percent. This result stands in contrast to the results from the previous section, and suggests that students do not optimally take their family and local labor market information into account when forming their beliefs.

3.3 Robustness and Altonji-Elder-Taber bounds

Taken together, the results show that subjective completion beliefs formed during secondary education are predictive over a long time horizon, which is consistent with substantial inertia due to preexisting beliefs in these choices, as was hypothesized in the studies cited above. Moreover, these early subjective completion beliefs are predictive even after accounting for a comprehensive set of previously identified, important characteristics. In the appendix, we present further results showing the robustness of these findings across a number of alternative specifications.

First, we show that the results change little when p_i is treated as the unconditional completion probability: We modify the specification to one where we use only students who expressed positive intentions in the estimation sample, and additionally control for the subjective investment probability (cf. Table C2). Next, we show that the results are robust to dichotomizing the subjective belief to a dummy variable (cf. Table C3), thus accounting for potential non-linearity, as discussed in Pinger (2015).

A key determinant is GPA, which the literature has found to be the main driver of learning about own ability among college students. To show that our results do not hinge on the measure of GPA we use, we assess various alternative standardizations and specifications. First, we standardize GPA within high schools, since grades might be based on different standards across school tracks (Table C5), and within federal states, which accounts for potentially different grading standards across state education systems (Table C6). Further, we use a fifth-order polynomial in GPA to demonstrate that the effects of beliefs are not spuriously picking up non-linearities in academic ability (Table C6). Additionally, we use federal state dummies (Table C6) instead of the region dummies used in the main specification. Finally, we present separate estimations for students enrolled in high school when answering the youth questionnaire to account in a completely flexible way for the different default choices discussed above (Table C4).

Although the results in Columns (1)-(4) in Table 2 show that the coefficient on p_i does not change much even after including a very large set of potential confounders, a remaining concern might be that the effect of subjective beliefs, α, is confounded with further unobserved variables, i.e., in terms of our empirical model, that there are unobserved variables in ϵ_i that are correlated with p_i. In order to show that our results are robust to this selection on unobservables, we go one step further and use a bounding strategy for the coefficients introduced by Altonji, Elder and Taber (2005*a*,*b*, 2008, hereafter, AET) by taking into account potential selection on unobservable tastes and preferences for education when estimating (5). We show how α varies if there were a correlation ρ between unobservable components of d_i and p_i, and we present a suggestive upper bound under the assumption that the correlation between observables is informative about the correlation between unobservables. In contrast to AET, our main variable is a fraction rather than an indicator. Thus, instead of estimating a bivariate probit, we estimate a probit with continuous endogenous explanatory variable, or "probit eev".[17] Note that Column (4) of Table 1 in combination with Column (4) of Table 2 is equivalent to the probit eev with $\rho = 0$; hence, the probit eev model nests the two separate models above. More detailed information on the probit eev estimation and the AET bound is provided in Appendix A.1. Column (5) constrains ρ to be equal to the selection-on-observables $\hat{\rho}^o$. Finally, Columns (6) to (7) contain the probit eev estimates using the full set of covariates and ρ constrained to 0.1 and 0.3, respectively. All coefficients are positive up to a correlation of 0.3. This means that our conclusions remain valid even if the unobserved correlation were more than twice as large as the upper bound based on selection on observables. Furthermore the coefficients remain statistically significant when the outcomes of interest are intentions and investments. This is a sizeable correlation when comparing it to the applications considered in AET, and to the selection on observables estimated in our data. Thus, we conclude that the subjective completion belief is a major predictor of intentions, investments, and completion, which is robust to observed and unobserved confounders, using conservative bounds.

4 A sequential model of education choice with completion beliefs

In this section, we develop and estimate a model of sequential human capital investment along the lines of Taber's (2000; 2001) seminal contribution. Our model is deliberately held simple, but it is capable of accounting for various features shown to be relevant in the literature. First, we allow for the sequential nature of the process: students can only decide whether they want to go to university if they previously chose to finish high school (Altonji, 1993; Comay, Melnik and Pollatschek, 1973). Second, we introduce the dynamics of the optimization process: when deciding whether to enter the labor market or to continue with high school, forward-looking students account for the option value of continuing education after finishing high school (Stange, 2012; Trachter, 2015). Finally, we allow for unobserved factors that influence students' choice utilities, which may be correlated across choices and over time, and which is a topic of substantial attention in the returns to education literature (see, e.g., Belzil, 2007; Card, 2001). To quantify the relevance of *ex ante* completion beliefs in such a model, we incorporate our survey measure into the model using Dahl's (2002) semi-parametric selection approach to obtain counterfactual, track-specific uncertainty measures for every individual.[18]

[17] The use of a continuous normal variable is motivated by the estimation of (1), where we found that it made little difference whether the equation was estimated by OLS or a fractional response model (cf. Appendix, Table C1). As a robustness check, we dichotomize the subjective beliefs at $p \geq 70$ percent and estimate bivariate probit regressions as in AET. Estimates for such an approach can be found in the Appendix, Table C3. The results are qualitatively similar but somewhat attenuated, which is likely due to the artificial measurement error introduced by the dichotomization.

[18] An alternative strategy is to interpret the beliefs as a measure of overall post-secondary completion uncertainty, as a non-cognitive skill rather than an economic construct, and hence use the same observed p_i for all tracks. Results and related discussions of such an approach can be found in Kunz and Staub (2016).

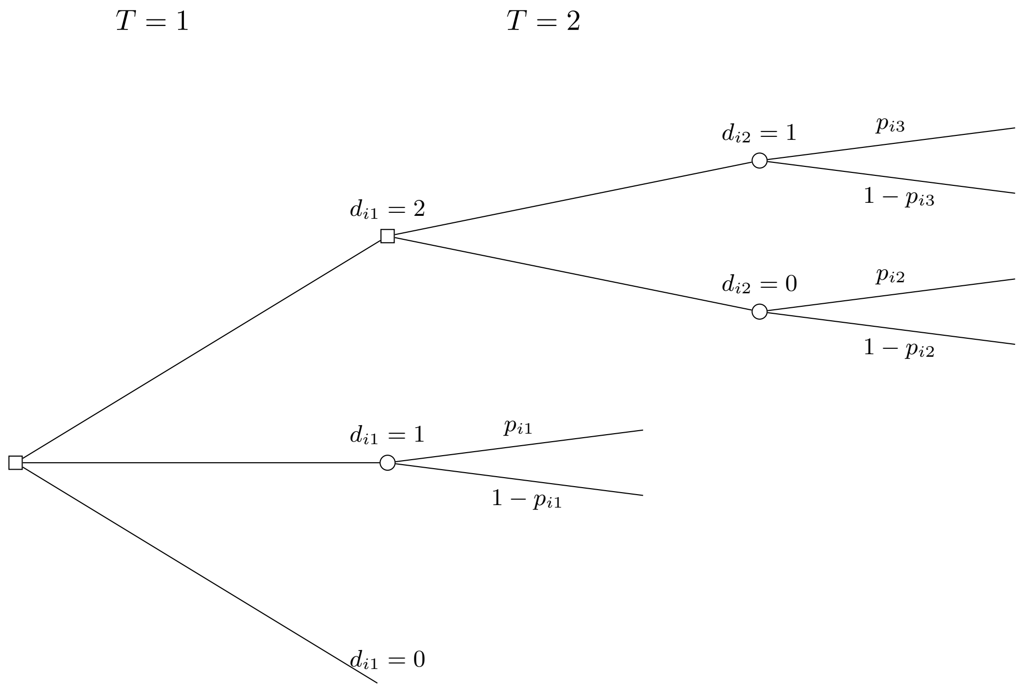


Figure 3: Sequential education decisions and timing of events

4.1 Empirical Model

We consider a stylized two-period model in which students sequentially choose between risky education paths, as outlined in Figure 2. *Ex ante*, students do not know for certain whether they will successfully complete the chosen education track, but they have subjective beliefs, p_{ij}, about the probability of finishing. The survey only elicits the belief for the intended education path; the beliefs about the other, hypothetical paths are not observed. We predict these beliefs using a model which takes into account possible selection which could result, for instance, from students' comparative advantage in their intended track. That is, we first estimate a multinomial probit model of the intentions for each track using the full specification from the previous sections and students' beliefs of starting a post-secondary education. We then use these first-stage estimates to obtain counterfactual, selection-adjusted predictions of the completion beliefs for each post-secondary track, p_{ij} (for details, see Dahl, 2002, and Appendix A.2). Table 3 tabulates the correlation between the predicted p_{ij} by intended investment. The figures in the table highlight the similarity between students intending to invest in either a tertiary apprenticeship or a university degree: for both, there is a strong correlation between $\hat{p}_{i2}$ and $\hat{p}_{i3}$ while the correlations of both these beliefs with $\hat{p}_{i1}$ is low. The pattern for students intending to invest in an apprenticeship is different in that the correlation between their two apprenticeship beliefs, p_{i1} and p_{i2}, is also high, while the correlation between p_{i1} and p_{i3} is somewhat lower. The correlation matrix of students without intentions to invest at the time of the initial survey is more similar to that of the students intending to invest in apprenticeships, but the correlation between p_{i1} and p_{i3} is substantially weaker.

The first period or first stage ($T = 1$) of the sequential model occurs when students finish compulsory education at the age of 17 years. At this point, they face the choice between dropping out of school

Table 3: Correlation between predicted track-specific completion beliefs by investment intentions

	No intentions			*Apprenticeship*			*Tert. apprenticeship*			*University*		
	$\hat{p}_1$	$\hat{p}_2$	$\hat{p}_3$	$\hat{p}_1$	$\hat{p}_2$	$\hat{p}_3$	$\hat{p}_1$	$\hat{p}_2$	$\hat{p}_3$	$\hat{p}_1$	$\hat{p}_2$	$\hat{p}_3$
$\hat{p}_1$	1.000			1.000			1.000			1.000		
$\hat{p}_2$	0.574	1.000		0.690	1.000		0.361	1.000		0.214	1.000	
$\hat{p}_3$	0.121	0.559	1.000	0.278	0.557	1.000	0.351	0.640	1.000	0.320	0.571	1.000

Note: Table entries are sample correlations between predicted track-specific completion beliefs, estimated by Dahl's (2002) multinomial selection model as outlined in Appendix A.2 and Section 4.1. Total number of observations: 2,116 (no intentions: 197 obs.; apprenticeship: 883 obs.; tertiary apprenticeship: 456 obs.; university: 560 obs.).
Source: SOEP 2000-2013 (v30), INKAR 2012, own calculations.

($d_{i1} = 0$), investing in an apprenticeship training ($d_{i1} = 1$), or continuing with high school education ($d_{i1} = 2$). A high school degree involves the option value of continuing with tertiary education. Students who choose high school reach the second stage ($T = 2$), after which they have the choice of either investing in a tertiary apprenticeship ($d_{i1} = 2, d_{i2} = 0$) or in a university education ($d_{i1} = 2, d_{i2} = 1$).[19]

As mentioned above, apprenticeships, tertiary apprenticeships, and university all involve uncertainty, which we model according to equations (2)-(4). By backward induction, we begin with the students' second-stage problem. Students advancing to the second stage choose between starting a tertiary apprenticeship ($j = 2$) or going to university ($j = 3$). We denote this choice by d_{i2}, a binary variable where 1 represents choosing university,

$$d_{i2} = \begin{cases} 1 & \text{if } U_{i3} - U_{i2} > 0 \\ 0 & \text{if } U_{i3} - U_{i2} \leq 0, \end{cases}$$

which we specify, analogously to equation (4), as

$$\begin{aligned} U_{i2} &= \alpha_2 p_{i2} + x'_{i,t+1}\beta_2 + \delta_2\theta_i + \epsilon_{i2} \equiv z_{i2,t+1} + \epsilon_{i2}, \\ U_{i3} &= \alpha_3 p_{i3} + x'_{i,t+1}\beta_3 + \delta_3\theta_i + \epsilon_{i3} \equiv z_{i3,t+1} + \epsilon_{i3}. \end{aligned}$$

Here, $x_{i,t+1}$ consists of the same covariates considered above. Covariates that vary over time, such as some family characteristics (household income and parental unemployment status) and all labor market conditions, are measured two years after the youth questionnaire was answered, which is the time one would need to start tertiary education after obtaining a high school degree.[20] This exogenous variation in the decision problem induced by the timing of events provides an additional source of identification (see French and Taber, 2011; Taber, 2000, for a discussion on the identification for these models), which has become standard practice in the literature on dynamic models of education choice (e.g., Heckman et al., 2014; Taber, 2001). To allow for dependence of the unobservables between the two time periods in a flexible way, we add a standard normal random variable θ_i to the utilities, capturing unobserved tastes and preferences for education. We assume that $\epsilon_{i3} - \epsilon_{i2} \sim N(0, \sigma^2)$; thus

[19] In principle, students could also drop out at this point, but this is an extremely rare event in the data and therefore not modeled (see also Fossen and Glocker, 2014).
[20] We use students' location at the age of 17 for the region fixed effects and the regional characteristics, to avoid a bias due to moving.

the probability of choosing university is given by

$$P(d_{i2} = 1) \quad = \quad \Phi\left(\frac{z_{i3,t+1} - z_{i2,t+1}}{\sigma}\right),$$

where $\Phi(\cdot)$ represents the univariate normal cdf.

In the first stage, the student has an expectation about her second-stage decision (she knows the distribution of $\epsilon_{i3} - \epsilon_{i2}$) but does not know her realized value. If students knew their realized $\epsilon_{i3} - \epsilon_{i2}$ at the time of the first stage, the model would reduce to a static polychotomous choice problem. Thus, a student's expectation about her value of advancing to the second stage, as formed during the first stage, is

$$\mathrm{E}(\max(U_{i3} - U_{i2}, 0)) \quad = \quad z_{i2,t} + \sigma\left[\Phi\left(\frac{z_{i3,t} - z_{i2,t}}{\sigma}\right)\frac{z_{i3,t} - z_{i2,t}}{\sigma} + \phi\left(\frac{z_{i3,t} - z_{i2,t}}{\sigma}\right)\right] \equiv EV_{i,t},$$

and $\phi(\cdot)$ denotes the normal pdf.[21] Corresponding to the student's information set and time-varying family background, labor market and education supply and demand characteristics are now measured at time t, one year before the student answers the youth questionnaire. The difference between utility from continuing with high school and utility from dropping out of high school is then

$$\begin{aligned} U_{iHS} - U_{i0} \quad &= \quad \alpha_{HS} p_{i2} + x'_{i,t}\beta_{HS} + \delta_{HS}\theta_i + EV_{i,t} + \epsilon_{iHS} \\ &\equiv \quad z_{iHS,t} + EV_{i,t} + \epsilon_{iHS}, \end{aligned}$$

which comprises EV_i, the option value of continuing to the second stage. Finally, the apprenticeship utility is

$$U_{i1} - U_{i0} \quad = \quad \alpha_1 p_{i1} + x'_{i,t}\beta_1 + \delta_1\theta_i + \epsilon_{i1} \equiv z_{i1,t} + \epsilon_{i1}.$$

From the two preceding equations, it is clear that first-stage choices are made relative to the baseline utility U_{i0}, which corresponds to dropping out of high school (i.e., not investing in any post-secondary education). The model requires two additional normalizations. First, since the unobserved heterogeneity (θ_i) has no natural scale, we set $\delta_1 = 1$. Thus, the impacts of unobserved heterogeneity on second-stage utilities, δ_2 and δ_3, are then estimated relative to a one standard deviation impact on high school utility. Second, we normalize $z_{iHS,t} = 0$ since z_{iHS}, z_{i2}, and z_{i3} are not separately identified.[22] This means, for example, that α_2 estimates the combined impact of uncertainty on high school and tertiary apprenticeship utility; and α_3, the combined impact on high school and university utility.

[21] Further information on the model and the derivation of the EV_i are discussed more explicitly in Appendix A.3.

[22] Specifically, without further assumptions or restrictions, we cannot distinguish, for instance, between the first, additive part of EV_i (i.e., $z_{i2,t}$), and the first, additive part of $U_{iHS} - U_{i0}$ (i.e., $z_{iHS,t}$).

Then, since the ϵ's are normally distributed, the first-stage choice probabilities are

$$\begin{aligned} P(d_{i1}=2) &= \Phi_2\left(EV_{i,t},\ \ EV_{i,t}-z_{i1,t}\right), \\ P(d_{i1}=1) &= \Phi_2\left(z_{i1,t},\ \ z_{i1,t}-EV_{i,t}\right), \\ P(d_{i1}=0) &= 1-P(d_{i1}=1)-P(d_{i1}=2), \end{aligned}$$

where $\Phi_2(\cdot)$ stands for the bivariate standard normal cdf. The individual likelihood contribution, conditional on the unobserved heterogeneity θ_i, is given by

$$\begin{aligned} l_i(\theta_i) &= \{1-P(d_{i1}=1)-P(d_{i1}=2)\}^{\mathbf{1}(d_{i1}=0)} \times \{P(d_{i1}=1)\}^{\mathbf{1}(d_{i1}=1)} \\ &\quad \times \{P(d_{i1}=2)[1-P(d_{i2}=1)]\}^{\mathbf{1}(d_{i1}=2,d_{i2}=0)} \\ &\quad \times \{P(d_{i1}=2)P(d_{i2}=1)\}^{\mathbf{1}(d_{i1}=2,d_{i2}=1)}, \end{aligned}$$

and to obtain the marginal likelihood contribution, we integrate over the distribution of θ,

$$l_i = \int l_i(\theta_i)\phi(\theta_i)d\theta_i,$$

an expression which we approximate by simulation, $\tilde{l}_i$, by taking 100 random draws from the distribution of θ_i. We then maximize the simulated sample log-likelihood $\sum_i \ln \tilde{l}_i$,[23] replacing the unobserved beliefs with our predictions $(\hat{p}_{i1}, \hat{p}_{i2}, \hat{p}_{i3})$.

4.2 Estimation Results

The estimated parameters are depicted in Table 4 in two panels. The panel on the left contains estimates from a constrained version of the model without heterogeneity ($\theta_i = 0$ for all i), whereas the panel on the right contains estimates from the full model with unobserved heterogeneity. Moving from left to right, the columns again contain the expanding set of covariates considered previously. With the exception of the family and regional labor market determinants, all the regressors are time-invariant.[24] The estimated coefficients on the beliefs p_{ij} are all positive. The coefficients in the two panels with $d_{i1} = 2$ are large and significant, indicating that subjective completion beliefs are important determinants of second-stage participation—of completing high school and beginning a tertiary apprenticeship or university study. In the apprenticeship category, the estimates are smaller and only significant in the columns which control for all observables. Thus, for this category, the beliefs incorporate the predictive information from our observable covariates to a much smaller extent than the two other, higher categories.

To illustrate the effects of the completion beliefs on investment, Figure 4 plots predicted investment

[23] We used antithetic random draws as well as larger numbers of draws with little impacts on the estimates.

[24] The parameter σ is only identified when time-varying covariates are included (French and Taber, 2011; Taber, 2000). It is estimated only in Columns (4) and (8), while it is constrained to 1 otherwise. To further facilitate identification, the number of universities and the number of university students are only included in the second stage and EV. Results are robust to the inclusion of these variables in the first stage.

Table 4: Dynamic models of actual investment

Dependent variables: Jointly estimated sequential model of investment in apprenticeship, tertiary apprenticeship, and university. Base category: no investment.

	Dynamic model				Dyn. model with unobs. heterogeneity			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Apprenticeship $(d_1 = 1)$								
p_1	0.510	0.772	0.721	1.160	0.645	0.895	0.849	1.264
	(0.479)	(0.531)	(0.575)	(0.629)	(0.486)	(0.540)	(0.584)	(0.640)
$\theta = 1$								
Tertiary apprenticeship $(d_1 = 2, d_2 = 0)$								
p_2	1.708	0.812	1.070	1.322	1.839	0.921	1.202	1.419
	(0.493)	(0.536)	(0.660)	(0.693)	(0.498)	(0.542)	(0.666)	(0.701)
θ					0.827	0.831	0.834	0.851
					(0.061)	(0.062)	(0.062)	(0.051)
University $(d_1 = 2, d_2 = 1)$								
p_3	2.525	1.996	2.182	2.194	2.675	2.134	2.346	2.293
	(0.718)	(0.792)	(0.911)	(1.099)	(0.722)	(0.797)	(0.917)	(1.104)
θ					0.838	0.843	0.847	0.858
					(0.048)	(0.051)	(0.052)	(0.070)
σ				0.049				0.052
				(0.279)				(0.283)
N	2’116	2’116	2’116	2’116	2’116	2’116	2’116	2’116
Fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Academic		✓	✓	✓		✓	✓	✓
Personality			✓	✓			✓	✓
Family+Labor market				✓				✓

Note: Table presents estimates of the model in equation (6). In the panel “Dynamic model”, $\theta_i = 0$ for all i. The model in the panel “Dyn. model with unobs. heterogeneity” estimated by MSL with 100 random draws from $N(0, 1)$. The sets of covariates correspond to those in Table 2. Standard errors in parentheses. All regressions include an indicator for being in high school with 17, region and time fixed effects.
Source: SOEP 2000-2013 (v30), INKAR 2012, own calculations.

probabilities for the different education tracks against p_{ij}. The top four graphs show how the investment probabilities change with changes in p_{i1}, p_{i2}, p_{i3}, and all three beliefs jointly, respectively, fixing all other variables at their sample averages ($\bar{x}_i'\beta_j$). The bottom four graphs are evaluated at $x_i\beta_j = 0$, illustrating the changes in investment probabilities for the 'marginal student'.

The predicted shifts in post-secondary investment associated with changes in the completion probabilities are large. Increasing the completion belief for one specific track (say, p_1) increases the investment in that respective track (say, apprenticeship), for both average and marginal students. However, how an increase in one track-specific belief affects investment in other tracks varies. For instance, increasing p_2 for average students does not only induce these students to invest more in tertiary apprenticeships but also in university education, as these increase the likelihood of second-stage participation. Increasing p_3 for average students only increases university enrollment while reducing tertiary apprenticeship enrollment. And for marginal students, a higher p_2 is not related to increased university enrollment. Increasing uniformly all beliefs tends to increase investment in all tracks, for average as well as marginal students. As a consequence, the probability of not investing decreases; for marginal students, substantially so. Note that for a marginal student, tertiary apprenticeship and university investment are identical since $\bar{x}_i'\beta_j$ are all set to zero, so that beliefs are the only measure which sets them apart and which are equal in this example (as well as in the graph for p_1, where both $p_2 = p_3 = 0$).

What is the role of unobserved preferences or skills for post-secondary education, θ_i? Comparing the two panels of Table 4, we see that all the significant coefficients in the panel on the right, which accounts for such heterogeneity, are somewhat larger than the ones from the panel on the left. Recall that θ_i has no natural scale—its scale has been fixed such that a unit coefficient in the index corresponds to apprenticeship. The estimated coefficients for θ_i in the tertiary apprenticeship and university categories are highly significant and quite similar in magnitude, between 0.84 and 0.85 across all specifications (5)-(8). The results show that there is a strong positive correlation between unobserved preferences for any post-secondary education. Unobserved preferences for education are very important for adolescents' investment decisions, as found in prior literature (e.g. Bulman, 2015; D'Haultfoeuille and Maurel, 2013; Huntington-Klein, 2015*a*; Wiswall and Zafar, 2015*a*). On the other hand, there is no evidence for differences between unobserved tertiary apprenticeship-specific skills versus university-specific skills, which might be a consequence of preference updating during high school.

Figure 5 visualizes how the effect of completion beliefs might differ for different "types" of students. Based on the estimates of the full specification from Column (8), we define four types of students by their academic ability level (high versus low GPA) and their unobserved skill level (high versus low θ_i). Low and high levels of GPA and θ_i are defined as the 25th and 75th percentiles in these variables' distributions. Their predicted education investment choice probabilities are evaluated at sample means (Panel (A), average student) and at $x_i'\beta_j = 0$ (Panel (B), 'marginal' student), and plotted over a joint change in all three p_{ij} from 0 to 1. This corresponds to the setup of the top and bottom right panels from Figure 4. In both Panels (A) and (B), moving from the left-hand-side to the right-hand-side graphs—that is, changing θ_i while holding GPA fixed—is associated with a starker change in the slopes of the completion beliefs than moving from the top to the bottom graphs—changing GPA for

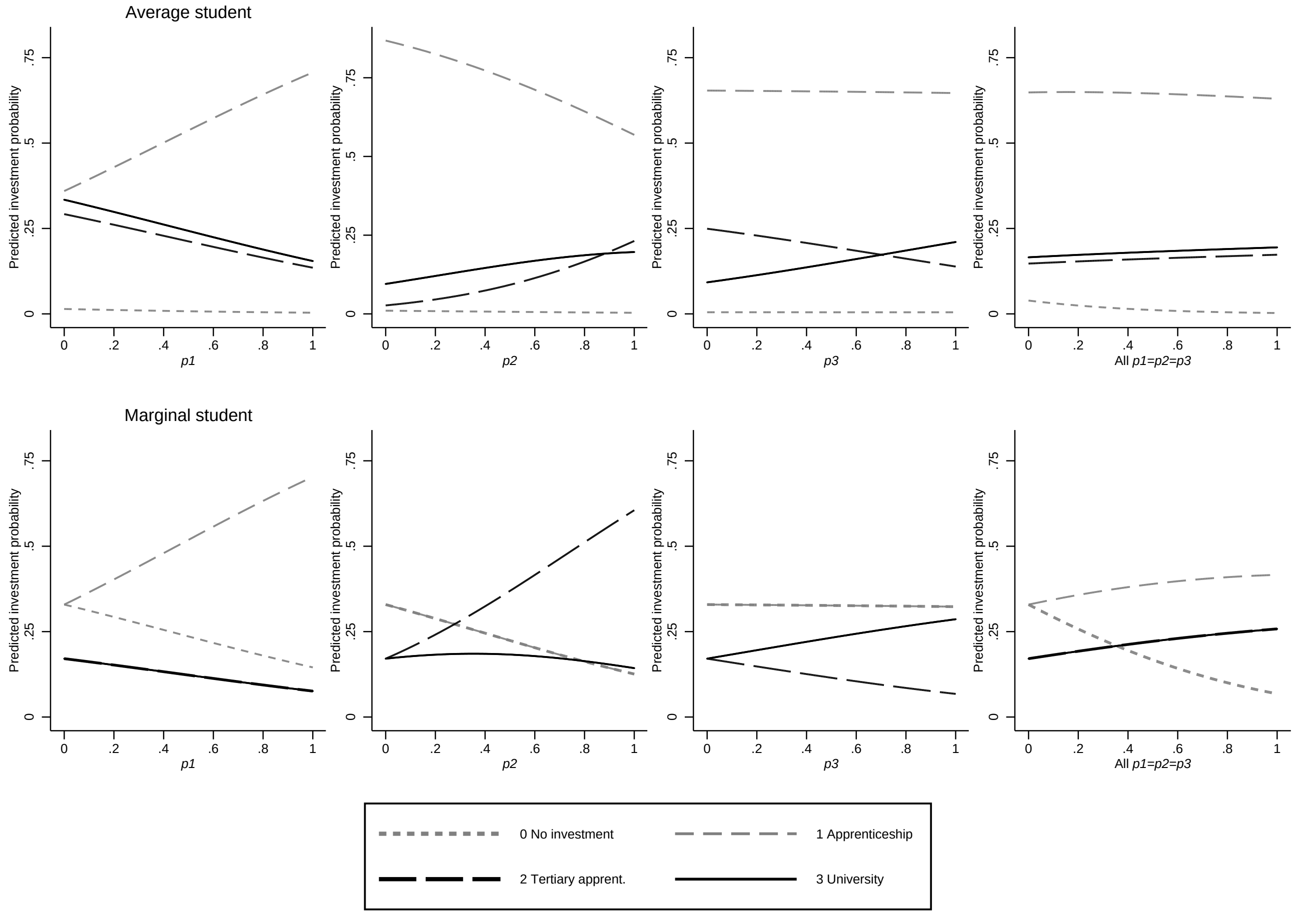
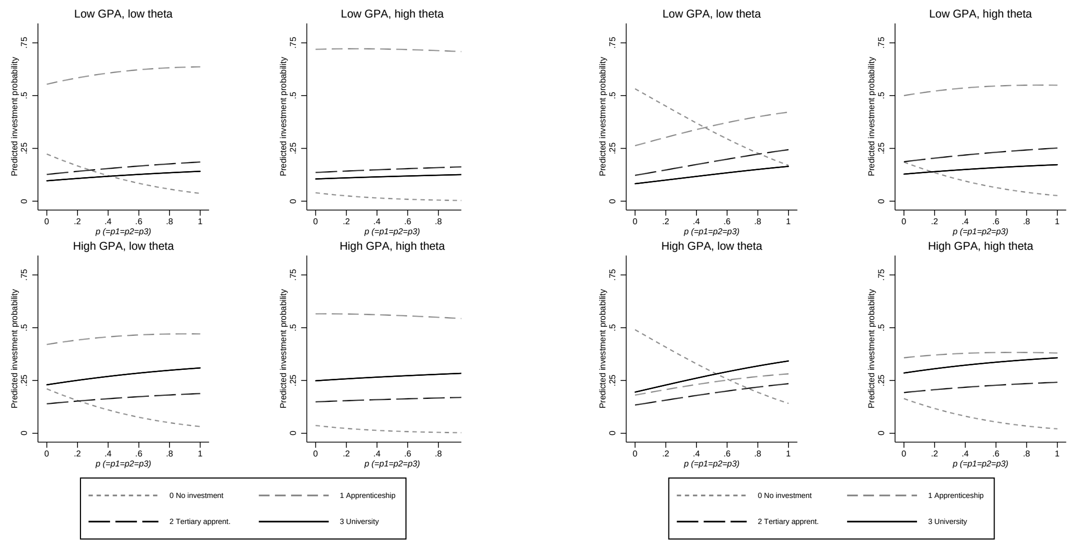


Figure 4: Subjective completion beliefs and predicted investment probabilities
Notes: Predicted probabilities constructed using estimates from Column (8) of Table 4. Top row: evaluated at sample means, $\bar{x}_i'\beta_j$; bottom row: evaluated at $\bar{x}_i'\beta_j = 0$.
Source: SOEP 2000-2013 (v30), INKAR 2012, own calculations.

fixed θ_i. This indicates that unobserved skills and preferences influence the effect of completion beliefs more strongly than GPA. The effects are also more pronounced for the marginal than the average student. For average students who have both high observed and unobserved skills (lower right graph of Panel (A)), subjective completion beliefs have negligible effects on investment probabilities. Yet, for adolescents with low unobserved skills and high GPA (lower left), subjective beliefs positively influence all education tracks. For students with low academic performance, subjective beliefs are more relevant if they also have a low preference for education (top left). A similar picture emerges for the marginal student where the slopes are steeper for students with a low preference for post-secondary education ("low theta") and steepest for those that also have a low academic ability (which again appears to be less relevant than the unobserved preferences). In sum, these findings suggests that subjective beliefs are most relevant for students with low academic ability and low unobserved skills, a group largely ignored in the current literature.

4.3 Subjective Beliefs, and direct vs indirect effects on investment

The final question we address is the extent to which changes in covariates are mediated by subjective beliefs. Here, we focus on youths' investment in any post-secondary education because adolescents at

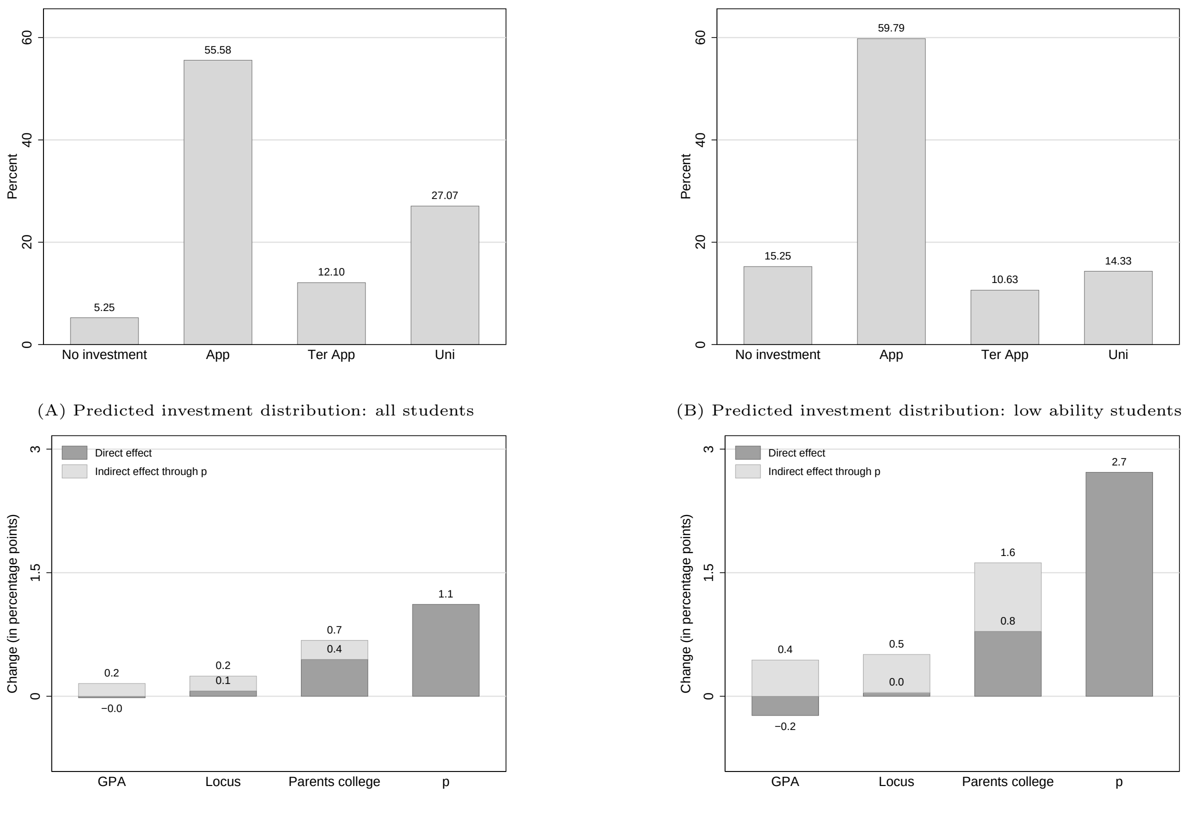


(A) Average student (B) Marginal student

Figure 5: THE ROLE OF ACADEMIC ABILITY AND UNOBSERVED HETEROGENEITY
Notes: Predicted probabilities constructed using estimates from Column (8) of Table 4, evaluated at sample means ($\bar{x}_i'\beta_j$) for Panel (A), and at $x_i'\beta_j = 0$ for Panel (B). High GPA and θ are evaluated at the 75th percentiles; low GPA and θ, at the 25th percentile.
Source: SOEP 2000-2013 (v30), INKAR 2012, own calculations.

risk of dropping out of school after finishing compulsory education are a key policy target population. Focusing on the dropout risk has the additional advantage of being directly comparable to the reduced-form estimates of Section 3 where we compared any post-secondary investment to no investment. To disentangle the effects, we calculate average changes in the predicted investment probability for (*i*) a *ceteris paribus* change in a covariate of interest, and (*ii*) its corresponding *mutatis mutandis* change. The latter is the sum of the covariate's direct *ceteris paribus* change plus the indirect change that the covariate has through the belief. The results for three selected variables are presented in Figure 6, using the estimates from Table 4, Column (8). We present average changes for two populations: all students, and a "low ability population". While the predicted investment distribution of all students in Panel (A) is virtually identical to the actual distribution in our sample and to the official statistics in Germany, the low ability students in Panel (B) are at much higher risk of not investing in post-secondary education; if they invest, their chosen path is more likely to be vocational.

The two panels at the bottom of Figure 6, Panels (C) and (D), show the percentage-point reduction in the predicted probability of not investing in any post-secondary education, for the whole population and the low ability population, respectively. We compare three covariates that have been highlighted in the literature as key determinants of human capital accumulation: GPA, a measure of cognitive ability; the (internal) locus of control, a measure of non-cognitive ability; and an indicator for having at least one college-educated parent, a measure of socio-economic status. As a reference, the panels also depict the direct effect of the subjective completion probabilities, $p_{i1} = p_{i2} = p_{i3}$. We consider changes of one standard deviation in each of these variables, with the exception of having at least one college-educated parent, for which we consider a unit change. The darker bars denote the direct (or *ceteris paribus*) effects, while the lighter bars depict the portion of the total effect that works indirectly through increasing the completion beliefs. Hence their portion indicates the "importance"



(A) Predicted investment distribution: all students

(B) Predicted investment distribution: low ability students

(C) Predicted reduction in no investment: all students

(D) Predicted reduction in no investment: low ability students

Figure 6: Comparison of interventions
Notes: All predictions constructed using estimates from Column (8) of Table 4. Figures (A) and (C), "all students" we average over the entire estimation sample and use 100 draws for each student from θ_i with mean 0. Figures (B) and (D), "low ability students": averages over individuals with GPA≤ -0.5 and unobserved skills with 100 draws from θ_i with mean -1 with mean equal to -1. Top Figures (A), (B): average predicted probabilities for investment in post-secondary education. Bottom Figures (C), (D): predicted reductions, in percentage points, in the probability not to invest for a one standard deviation increase in GPA, locus of control, p $(= p_{i1} = p_{i2} = p_{i3})$, and for a unit increase in parents college. Numbers on top of the bars denote the total change, those below the direct effect, thus their difference is the indirect effect.
Source: SOEP 2000-2013 (v30), INKAR 2012, own calculations.

of the indirect channel through the three p_{ij}.

All variables shown in the panels reduce the probability of not investing in any education. Our model implies that an increase in students' GPA by one standard deviation would leave their dropout risk essentially unaffected, assuming this change left the students' subjective beliefs unaffected. However, an increased GPA comes hand in hand with an increase in subjective belief that in turn reduces the dropout risk by 0.2 percentage points (or 3.8 percent). The fact that GPA has no substantial direct effect on dropout risk does not imply that GPA is unimportant for education investments; however, the effect of GPA takes place at the intensive margin, that is, between different types of post-secondary education (in particular, from apprenticeships towards university), rather than at the extensive margin. A similar picture emerges for the locus of control, which has only negligible direct effects on investment when beliefs are held constant. Again, its total effect is 0.2 percentage points in the total student population and 0.5 percentage points among the low ability and low preference population. Hence, this effect is driven entirely by its impact through the subjective beliefs. We interpret this result as strong evidence for the hypothesis of Coleman and DeLeire (2003, p3), that "locus of control operated through teenagers' expectations of the returns to human capital investments". Finally, roughly a third of the intergenerational effect, captured by having at least one college-educated parent, is estimated to be due to the increasing subjective completion belief in total population, and half of the effect in the low ability population. It is reassuring that Figure 6 also confirms the magnitude of our reduced-form estimates: Increasing beliefs by one standard deviation reduces the probability of not investing in any post-secondary education by 1.1 percentage points, which is roughly a 21 percent reduction in the population share that does not invest (5.25 percent). Even though the percentage-points change among the low-ability group is larger (2.7), the percent reduction is slightly smaller—18 percent—due to a higher share (15.25 percent) not investing in this group.

5 Conclusion

In this paper, we investigated the role of uncertainty about the likelihood of completion in youths' post-secondary education choices using their elicited subjective beliefs about successfully finishing their chosen post-secondary education. The students' young age and the long time horizon make this an especially hard problem, and it is remarkable that these necessarily crude initial beliefs retain their predictive power over several years. The effects of subjective beliefs on investment intentions and actual investments in post-secondary education are substantial, and remain so even after controlling for a large set of observable characteristics, and bounding against unobservables. Moreover, subjective beliefs have an explanatory power comparable to that of academic and personality variables combined. Finally, our results indicate that subjective probabilities of completion are also predictive of actual completion. Thus, students' beliefs contain private information currently not captured in empirical human capital models. Conversely, our results also suggest that students disregard some relevant information when forming their beliefs, such as family and education market characteristics; suggesting a potential avenue for informational policy interventions.

The results from the dynamic sequential model with unobserved heterogeneity shed light on some additional aspects of education choice. For one, the sequentiality of choices shows that subjective completion beliefs have a highly significant effect on the combined high school and second-stage choices. Furthermore, we have seen that accounting for the option value and for unobserved skills can modify the salience of the effect of beliefs on the choice probabilities. Differentiating between post-secondary education choices, we find that subjective beliefs are most relevant for students who aim for a university degree. Inertia for these students is even stronger than previously documented: Among college students, Zafar (2011*b*) found beliefs at the time of college enrollment to be strong predictors of success throughout college; our results extend this finding to beliefs formed already much earlier, and which also affect whether students enroll in college in the first place.

Importantly, subjective beliefs are also highly relevant for students who start an apprenticeship. Our results suggest that subjective beliefs are of crucial importance for students with lower academic ability and low unobserved preferences or skills for post-secondary education, who primarily invest in apprenticeships. These students have been largely ignored in the present literature on subjective beliefs in education choice, and evidence on their learning/decision-making processes is scant. Our study suggests that these students deserve much more attention, especially since apprenticeship systems are now tested or implemented in several countries (e.g., President Obama's State of the Union Address, 2014).

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A Additional derivations

A.1 Altonji-Elder-Taber with continuous explanatory variable

We estimate models (1) and (5) jointly, imposing the following structure on the unobservables

$$(\upsilon_i, \epsilon_i) \sim \Phi_2(0, 0, 1, 1, \rho), \tag{6}$$

where $\Phi_2(\cdot)$ denotes the bivariate normal distribution, and its arguments are the two errors' means, variances, and their correlation. In other words, we estimate probit models for all outcomes d_i with p_i as a normal endogenous explanatory variable [denoted probit eev hereafter].

The corresponding log-likelihood is given by

$$\ln L(d_i, p_i; x_i, \alpha, \beta^d, \beta^p, \rho) = \sum_{i=1}^{n} \ln \Phi \left[(2d_i - 1) \left(\frac{x_i'\beta^d + \alpha p_i + \rho(p_i - x_i'\beta^p)}{\sqrt{1-\rho^2}} \right) \right] + \ln \phi \left(p_i - x_i'\beta^p \right). \tag{7}$$

For more information, see the discussion in Greene (2012, p747f).

As in AET, we present results for the case when selection on unobservables is equal of the selection on observables, i.e. we estimate the model replacing

$$\rho = \frac{cov(x_i'\beta^d, x_i'\beta^p)}{var(x_i'\beta^d)} \equiv \hat{\rho}^o$$

as a suggestive upper bound.

A.2 Details for Dahl's selection correction

Given the youth questionnaire, we observe the subjective completion beliefs only for the intended post-secondary track. To correct for potentially selected beliefs p_{ij} where $j = 1, 2, 3$, we use Dahl's (2002) selection correction in the following way to obtain predicted beliefs for the non-intended tracks.

First we estimate a first-stage multinominal probit model for intentions $j = 0, 1, 2, 3$, using the subjective investment beliefs, p_i^{invest} (the probability of investing in the intended track, which is excluded from the other specifications), academic ability, personality, and family background. The latent intentions are specified as

$$\tilde{d}_{ij}^{want} = \tau_j^{fs} p_i^{invest} + x_i'\beta_j^{fs} + \upsilon_j^{fs} \text{ for } j = 0, 1, 2, 3,$$

where we used the superscript fs to denote the parameters and error of this first stage equation. Second, we then estimate a second-stage fractional probit quasi-likelihood regressions separately for each j using polynomial functions of the first-stage predicted intention probabilities:

$$p_{ij} = x_i'\beta_j^{ss} + \tau_{1j}^{ss}\hat{P}r(d_i^{want} = j) + \tau_{2j}^{ss}\hat{P}r(d_i^{want} = j)^2 + \tau_{3j}^{ss}\hat{P}r(d_i^{want} = j)^3 + \sum_{k \neq j} \tau_{kj}^{ss}\hat{P}r(d_i^{want} = j) \cdot \hat{P}r(d_i^{want} = k) + \upsilon_i^{ss},$$

with the superscript ss denoting the second-stage parameters and error. Finally, we use this second stage to predict for each student the $\hat{p}_{ij}$'s for each j, which are then used in the structural model.

A.3 Details for Emax in the normal model and error term structure

We use the following definitions from Section 4, where for simplicity we ignore i and t subscripts,

$$\begin{aligned} U_3 &= p_3\mu_3 + (1-p_3)\mu_3 + x'\beta_3 + \delta_3'\theta + \varepsilon_3 \equiv z_3 + \varepsilon_3 \ , \\ U_2 &= p_2\mu_2 + (1-p_2)\mu_2 + x'\beta_2 + \delta_2'\theta + \varepsilon_2 \equiv z_2 + \varepsilon_2, \end{aligned}$$

and we define $z_3 - z_2 \equiv \Delta_2$ and $\nu_2 \equiv \varepsilon_3 - \varepsilon_2$. When ε_3 and ε_2 are both iid normal we have that

$$\begin{pmatrix} \varepsilon_3 \\ \varepsilon_2 \\ \nu_2 \end{pmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & -1 \\ 1 & -1 & 2 \end{bmatrix} \right),$$

and

$$\begin{aligned} E(\varepsilon_3|\nu_2 > -\Delta_2) &= \frac{\sqrt{2}}{2} \cdot \frac{\phi(-\widetilde{\Delta}_2)}{1-\Phi(-\widetilde{\Delta}_2)} = \frac{\sqrt{2}}{2} \cdot \frac{\phi(\widetilde{\Delta}_2)}{\Phi(\widetilde{\Delta}_2)} \ , \\ E(\varepsilon_2|\nu_2 \leq \Delta_2) &= \frac{\sqrt{2}}{2} \cdot \frac{\phi(-\widetilde{\Delta}_2)}{\Phi(-\widetilde{\Delta}_2)} = \frac{\sqrt{2}}{2} \cdot \frac{\phi(\widetilde{\Delta}_2)}{1-\Phi(\widetilde{\Delta}_2)} \ , \end{aligned}$$

where $\widetilde{\Delta}_2 \equiv \dfrac{\Delta_2(p)}{\sqrt{2}}$. We can now write,

$$\begin{aligned} E(\max(U_3, z_2)) &= P(U_3 > z_2) \cdot E(U_3|z_3 > z_2) + P(U_3 \leq z_2) \cdot E(U_2|z_3 \leq z_2) \\ &= P(U_3 - U_2 > 0) \cdot (z_3 + E(\varepsilon_3|\nu_2 > -\Delta_2)) \\ &\quad + P(U_3 - U_2 \leq 0) \cdot (z_2 + E(\varepsilon_2|\nu_2 \leq -\Delta_2)) \\ &= \Phi(\widetilde{\Delta}_2) \cdot \big[z_3 + \frac{\sqrt{2}}{2} \cdot \frac{\phi(\widetilde{\Delta}_2)}{\Phi(\widetilde{\Delta}_2)}\big] + (1-\Phi(\widetilde{\Delta}_2)) \cdot \big[z_2 + \frac{\sqrt{2}}{2} \cdot \frac{\phi(\widetilde{\Delta}_2)}{1-\Phi(\widetilde{\Delta}_2)}\big] \\ &= \Phi(\widetilde{\Delta}_2) \cdot z_3 + \frac{\sqrt{2}}{2} \cdot \phi(\widetilde{\Delta}_2) + (1-\Phi(\widetilde{\Delta}_2)) \cdot z_2 + \frac{\sqrt{2}}{2} \cdot \phi(\widetilde{\Delta}_2) \\ &= z_2 + \Phi(\widetilde{\Delta}_2) \cdot (z_3 - z_2) + \sqrt{2} \cdot \phi(\widetilde{\Delta}_2) \\ &= z_2 + \Phi(\widetilde{\Delta}_2) \cdot \widetilde{\Delta}_2 \cdot \sqrt{2} + \sqrt{2} \cdot \phi(\widetilde{\Delta}_2) \\ &= z_2 + \sqrt{2} \cdot \big\{\Phi(\widetilde{\Delta}_2) \cdot \widetilde{\Delta}_2 + \cdot\phi(\widetilde{\Delta}_2)\big\} \end{aligned}$$

The variance-covariance structure of $(\varepsilon_3, \varepsilon_2, \nu_2)$ can be generalized, provided some regressors vary between stage 1 and stage 2 (French and Taber, 2011; Taber, 2000), as in the empirical model presented in Section 4: in this case, one can allow $V(\varepsilon_2) = V(\varepsilon) = \tilde{\sigma}^2$, so that the new covariance matrix is

$$\begin{pmatrix} \varepsilon_3 \\ \varepsilon_2 \\ \nu_2 \end{pmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}, \ \tilde{\sigma}^2 \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & -1 \\ 1 & -1 & 2 \end{bmatrix} \right),$$

In Section 4, we parametrize $\sigma^2 = 2\tilde{\sigma}^2$. While the correlation between utilities stemming from the ε's is quite rigid, the inclusion of $\delta_j\theta$ in z_j makes it possible to estimate the variance-covariance structure freely.

B Data

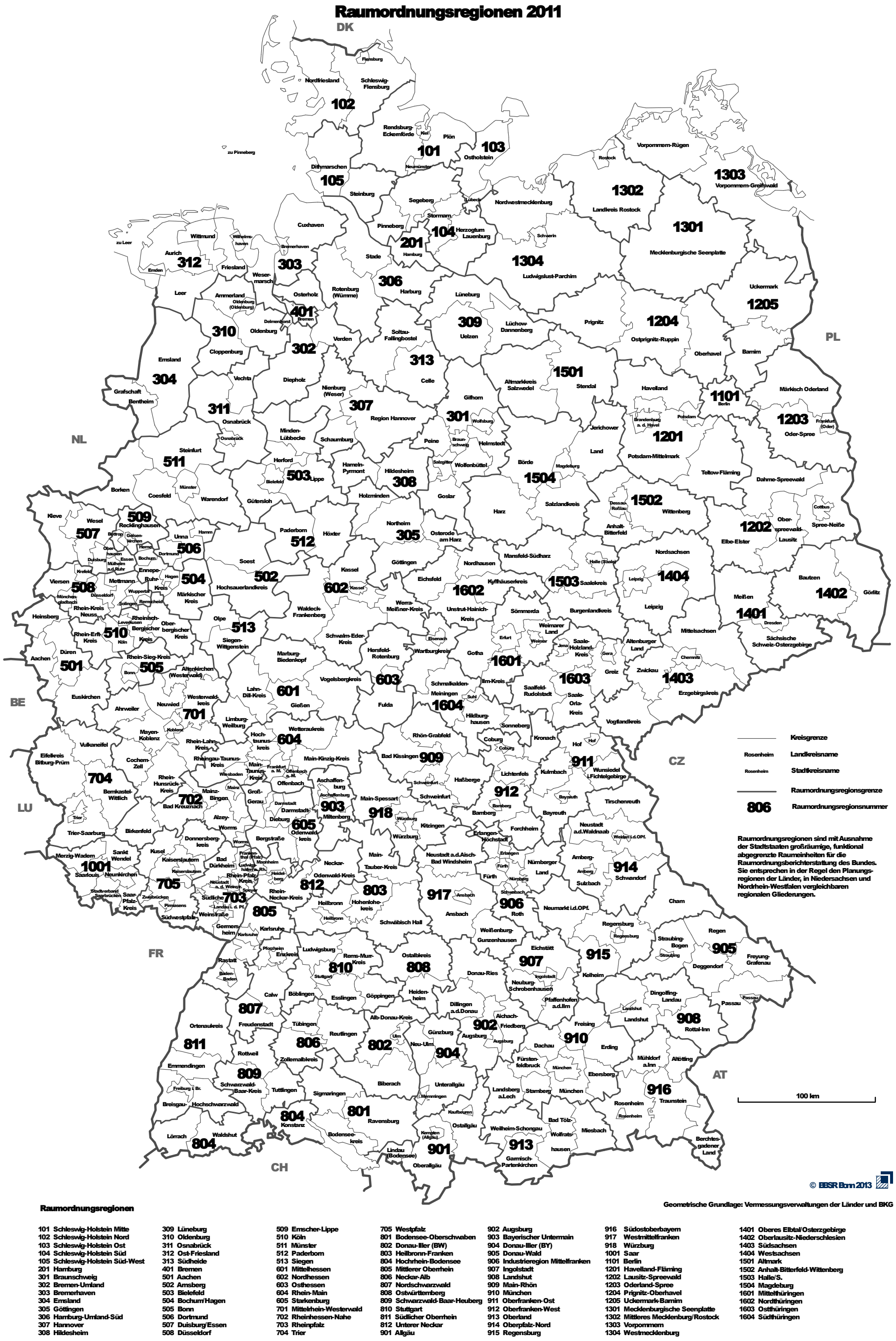

Figure B1: LOCAL LABOR MARKETS, 96 RAUMORDNUNGREGIONEN [ROR]
Source: BBSR (2013)

Table B1: Descriptive statistics by intentions to invest in post-secondary education

Variables	By intended investment level 0	1	2	3	Total
p	0.692	0.768	0.782	0.805	0.776
	(0.258)	(0.220)	(0.176)	(0.155)	(0.198)
Academic variables					
GPA (std)	-0.269	-0.288	-0.000	0.404	0.000
	(1.035)	(0.919)	(0.902)	(1.007)	(1.000)
Rec: Lowest Track (yes/no)	0.166	0.265	0.044	0.034	0.132
	(0.373)	(0.441)	(0.204)	(0.181)	(0.338)
Rec: Intermediate Track (yes/no)	0.248	0.351	0.271	0.150	0.259
	(0.432)	(0.477)	(0.445)	(0.358)	(0.438)
Rec: High school (yes/no)	0.284	0.092	0.524	0.698	0.402
	(0.452)	(0.289)	(0.500)	(0.459)	(0.490)
In high school (yes/no)	0.272	0.015	0.596	0.767	0.411
	(0.446)	(0.123)	(0.491)	(0.423)	(0.492)
Personality variables					
Locus of control (std)	-0.183	-0.155	0.028	0.209	0.000
	(1.066)	(0.961)	(0.911)	(0.894)	(0.952)
Risk attitudes (std)	-0.053	-0.012	-0.035	0.054	0.000
	(0.983)	(0.986)	(0.935)	(0.929)	(0.957)
Openness (std)	-0.180	-0.136	0.048	0.171	0.000
	(1.012)	(0.957)	(0.879)	(0.928)	(0.946)
Agreeableness (std)	-0.110	-0.049	0.067	0.039	-0.000
	(0.929)	(0.991)	(0.909)	(0.922)	(0.947)
Extraversion (std)	-0.127	-0.050	0.021	0.079	0.000
	(0.954)	(0.915)	(0.919)	(0.991)	(0.946)
Neuroticism (std)	0.068	0.010	0.052	-0.068	-0.000
	(0.960)	(0.925)	(0.886)	(1.003)	(0.946)
Conscientiousness (std)	-0.145	0.051	-0.059	0.026	0.000
	(0.985)	(0.943)	(0.915)	(0.954)	(0.946)
Family background variables					
Female (yes/no)	0.486	0.454	0.541	0.539	0.504
	(0.501)	(0.498)	(0.499)	(0.499)	(0.500)
No. siblings	1.613	1.710	1.433	1.496	1.570
	(1.461)	(1.494)	(1.206)	(1.099)	(1.316)
Second-generation migrant (yes/no)	0.746	0.680	0.574	0.557	0.623
	(0.436)	(0.466)	(0.495)	(0.497)	(0.485)
Parent college-educated (yes/no)	0.199	0.101	0.306	0.495	0.283
	(0.400)	(0.301)	(0.461)	(0.500)	(0.450)
Parent cur. unemployed (yes/no)	0.124	0.160	0.087	0.045	0.103
	(0.330)	(0.367)	(0.282)	(0.208)	(0.304)
Log. net household income	10.019	9.890	10.624	10.855	10.377
	(2.231)	(2.216)	(1.358)	(1.295)	(1.834)
Local labor market variables					
Cyclical youth unemployment (in Ror)	0.154	0.101	0.043	0.041	0.074
	(1.079)	(1.044)	(0.982)	(1.020)	(1.026)
No. of apprenticeship positions (in Ror)	98.380	98.544	98.538	99.368	98.791
	(4.906)	(5.261)	(5.600)	(5.124)	(5.279)
No. of students (in Ror)	23.700	22.711	24.156	25.730	24.095
	(14.204)	(14.354)	(13.991)	(14.091)	(14.223)
No. of high school graduates (in Ror)	26.081	25.755	27.289	27.758	26.775
	(6.313)	(6.526)	(6.218)	(7.064)	(6.673)
No. of Universities (in Ror)	10.789	9.620	10.916	11.381	10.585
	(10.304)	(9.666)	(10.037)	(9.988)	(9.938)
N	331(9.17%)	1'302(36.07%)	826(22.88%)	1'151(31.88%)	3'610

Notes: Cells contain sample means and standard deviations in parentheses. Intended investment levels in post-secondary education: no intention (0), apprenticeship (1), tertiary apprenticeship (2), or university (3). Individual characteristics are assessed at the time of answering the youth questionnaire (at age 17); p denotes the subjective completion belief; definitions of other variables are given in Appendix, Table B1.
Source: SOEP 2000-2013 (v30), INKAR 2012, own calculations.

Table B2: Descriptive statistics by subsample

	(A)	(B)	(B')	(C)	(C')
p	0.776 (0.198)	0.772 (0.201)	0.781 (0.192)	0.769 (0.197)	0.778 (0.190)
GPA (std)	0.000 (1.000)	-0.018 (1.019)	0.012 (1.009)	0.041 (1.024)	0.077 (1.016)
Rec: Lowest Track (yes/no)	0.132 (0.338)	0.135 (0.342)	0.134 (0.341)	0.109 (0.311)	0.106 (0.308)
Rec: Intermediate Track (yes/no)	0.259 (0.438)	0.272 (0.445)	0.270 (0.444)	0.247 (0.431)	0.249 (0.433)
Rec: High school (yes/no)	0.402 (0.490)	0.347 (0.476)	0.360 (0.480)	0.384 (0.487)	0.400 (0.490)
In high school (yes/no)	0.411 (0.492)	0.359 (0.480)	0.371 (0.483)	0.415 (0.493)	0.432 (0.496)
Locus of control (std)	0.000 (0.952)	0.028 (0.934)	0.046 (0.920)	0.055 (0.915)	0.063 (0.907)
Risk attitudes (std)	0.000 (0.957)	-0.088 (0.997)	-0.087 (0.995)	-0.153 (0.975)	-0.149 (0.976)
Openness (std)	0.000 (0.946)	-0.014 (0.978)	0.010 (0.971)	0.001 (1.014)	0.027 (1.014)
Agreeableness (std)	-0.000 (0.947)	-0.007 (0.986)	0.006 (0.982)	-0.011 (0.995)	0.006 (1.002)
Extraversion (std)	0.000 (0.946)	-0.009 (0.953)	0.009 (0.949)	-0.002 (0.963)	0.023 (0.964)
Neuroticism (std)	-0.000 (0.946)	-0.015 (0.979)	-0.030 (0.974)	-0.027 (1.019)	-0.046 (1.021)
Conscientiousness (std)	0.000 (0.946)	0.112 (0.952)	0.132 (0.945)	0.176 (0.961)	0.194 (0.954)
Female (yes/no)	0.504 (0.500)	0.506 (0.500)	0.508 (0.500)	0.496 (0.500)	0.499 (0.500)
Nr. siblings	1.570 (1.316)	1.639 (1.339)	1.630 (1.323)	1.633 (1.335)	1.622 (1.322)
Second-generation migrant (yes/no)	0.623 (0.485)	0.739 (0.439)	0.731 (0.443)	0.843 (0.364)	0.840 (0.367)
Parent college-educated (yes/no)	0.283 (0.450)	0.259 (0.438)	0.267 (0.443)	0.292 (0.455)	0.304 (0.460)
Parent cur. unemployed (yes/no)	0.103 (0.304)	0.124 (0.329)	0.120 (0.325)	0.130 (0.336)	0.129 (0.335)
Log. net household income	10.377 (1.834)	10.341 (1.800)	10.368 (1.773)	10.374 (1.822)	10.391 (1.804)
Cyclical youth unemployment (in Ror)	0.074 (1.026)	0.211 (1.034)	0.211 (1.035)	0.267 (1.083)	0.260 (1.082)
Nr. of apprenticeship positions (in Ror)	98.791 (5.279)	97.920 (4.988)	97.886 (5.039)	97.447 (5.034)	97.362 (5.067)
Nr. of students (in Ror)	24.095 (14.223)	22.952 (13.594)	23.018 (13.511)	22.395 (13.492)	22.572 (13.517)
Nr. of high school graduates (in Ror)	26.775 (6.673)	25.137 (5.514)	25.188 (5.520)	24.491 (5.155)	24.582 (5.158)
Nr. of Universities (in Ror)	10.585 (9.938)	10.333 (9.850)	10.321 (9.849)	10.208 (9.651)	10.225 (9.637)
N	3'610	2'116	1'919	1'372	1'255

Note: Table presents sample means and standard deviations in brackets in total and by subsample considered in Table 2, and C2 which shows the results of Table 2 conditional on intentions. The Column names, i.e. (A), refer to the respective panels in these Tables.
Source: SOEP 2000-2013 (v30), INKAR 2012, own calculations.

Table B3: Variable definitions

Variables	Description	Age	Missings
Core variables	*Missing values in the core variables are dropped from the estimation sample.*		
p	Subjective completion belief is a elicited measure, it ranges from 0 to 1, in 0.1 steps. The exact wording in German is: *Wenn Sie sich einmal Ihre berufliche und private Zukunft vorstellen: Wie wahrscheinlich ist es, dass die folgenden Entwicklungen eintreten werden?* [Stufen Sie bitte jeweils die Wahrscheinlichkeit auf einer Skala ein, die von 0 Prozent bis 100 Prozent geht.] *Ihre Ausbildung oder Ihr Studium erfolgreich abschließen?*	17	52
GPA (std)	Average of German and Math grades, standardized over the sample population, as a robustness check we additionally standardize within educational track (cf. Table C5).	17	43
Educational outcomes:	From the longitudinal information we assess whether the student has started/completed a respective educational track.	17-31	
$d \in \{0, 1, 2, 3\}$	Intentions/Start/Complete, disaggregated by the tracks: drop out, apprenticeship, tertiary apprenticeship (high school and apprenticeship), and university (includes all higher learning institutions).		
$d_1 \in \{0, 1, 2\}$	First stage in structural model: drop out, apprenticeship, and high school.		
$d_2 \in \{0, 1\}$	Second stage in structural model: tertiary apprenticeship and university.		
Start apprenticeship	Not used in the analysis, all individuals that stared before are dropped from the estimation sample.	17	487
Still in school	Used in intention regressions, but dropped in the investment/completion analysis.	17	1’420
Academic variables			
Recommendations:	To visit a secondary-school track teachers evaluate the students (age the age of 10), the base category is no recommendation, three indicators for Lowest Track (yes/no), Intermediate Track (yes/no), and High school (yes/no)	17	249
In high school (yes/no)	An indicator whether the student is currently in high school when answering the youth questionnaire.	17	105
Personality variables	*We standardize the personality variables to mean 0 and standard deviation 1.*		
Locus of control (std)	First principal component of 10 questions, of which three are reversed. Change in questionnaire adjusted as in Piatek and Pinger (2015).	17	337
Risk attitudes (std)	Assessed by a single question, ranging from 1-10.	17	306
Openness (std)	First principal component of 3 questions.	17	381
Agreeableness (std)	First principal component of 3 questions, of which one is reversed.	17	375
Extraversion (std)	First principal component of 3 questions, of which one is reversed.	17	378
Neuroticism (std)	First principal component of 3 questions, of which one is reversed.	17	378
Conscientiousness (std)	First principal component of 3 questions, of which one is reversed.	17	381
Individual and family characteristics	*Parental information, based on parents’ questionnaires, are merged with the children’s information.*		
Female (yes/no)	An indicator whether the individual is female.	17	

Nr. of siblings	Count of the number of siblings.	17	179
Second-generation migrant (yes/no)	An indicator whether the individual's parents are born in a foreign country, if information is missing recoded as second-generation migrant.	17	2'029
Parent college-educated (yes/no)	An indicator whether the individual has at least one college educated parent.	17	43
Parent cur. unemployed (yes/no)	An indicator whether the individual has at least one currently unemployed parent.	17	152
Log. net household income	Log of household pre-governmental income imputed by SOEP (0 income is treated as missing)	17	70
Fixed effects			
Year	Year of answering youth questionnaire, which is roughly identical to year of birth	17	
Region	Five regions based on federal states which are the level of educational-jurisdiction. For some of the regressions, the number of students in a state is too small. To obtain consistent samples, we use a broader grouping by dividing Germany into the following five regions (and an indicator for missing values). *Southern Germany*: Baden-Wuerttemberg, Bavaria; *Eastern Germany*: Berlin, Brandenburg, Saxony, Saxony-Anhalt, Mecklenburg-Western Pomerania; *Central Germany*: Hesse, Thuringia; *Western Germany*: North Rhine-Westphalia, Rhineland-Palatinate, Saarland; *Northern Germany*: Bremen, Hamburg, Lower Saxony, Schleswig-Holstein.	17	109
Regional labor market information	*Information from INKAR 2012/Statistical agency, merged onto the students residence with 17 and lagged by one year. Some are twice assessed for the estimation of the structural model, based on residence with 17 to avoid endogeneity due to moving (there are no missings as the location is always known at 179.*		
Cyclical youth unemployment	Cyclical component of local youth unemployment, extracted by HP-filter.	16/18	
Nr. of apprenticeship positions	Number of apprenticeship positions by all potential apprentices times 100.	16/18	
Nr. of students	Number of students enrolled in higher learning institutions by all residents in the age group times 1000.	16/18	
Nr. of high school graduates	Number of students with a high school degree in the region over all school-leavers times 1000.	16/18	
Nr. of universities	Count of higher learning institutions in the Ror, due to minimal variation over time we keep it constant.	16	

Note: Table presents variable descriptions and missing values for the baseline sample. All available individuals add up to 4'745, which then reduce to 40. The remaining missings are conditional on the estimation sample. All variables besides core variables are included in the estimation along with missing value indicators. More information on the regional indicators can be found under `http://www.inkar.de`

C Additional results

Table C1: Determinants of subjective completion beliefs, fractional response regressions

Dependent variable: Subjective completion belief with unconditional mean 0.776 and standard deviation 0.198				
	(1)	(2)	(3)	(4)
GPA (std)	0.037	0.029	0.029	0.029
	(0.003)	(0.003)	(0.003)	(0.003)
Rec: Lowest Track (yes/no)	0.026	0.024	0.026	0.026
	(0.013)	(0.013)	(0.013)	(0.013)
Rec: Intermediate Track (yes/no)	0.060	0.054	0.052	0.051
	(0.010)	(0.010)	(0.010)	(0.010)
Rec: High school (yes/no)	0.049	0.040	0.036	0.036
	(0.010)	(0.010)	(0.010)	(0.010)
In high school (yes/no)	0.003	0.001	-0.006	-0.006
	(0.008)	(0.008)	(0.008)	(0.008)
Locus of control (std)		0.024	0.023	0.023
		(0.004)	(0.004)	(0.004)
Risk attitudes (std)		0.005	0.004	0.004
		(0.004)	(0.004)	(0.004)
Openness (std)		0.005	0.004	0.004
		(0.004)	(0.004)	(0.004)
Agreeableness (std)		0.006	0.007	0.007
		(0.004)	(0.004)	(0.004)
Extraversion (std)		0.016	0.017	0.017
		(0.004)	(0.004)	(0.004)
Neuroticism (std)		-0.002	-0.000	-0.000
		(0.004)	(0.004)	(0.004)
Conscientiousness (std)		0.031	0.032	0.033
		(0.004)	(0.004)	(0.004)
Female (yes/no)			-0.010	-0.009
			(0.007)	(0.007)
Nr. siblings			-0.003	-0.003
			(0.002)	(0.002)
Second-generation migrant (yes/no)			-0.008	-0.008
			(0.013)	(0.013)
Parent college-educated (yes/no)			0.009	0.008
			(0.007)	(0.007)
Parent cur. unemployed (yes/no)			0.003	0.003
			(0.012)	(0.012)
Log. net household income			0.006	0.006
			(0.002)	(0.002)
N	3'610	3'610	3'610	3'610
R_n^2	0.065	0.128	0.134	0.134
Fixed effects	✓	✓	✓	✓
Academic	✓	✓	✓	✓
F (p-value)	185.410 (0.000)	115.637 (0.000)	102.904 (0.000)	102.956 (0.000)
Personality		✓	✓	✓
F (p-value)		218.885 (0.000)	216.912 (0.000)	218.254 (0.000)
Family Background			✓	✓
F (p-value)			17.503 (0.014)	16.847 (0.018)
Labor market				✓
F (p-value)				1.819 (0.874)

Note: The Table presents Bernoulli pseudo-maximum likelihood with probit conditional expectation function, as proposed by Papke and Wooldridge (1996, 2008). We report marginal effects and robust standard errors in round brackets, our goodness of fit measure is a nonlinear R-squared measure and is calculated as the squared correlation coefficient between the estimated conditional expectation and the observed subjective beliefs: $R_n^2 = corr(\hat{p}, p)^2$, where $\hat{p} = \Phi(x'\hat{\beta})$ due to the probit specification. The regressions of subjective beliefs are presented on varying sets of covariates, in (1) only on academic region and time fixed effects (coefficients not presented), (2) adds personality, (3) family background and individual characteristics, and (4) local labor market characteristics. We present the unconditional mean $\bar{p}$ and standard deviation $SD(p)$ of the dependent variable.
Source: SOEP 2000-2013 (v30), INKAR 2012, own calculations.

Table C2: Robustness: Conditional on intentions and subjective investment beliefs

Dependent variable: Indicator variables for actual investment, and completion.							
	probit				probit eev		
					$\rho = \hat{\rho}^o$	$\rho = .1$	$\rho = .3$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(B') Actual investment, conditional on intentions							
p	0.901	0.845	0.814	0.713	0.702	0.609	0.380
	(0.256)	(0.262)	(0.268)	(0.275)	(0.275)	(0.274)	(0.262)
	[0.058]	[0.053]	[0.048]	[0.032]			
R^2_n	0.085	0.095	0.111	0.201			
$R^2_n(p)$	0.104	0.111	0.124	0.210			
Sample: $N = 1'919$, $\bar{d} = 0.96$, $\bar{p} = 0.78$, $SD(p) = 0.19$, $\hat{\rho}^o = 0.010$							
(B") Actual investment, conditional on investment beliefs							
p	0.997	0.915	0.902	0.862	0.610	0.553	0.326
	(0.223)	(0.228)	(0.239)	(0.249)	(0.296)	(0.295)	(0.283)
	[0.069]	[0.062]	[0.056]	[0.044]			
R^2_n	0.087	0.100	0.120	0.182			
$R^2_n(p)$	0.113	0.121	0.138	0.197			
Sample: $N = 2'116$, $\bar{d} = 0.96$, $\bar{p} = 0.77$, $SD(p) = 0.20$, $\hat{\rho}^o = 0.045$							
(C') Actual completion, conditional on intentions							
p	0.467	0.478	0.466	0.456	0.457	0.353	0.135
	(0.198)	(0.202)	(0.208)	(0.211)	(0.211)	(0.210)	(0.201)
	[0.185]	[0.189]	[0.185]	[0.180]			
R^2_n	0.095	0.098	0.106	0.125			
$R^2_n(p)$	0.099	0.101	0.109	0.128			
Sample: $N = 1'244$, $\bar{d} = 0.55$, $\bar{p} = 0.78$, $SD(p) = 0.19$, $\hat{\rho}^o(se) = -0.001$							
(C") Actual completion, conditional on investment beliefs							
p	0.434	0.410	0.387	0.373	0.194	0.113	-0.096
	(0.181)	(0.185)	(0.190)	(0.192)	(0.211)	(0.210)	(0.201)
	[0.172]	[0.162]	[0.147]	[0.140]			
R^2_n	0.089	0.093	0.102	0.121			
$R^2_n(p)$	0.092	0.096	0.104	0.123			
Sample: $N = 1'372$, $\bar{d} = 0.54$, $\bar{p} = 0.77$, $SD(p) = 0.20$, $\hat{\rho}^o = 0.019$							
Fixed effects	✓	✓	✓	✓	✓	✓	✓
Academic		✓	✓	✓	✓	✓	✓
Personality			✓	✓	✓	✓	✓
Family Background				✓	✓	✓	✓
Labor market				✓	✓	✓	✓

Note: Table presents robustness from the main results in Table 3, as in presents coefficients (robust standard errors in round and average marginal effects in squared brackets), from probit (1)-(4) and probit endogenous explanatory variable (5)-(8) regressions of varying educational outcomes on subjective completion beliefs and varying sets of covariate, in (1) on in high school, region and time fixed effects, (2) adds academic, (3) adds personality, (4) to (8) family background, individual, and local labor market characteristics. We present the regressions, restricting the sample to those with positive intentions in Panel B' and C'. Alternatively, we include the subjective investment probability as an additional covariate in all regressions of Panel B" and C"

Source: SOEP 2000-2013 (v30), INKAR 2012, own calculations.

Table C3: Robustness: dichotomizing subjective beliefs ($p \geq 0.70$)

Dependent variable: Indicator variables for educational intentions, actual investment, and completion.								
	probit				bivariate probit			
					$\rho = .05$	$\rho = .1$	$\rho = .2$	$\rho = .3$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(A) Intentions								
p	0.381	0.321	0.276	0.266	0.181	0.095	-0.075	-0.243
	(0.066)	(0.069)	(0.070)	(0.070)	(0.070)	(0.070)	(0.069)	(0.068)
	[0.068]	[0.055]	[0.046]	[0.044]				
R_n^2	0.029	0.040	0.048	0.057				
$R_n^2(p)$	0.043	0.049	0.055	0.063				
Sample: $N = 3'610$, $\bar{d} = 0.91$, $\bar{p} = 0.79$, $SD(p) = 0.41$								
(B) Actual investment								
p	0.491	0.453	0.439	0.431	0.345	0.259	0.088	-0.083
	(0.108)	(0.111)	(0.113)	(0.119)	(0.118)	(0.118)	(0.116)	(0.114)
	[0.045]	[0.039]	[0.035]	[0.029]				
R_n^2	0.087	0.100	0.120	0.182				
$R_n^2(p)$	0.112	0.120	0.137	0.197				
Sample: $N = 2'116$, $\bar{d} = 0.96$, $\bar{p} = 0.79$, $SD(p) = 0.41$								
(B') Actual investment, conditional on intentions								
p	0.476	0.453	0.441	0.440	0.353	0.266	0.094	-0.077
	(0.120)	(0.122)	(0.123)	(0.129)	(0.129)	(0.128)	(0.127)	(0.124)
	[0.040]	[0.037]	[0.034]	[0.025]				
R_n^2	0.085	0.095	0.111	0.201				
$R_n^2(p)$	0.108	0.114	0.128	0.216				
Sample: $N = 1'919$, $\bar{d} = 0.96$, $\bar{p} = 0.81$, $SD(p) = 0.40$								
(C) Actual completion								
p	0.236	0.225	0.219	0.217	0.130	0.043	-0.132	-0.307
	(0.089)	(0.091)	(0.093)	(0.094)	(0.094)	(0.094)	(0.093)	(0.091)
	[0.094]	[0.089]	[0.087]	[0.086]				
R_n^2	0.089	0.093	0.102	0.121				
$R_n^2(p)$	0.093	0.097	0.105	0.124				
Sample: $N = 1'372$, $\bar{d} = 0.54$, $\bar{p} = 0.79$, $SD(p) = 0.41$								
(C') Actual completion, conditional on intentions								
p	0.266	0.271	0.273	0.269	0.181	0.093	-0.083	-0.261
	(0.097)	(0.099)	(0.101)	(0.102)	(0.102)	(0.101)	(0.100)	(0.099)
	[0.106]	[0.108]	[0.108]	[0.107]				
R_n^2	0.095	0.098	0.106	0.125				
$R_n^2(p)$	0.100	0.103	0.111	0.129				
Sample: $N = 1'244$, $\bar{d} = 0.55$, $\bar{p} = 0.81$, $SD(p) = 0.39$								
Fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Academic		✓	✓	✓	✓	✓	✓	✓
Personality			✓	✓	✓	✓	✓	✓
Family Background				✓	✓	✓	✓	✓
Labor market				✓	✓	✓	✓	✓

Note: Table presents robustness of the main Table 3, where instead of the continuous p we use a dummy for $p \leq 70$. The Table is analogous to Table 3. In the bivariate probit regressions we restrict the correlation between the errors to be 0.05, 0.1, 0.2, 0.3.
Source: SOEP 2000-2013 (v30), INKAR 2012, own calculations.

Table C4: Robustness: separate regressions by high school attendance

Dependent variable: Indicator variables for educational intentions, actual investment, and completion.								
	Not in high school				In high school			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(A) Intentions								
p	0.989	0.880	0.789	0.788	0.655	0.446	0.425	0.454
	(0.160)	(0.164)	(0.167)	(0.168)	(0.303)	(0.311)	(0.329)	(0.338)
	[0.179]	[0.158]	[0.140]	[0.137]	[0.071]	[0.048]	[0.043]	[0.043]
R_n^2	0.015	0.030	0.043	0.050	0.030	0.042	0.061	0.088
$R_n^2(p)$	0.043	0.051	0.058	0.066	0.036	0.044	0.063	0.090
N	2'125	2'125	2'125	2'125	1'485	1476	1476	1476
(B) Actual investment								
p	1.018	0.993	0.978	0.975	1.122	0.557	0.006	-0.679
	(0.241)	(0.249)	(0.259)	(0.277)	(0.622)	(0.605)	(0.711)	(0.872)
	[0.097]	[0.092]	[0.085]	[0.068]	[0.036]	[0.010]	[0.000]	[0.000]
R_n^2	0.065	0.080	0.102	0.181	0.078	0.187	0.322	0.439
$R_n^2(p)$	0.095	0.106	0.126	0.202	0.099	0.191	0.322	0.441
N	1'356	1'356	1'356	1'356	584	582	582	582
(B') Actual investment, conditional on intentions								
p	0.943	0.979	0.928	0.877	0.710	0.088	-0.678	-3.016
	(0.277)	(0.285)	(0.285)	(0.310)	(0.653)	(0.651)	(0.835)	(1.212)
	[0.080]	[0.080]	[0.071]	[0.043]	[0.024]	[0.002]	[-0.002]	[0.000]
R_n^2	0.078	0.090	0.113	0.244	0.071	0.183	0.324	0.475
$R_n^2(p)$	0.100	0.113	0.131	0.257	0.078	0.183	0.327	0.496
N	1'207	1'207	1'207	1'207	546	544	544	544
(C) Actual completion								
p	0.534	0.501	0.427	0.389	0.247	0.193	0.376	0.399
	(0.212)	(0.215)	(0.219)	(0.224)	(0.347)	(0.359)	(0.389)	(0.399)
	[0.203]	[0.190]	[0.162]	[0.147]	[0.097]	[0.076]	[0.147]	[0.153]
R_n^2	0.053	0.062	0.071	0.102	0.115	0.120	0.145	0.170
$R_n^2(p)$	0.059	0.067	0.074	0.104	0.116	0.120	0.146	0.172
N	802	802	802	802	570	570	570	570
(C') Actual completion, conditional on intentions								
p	0.487	0.500	0.442	0.417	0.460	0.411	0.586	0.629
	(0.237)	(0.241)	(0.246)	(0.252)	(0.362)	(0.374)	(0.402)	(0.413)
	[0.183]	[0.187]	[0.165]	[0.155]	[0.180]	[0.161]	[0.229]	[0.240]
R_n^2	0.059	0.067	0.075	0.104	0.110	0.114	0.134	0.160
$R_n^2(p)$	0.063	0.072	0.078	0.107	0.112	0.115	0.137	0.163
N	709	709	709	709	535	535	535	535
FE	✓	✓	✓	✓	✓	✓	✓	✓
Academic		✓	✓	✓		✓	✓	✓
Personality			✓	✓			✓	✓
Family Background				✓				✓
Labor market				✓				✓

Note: Table presents coefficients (robust standard errors in round and average marginal effects in squared brackets), from probit (1)-(4) and probit endogenous explanatory variable (5)-(8) regressions of varying educational outcomes on subjective completion beliefs and varying sets of covariate, in (1) on in high school, region and time fixed effects, (2) adds academic, (3) adds personality, (4) to (8) family background, individual, and local labor market characteristics.
Source: SOEP 2000-2013 (v30), INKAR 2012, own calculations.

Table C5: Robustness: GPA standardized within high school and using federal states fixed effects

Dependent variable: Indicator variables for educational intentions, actual investment, and completion.								
	Federal states, Fixed effects				GPA, std by federal states			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(A) Intentions								
p	0.928	0.817	0.723	0.710	0.921	0.811	0.718	0.706
	(0.142)	(0.146)	(0.149)	(0.150)	(0.142)	(0.146)	(0.149)	(0.151)
	[0.141]	[0.123]	[0.108]	[0.104]	[0.140]	[0.122]	[0.107]	[0.103]
R_n^2	0.027	0.038	0.047	0.055	0.029	0.040	0.048	0.056
$R_n^2(p)$	0.048	0.054	0.058	0.066	0.049	0.055	0.059	0.067
Sample: $N = 3'610$, $\bar{d} = 0.91$, $\bar{p} = 0.78$, $SD(p) = 0.20$								
(B) Actual investment								
p	1.033	0.959	0.941	0.882	0.997	0.923	0.910	0.862
	(0.224)	(0.229)	(0.242)	(0.253)	(0.223)	(0.228)	(0.239)	(0.249)
	[0.071]	[0.064]	[0.058]	[0.045]	[0.069]	[0.062]	[0.057]	[0.044]
R_n^2	0.089	0.102	0.121	0.179	0.087	0.100	0.120	0.182
$R_n^2(p)$	0.117	0.124	0.141	0.195	0.113	0.121	0.138	0.197
Sample: $N = 2'116$, $\bar{d} = 0.96$, $\bar{p} = 0.77$, $SD(p) = 0.20$								
(B') Actual investment, conditional on intentions								
p	0.924	0.877	0.839	0.713	0.901	0.858	0.825	0.716
	(0.255)	(0.263)	(0.270)	(0.278)	(0.256)	(0.261)	(0.267)	(0.274)
	[0.058]	[0.054]	[0.048]	[0.032]	[0.058]	[0.054]	[0.048]	[0.032]
R_n^2	0.089	0.098	0.114	0.200	0.085	0.095	0.110	0.201
$R_n^2(p)$	0.108	0.115	0.128	0.209	0.104	0.110	0.124	0.210
Sample: $N = 1'919$, $\bar{d} = 0.96$, $\bar{p} = 0.78$, $SD(p) = 0.19$								
(C) Actual completion								
p	0.408	0.378	0.363	0.350	0.434	0.412	0.390	0.377
	(0.180)	(0.184)	(0.189)	(0.191)	(0.181)	(0.185)	(0.190)	(0.192)
	[0.162]	[0.150]	[0.144]	[0.139]	[0.172]	[0.163]	[0.155]	[0.150]
R_n^2	0.078	0.082	0.091	0.110	0.089	0.093	0.102	0.121
$R_n^2(p)$	0.081	0.085	0.093	0.112	0.092	0.096	0.104	0.123
Sample: $N = 1'372$, $\bar{d} = 0.54$, $\bar{p} = 0.77$, $SD(p) = 0.20$								
(C') Actual completion, conditional on intentions								
p	0.454	0.455	0.456	0.443	0.467	0.479	0.468	0.458
	(0.197)	(0.200)	(0.206)	(0.210)	(0.198)	(0.202)	(0.208)	(0.211)
	[0.180]	[0.180]	[0.180]	[0.175]	[0.185]	[0.190]	[0.185]	[0.181]
R_n^2	0.084	0.087	0.095	0.114	0.095	0.098	0.106	0.125
$R_n^2(p)$	0.088	0.090	0.098	0.117	0.099	0.101	0.109	0.128
Sample: $N = 1'244$, $\bar{d} = 0.55$, $\bar{p} = 0.78$, $SD(p) = 0.19$								
Fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Academic		✓	✓	✓		✓	✓	✓
Personality			✓	✓			✓	✓
Family Background				✓				✓
Labor market				✓				✓

Note: Table presents coefficients (robust standard errors in round and average marginal effects in squared brackets), from probit (1)-(4) and probit endogenous explanatory variable (5)-(8) regressions of varying educational outcomes on subjective completion beliefs and varying sets of covariate, in (1) on in high school, region and time fixed effects, (2) adds academic, (3) adds personality, (4) to (8) family background, individual, and local labor market characteristics.
Source: SOEP 2000-2013 (v30), INKAR 2012, own calculations.

Table C6: Robustness: GPA standardized within federal states and including a fifth order polynomial in GPA

Dependent variable: Indicator variables for educational intentions, actual investment, and completion.								
	GPA, std by high school attendance				GPA, polynomial			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(A) Intentions								
p	0.921	0.810	0.717	0.704	0.921	0.807	0.715	0.704
	(0.142)	(0.146)	(0.149)	(0.151)	(0.142)	(0.146)	(0.150)	(0.151)
	[0.140]	[0.122]	[0.107]	[0.103]	[0.140]	[0.121]	[0.106]	[0.103]
R^2_n	0.029	0.040	0.048	0.056	0.029	0.041	0.049	0.058
$R^2_n(p)$	0.049	0.055	0.059	0.067	0.049	0.056	0.060	0.068
Sample: $N = 3'610$, $\bar{d} = 0.91$, $\bar{p} = 0.78$, $SD(p) = 0.20$								
(B) Actual investment								
p	0.997	0.918	0.905	0.866	0.997	0.889	0.877	0.832
	(0.223)	(0.228)	(0.240)	(0.249)	(0.223)	(0.227)	(0.239)	(0.250)
	[0.069]	[0.062]	[0.057]	[0.044]	[0.069]	[0.057]	[0.052]	[0.040]
R^2_n	0.087	0.100	0.120	0.182	0.087	0.109	0.129	0.191
$R^2_n(p)$	0.113	0.121	0.138	0.197	0.113	0.128	0.146	0.205
Sample: $N = 2'116$, $\bar{d} = 0.96$, $\bar{p} = 0.77$, $SD(p) = 0.20$								
(B') Actual investment, conditional on intentions								
p	0.901	0.849	0.818	0.717	0.901	0.838	0.810	0.703
	(0.256)	(0.262)	(0.268)	(0.275)	(0.256)	(0.263)	(0.270)	(0.280)
	[0.058]	[0.053]	[0.048]	[0.032]	[0.058]	[0.050]	[0.045]	[0.030]
R^2_n	0.085	0.095	0.110	0.201	0.085	0.102	0.119	0.208
$R^2_n(p)$	0.104	0.110	0.124	0.210	0.104	0.117	0.132	0.216
Sample: $N = 1'919$, $\bar{d} = 0.96$, $\bar{p} = 0.78$, $SD(p) = 0.19$								
(C) Actual completion								
p	0.434	0.410	0.387	0.373	0.434	0.421	0.403	0.392
	(0.181)	(0.184)	(0.190)	(0.192)	(0.181)	(0.185)	(0.191)	(0.193)
	[0.172]	[0.162]	[0.153]	[0.148]	[0.172]	[0.167]	[0.160]	[0.155]
R^2_n	0.089	0.093	0.102	0.121	0.089	0.097	0.105	0.125
$R^2_n(p)$	0.092	0.096	0.104	0.123	0.092	0.099	0.108	0.127
Sample: $N = 1'372$, $\bar{d} = 0.54$, $\bar{p} = 0.77$, $SD(p) = 0.20$								
(C') Actual completion, conditional on intentions								
p	0.467	0.479	0.467	0.456	0.467	0.498	0.488	0.476
	(0.198)	(0.202)	(0.208)	(0.211)	(0.198)	(0.203)	(0.209)	(0.212)
	[0.185]	[0.189]	[0.185]	[0.180]	[0.185]	[0.197]	[0.193]	[0.189]
R^2_n	0.095	0.098	0.106	0.125	0.095	0.102	0.109	0.128
$R^2_n(p)$	0.099	0.101	0.109	0.128	0.099	0.105	0.113	0.131
Sample: $N = 1'244$, $\bar{d} = 0.55$, $\bar{p} = 0.78$, $SD(p) = 0.19$								
FE	✓	✓	✓	✓	✓	✓	✓	✓
Academic		✓	✓	✓		✓	✓	✓
Personality			✓	✓			✓	✓
Family Background				✓				✓
Labor market				✓				✓

Note: Table presents coefficients (robust standard errors in round and average marginal effects in squared brackets), from probit (1)-(4) and probit endogenous explanatory variable (5)-(8) regressions of varying educational outcomes on subjective completion beliefs and varying sets of covariate, in (1) on in high school, region and time fixed effects, (2) adds academic, (3) adds personality, (4) to (8) family background, individual, and local labor market characteristics.
Source: SOEP 2000-2013 (v30), INKAR 2012, own calculations.