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Marijuana Consumption, Educational Outcomes and Labor Market Success: Evidence from Switzerland

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Abstract

In this paper, we analyze the impact of onset of marijuana consumption during different periods in youth on educational outcomes and labor market success using a Swiss data set. In order to deal with endogeneity, we estimate a multivariate probit model with an instrumental variables strategy. Our results seem to suggest that onset of marijuana consumption under age 14 leads to a significantly lower probability of having at least a secondary education, and onset of consumption between age 15 and 16 as well as between age 17 and 18 leads to a significantly lower probability of having a tertiary education. While we do not find any impact of marijuana consumption on the probability of being unemployed, onset of marijuana consumption under age 14 and between age 15 and 16 leads to a significantly higher probability of working less than 80%.

JEL classification: I 19 (Health: Other), I 21 (Analysis of Education)
Keywords: Risky behavior, production of human capital, multivariate probit

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1 Motivation

Binge drinking among youths has become a common phenomenon in many countries, as well as consumption of marijuana, hallucinogens and other drugs. According to the European School Survey Project on Alcohol and Other Drugs[1], about 21% of 16-year-old students in nearly 40 European countries in 2003 had consumed cannabis at some point in their life. In Switzerland, the lifetime prevalence for the same age group was even 40 % in the same year. The short-term effects of risky behavior, such as hangovers and drug-related accidents, are immediately clear, but there also exists evidence on the long-term consequences of risky behavior. Medical research has shown adverse effects of regular and prolonged marijuana and alcohol consumption on cognitive ability, especially on mnemonic and concentration ability. Economic research on risky behavior of youths has shown that at least some risky behaviors seem to translate into lasting negative impacts on human capital accumulation of individuals.

Existing economic research in the field focuses in most cases on a specific subsample of the population, for example high school students, and on relatively short-term consequences for outcomes. In this paper, we present several innovations. First of all, we take a longer-term perspective with respect to outcomes and analyze a broader sample of the population, not only high school or college students, using a Swiss data set. As yet, most evidence on the topic stems from U.S. data, and there is only scarce evidence on the effects of risky behavior using European data sets. In addition, the existing literature tries in most cases to analyze the impact of a risky behavior at any point in time on educational outcomes. In contrast, we explicitly focus on the timing of onset of marijuana consumption periods and their respective impact on educational and labor market success of the individual. We also measure educational success as having finished at least a secondary-level or a tertiary-level education instead of analyzing the impact of risky behavior on years of schooling as there is considerable evidence on sheepskin effects in education, i.e. the fact that there are very large increases in returns to

[1] www.espad.org

schooling after the completion of numbers of years that usually correspond to the completion of a degree (Hungerford and Solon 1987). In addition, we also use a novel instrumental variable: the local number of drug-related offences as a supply-side instrument. We believe that this is a convincing instrument to establish the causal effect of marijuana consumption at different periods in youth on our outcomes of interest.

Up to now, the theoretical literature on human capital investments either followed an education economic (Becker 1962, Ben-Porath 1967) or a health economic (Grossman 1972) point of view. The two types of models have different implications for an individual's stock of human capital: while investments in education increase individual productivity, health investments increase the amount of time available for production. In a recent paper, James Heckman (2007) proposed a synthesis of the two distinct literatures on health and education economics and developed a lifetime model of investment in human capital. In his model, altruistic parents invest into their offspring's capabilities (i.e. cognitive and non-cognitive skills, and health). The model features various characteristics that capture insights from neurological and medical research on the development of human capabilities. Heckman's model allows for the identification of critical and sensible periods during youth. We use this concept and test if there are more or less detrimental periods with respect to timing of initiation of drug consumption for both educational outcomes and labor market success.

Our results from both a simple probit and a multivariate probit approach suggest that there are indeed different effects depending on the ages of onset of marijuana consumption. Onset of marijuana consumption under age 14 significantly decreases the probability of having at least a secondary education, while onset of consumption aged 15 or 16 as well as aged 17 or 18 significantly decreases the probability of having a tertiary education. While we do not find any effect of marijuana consumption on the probability of being unemployed, having started to smoke marijuana under age 14 or between age 15 and 16 significantly increase the probability of working only part-time (less than 80%). As these results were derived from a multivariate probit instrumental variable estimation strategy that takes the possible endogeneity

of marijuana consumption into account, we are confident that they represent indeed a causal effect.

The remainder of our paper is organized as follows. Part 2 presents a brief literature review for results on various kinds of risky behavior. Part 3 introduces the data set and provides descriptive statistics, part 4 outlines our estimation strategy and presents the results, and part 5 concludes.

2 Literature Review

In the last few years, literature on the impact of various risky behaviors on the accumulation of human capital and on labor market outcomes of young adults has considerably increased. The newer studies also take into account possible biases of the results due to endogeneity problems and adresses these issues using different identification strategies. We start this literature review with the effects of alcohol consumption. DeSimone and Wolaver (2005) analyze the impact of alcohol consumption on grades in high school. Using the Youth Risk Behavior Survey and proxies for unobserved individual characteristics like risk and time preference and mental health, they find a significantly negative impact of alcohol consumption on grades. Not surprisingly, the negative effect of binge drinking (defined as having five or more alcoholic drinks within a few hours) they find is over twice as large than the effect for any alcohol consumption. Williams et al. (2003) use the Harvard School of Public Health's College Alcohol Study in order to estimate the effect of alcohol use on grades in college, using state-level alcohol prices as instruments. Although they find a small positive effect of drinking on grades, this effect is outweighed by a slightly larger negative effect via reduced hours of studying due to alcohol consumption.

On a closely related topic, the impact of drinking on high school dropout, Chatterji and DeSimone (2005) use the National Longitudinal Survey of Youth 1979 Young Adults and an instrumental variables approach in order to identify the causal effect of alcohol consumption. Their IV estimates show even larger negative coefficients than their OLS estimates and a significantly negative impact of both drinking and binge drinking on the probability of

finishing high school.

With respect to early labor market outcomes of young adults, Chatterji and DeSimone (2006) analyze the impact of drinking while in 10th grade on wages and employment status. Using an OLS strategy because of the lack of convincing instruments, they find significantly positive wage effects for males and no effects for females. They conjecture that binge drinking is correlated with unobserved social skills that are remunerated by employers.

We continue with the literature on effects of smoking. Cook and Hutchinson (2006) analyze the effects of both smoking and drinking in 11th grade on the probability of finishing high school. While they do not find an effect of drinking, they do find one of smoking and explain this finding by smoking as a signal of "being off track" in school. Hence, peer effects, not interpersonal differences in time preference, seem to be the transmission channel for their findings. Levine et al. (1997) also use the NLSY and different fixed-effects methods (panel and siblings fixed effects) for their analysis of the effect of smoking on wages and find that smokers' wages are between 4 and 8 % lower than nonsmokers' wages.

We finish this brief survey with some earlier results on our topic of interest, the impact of marijuana consumption on educational success. Liccardo Pacula et al. (2003) use the National Education Longitudinal Study and a differences-in-differences approach and find that marijuana use in high school does not seem to have an impact on results in standardized test scores, except for the scores in mathematics. Register et al. (2001), however, use the NLSY and two-stage least sqares estimation and find that marijuana use as well as consumption of other drugs reduce educational attainment by about one year.

Van Ours and Wechsler (2009) use an Australian data set and a duration model identification approaches in order to assess the causal impact of the timing of marijuana initiation on educational attainment. They find that earlier initiation into cannabis use leads to a significant reduction of years of schooling, and that this effect is larger for females.

To sum up, the results seem to suggest that there are indeed adverse effects of early smoking and marijuana initiation on educational outcomes. For the

case of alcohol and marijuana use, it seems to be the case that both drugs have adverse effects on the hippocampus of adolescents, a region of the brain that is related to mnemonic and learning abilities (see Lisdahl Medina et al. 2007 for more details). This finding could provide an explanation for the worse educational outcomes of teenage alcohol and marijuana users.
In the next section, we continue with a brief description of our data set and descriptive statistics.

3 The Data Set

Our empirical analysis is based on the 2002 Swiss Health Survey (Schweizerische Gesundheitsbefragung), a representative sample of the Swiss resident population. It is carried out every five years by the Swiss Federal Statistical Office in order to gain insights on the health status of Switzerland's population age 15 and older. Questions include the physical, mental and social health status; conditions of living, health-related behavior, but also items like repondents' level of education, employment and income and many more. The survey consists of two parts, the first one being a computer-assisted telephone interview, the second one being a questionnaire that was sent out to participants of the phone interview. The total sample size is $n = 19{,}706$, but we used only respondents age 40 and under for our empirical analyses because the data for our instrumental variable are only available for this time period. Our restricted sample still consists of 4,998 individuals.
The following section provides some interesting descriptive features of the data set. Complete summary statistics for the other variables of interest are provided in Appendix A.
The lifetime prevalence of marijuana consumption in the entire sample is 27.06%. Only 0.36% of individuals started to smoke marijuana before they turned 14, but 8.19% started between age 15 and 16 and another 9.66% started between age 17 and 18. The rest started consumption later in life.

Table 1: Age of onset of marijuana use

	Onset of marijuana consumption
Never	72.94%
Under 14	0.36%
Betw. 15-16	8.19%
Betw. 17-18	9.66%
Later	8.85%

The vast majority of all respondents in the sample has finished at least a secondary education, either school-based or in the vocational system. Only around 2.35% of individuals have not finished compulsory schooling, and 10% have at least finished compulsory schooling. However, only 8% of respondents have a university-level tertiary education, but another 11% have a tertiary-level vocational education.

A look at educational outcomes by the age of onset of marijuana consumption reveals a much higher percentage of individuals with only compulsory schooling among respondents who started before they turned 14. Also, among those who started age 15 and 16, the percentage of individuals with no more than compulsory schooling is higher than among the never-smokers. However, among those who started between age 17 and 18, the number is lower (6.88%) than in the entire sample.

Table 2: Educational outcomes by age of onset of marijuana use

	Never	Under 14	Betw. 15-16	Betw. 17-18	Entire sample
Not answered	0.07%	5.56%	0.25%	0	0.08%
Less than compulsory	2.31%	0	3.69%	1.46%	2.35%
Compulsory school	9.96%	44.44%	12.29%	6.88%	9.98%
Secondary: general	6.69%	0	9.83%	7.29%	6.98%
Secondary: vocational	61.53	27.78%	57.49%	63.33%	61.26%
Tertiary: vocational	11.68%	22.22%	10.32%	10.00%	11.45%
Tertiary: university	7.75%	0.00%	6.14%	11.04%	7.91%
n	4066	18	407	480	4998

Next, we look at labor market success, where our two outcomes of interest are employment status and being less than 80% employed. In the entire sample, only 1.77% of respondents were unemployed. This percentage is higher for all groups of marijuana users, and it is even lower (1.52%) for those who have never used marijuana. Interestingly, a much lower percentage of individuals who started to use marijuana between age 17 and 18 works less than 80% than every other group, where the percentage is around 35%. Not surprisingly, the number of women working less than 80% is much higher than the number of men (56.80% vs. 11.10%).

Table 3: Labor market success by age of onset of marijuana use

	Unemployed	Less than 80%
Never	1.52%	36.57%
Under 14	5.56%	33.33%
Betw. 15-16	3.44%	34.4%
Betw. 17-18	2.29%	26.67%
Entire sample	1.77%	35.43%

In the next section, we turn to our estimation strategy and empirical results.

4 Estimation Strategy and Results

4.1 Method

In order to assess whether onset of marijuana consumption in different periods in youth affects educational outcomes and labor market success, we estimate the following four-equation model by simulated maximum likelihood:[2]

$$outcome_i = \begin{cases} 1 & if \quad \alpha d1_i + \beta d2_i + \gamma d3_i + \delta X_i + \epsilon_{i1} > 0 \\ 0 & else \end{cases}$$

[2]All estimations were carried out using Stata's mvprobit module, written by Capellari and Jenkins (2003).

$$d1_i = \begin{cases} 1 & if \quad \theta IV1_i + \delta X_i + \epsilon_{i2} > 0 \\ 0 & else \end{cases}$$

$$d2_i = \begin{cases} 1 & if \quad \theta IV2_i + \delta X_i + \epsilon_{i3} > 0 \\ 0 & else \end{cases}$$

$$d3_i = \begin{cases} 1 & if \quad \theta IV3_i + \delta X_i + \epsilon_{i4} > 0 \\ 0 & else \end{cases}$$

Our outcomes of interest in the first equation are having at least a secondary education and having a tertiary education as measures of educational success, and being unemployed and working less than 80% as measures of labor market success. $d1$, $d2$ and $d3$ denote our regressors of interest, dummy variables for onset of marijuana consumption under age 14, between age 15 and 16 and between age 17 and 18, respectively. X denotes a vector of control variables, and IV denotes the instrumental variables that we use.

As already mentioned in the motivation, it is quite likely that in fact both marijuana consumption and educational attainment are driven by unobserved characteristics such as time preference. Hence, estimation of only the first equation would yield inconsistent estimates of our regressors of interest because it would not take into account the likely correlations between the error terms. The multivariate probit model assumes that error terms are multivariate normal with mean zero and a variance-covariance matrix V, where V has off-diagonal elements of $\rho_{jk} = \rho_{kj}$, and unit diagonal elements. The likelihood function is evaluated using the Geweke-Hajivassiliou-Keane smooth recursive simulator. It splits the joint normal probability density function into simulated conditional probabilities from a truncated normal distribution. The joint probability can then be written as the product of these conditional simulated probabilities.

In order to assess the causal impact of marijuana consumption of educational outcomes, we use an instrumental variables estimation strategy. We use two instruments: the first one are canton-level data on the availability of the

drug, measured as the number of drug trafficking delicts per capita at the time when the individual started to use marijuana. The second one is the individual's self-stated level of religiousness. The crucial assumptions for these being valid instruments for marijuana consumption are that they have to be uncorrelated with individual-level unobserved characteristics (e.g., time preference) that are possibly driving both educational and drug consumption decisions and that they have to be correlated with individual-level marijuana consumption. While the first assumption is untestable, we think that it is not completely unreasonable to believe that it is true in our setup. As far as we know, the econometric literature does not provide tests on instrument relevance or validity for nonlinear models with several endogenous variables. Following Koedel (2008), we ran a series of univariate probits and performed Wald tests in order to assess the relevance of our instruments. The Wald test rejected the hypothesis of instrument irrelevance at the 1%-level for onset of consumption aged 15 and 16 for both the regional and the religiousness instruments. The hypothesis of instrument irrelevance was rejected at the 10%-level for religiousness for those who started using marijuana below age 14, but it was not rejected for the regional availability for this age group. However, these univariate probit-based tests do not take into account that the instruments predict several endogenous regressors and hence they are only imperfect.

4.2 Selection and Construction of Variables

We measure educational outcomes as having at least a secondary-level education (vocational or school-based) and having a tertiary-level education (vocational or university-level). For the labor market estimations, our dependent variables are an indicator variable that takes the value of 1 if the individual is unemployed and an indicator variable that takes the value of 1 if the individual works less than 80%.

The vector X contains information on respondents' gender, age, their own and their parents' citizenship and proxies for individuals' risk attitude and time preference. We include information on an individuals' self-reported im-

portance of health and a balanced diet, their body mass index and if they use sunscreen. Lastly, we added a set of dummy variables for the respondents' region of origin and the size of the respondents' place of residence.

For the labor market-related estimations, we additionally include an indicator variable for being married and on the number of occasions that individuals were engaged in binge drinking activities during the last year (defined as having more than 6 or 8 alcoholic drinks on one occasion for females and males, respectively).[3]

Our regressors of interest in the estimations are dummy variables for the age when respondents started to smoke marijuana (under 12, between 13 and 14, between 15 and 16, between 17 and 18). We also have information on later onsets of marijuana use, but we do not use it in the empirical analysis. The reason is that most respondents in the sample have finished a secondary-level education that typically ends at age 18, hence, later onset of marijuana use should of course not have an impact on educational outcomes any more.

Lastly, the instrumental variables that we use are a regional supply-side IV and a measure of individuals' self-reported religiousness. The regional IV consists of the canton-level number of drug-related accidents at the time when the individual started to use marijuana. The underlying assumption for this being a valid IV is that an individual should be more likely to start smoking marijuana when the drug is more readily available. The measure of religiousness states on a scale from 1 to 7, where 1 means that the individual never attends religious services and 7 that he or she attends services every day. The assumption here is that more religious individuals should incur higher psychological costs of drug consumption and the probability of drug consumption should therefore decrease with their level of religiousness.

4.3 Results

Educational Outcomes

The following table presents results from simple probit and multivariate pro-

[3] We do not include this information in the regressions for educational outcomes because the data set does not contain information about the age at onset of consumption of alcohol and other drugs.

bit regressions for having at least a secondary-level and a tertiary-level education as the dependent variable. Cluster-robust standard errors are given in parentheses (clustering on region of origin). ***, **, and * denote significance levels of 1 %, 5%, and 10%, respectively. The regressions included controls for region of origin and the size of individuals' place of residence.
We have restricted the sample to respondents who have indicated that they are not in full-time training anymore, meaning that they are likely to have completed their education. Complete estimation results including estimated coefficients on all control variables are provided in Appendix B.

Table 4: Educational Outcomes: Regression Results

	secondary mvprobit	secondary probit	tertiary mvprobit	tertiary probit
Marijuana under 14	-1.725***	-0.962***	0.454	0.111
	[0.236]	[0.331]	[0.977]	[0.479]
Marijuana 15-16	-0.126	0.012	-0.290**	-0.158**
	[0.109]	[0.087]	[0.115]	[0.063]
Marijuana 17-18	0.323***	0.169***	-0.171*	-0.099*
	[0.111]	[0.046]	[0.104]	[0.060]
Age	0.078***	0.079***	0.049***	0.050***
	[0.006]	[0.006]	[0.003]	[0.003]
Female	-0.125**	-0.124***	-0.677***	-0.672***
	[0.050]	[0.048]	[0.044]	[0.046]
Body Mass Index	-0.001	0	-0.026***	-0.025***
	[0.005]	[0.005]	[0.007]	[0.007]
Mastery	0.02	0.022	0.007	0.01
	[0.040]	[0.039]	[0.019]	[0.019]
Optimism	0.08	0.085	0.142***	0.143***
	[0.057]	[0.058]	[0.021]	[0.021]
Uses sunscreen	0.406***	0.414***	0.202**	0.202**
	[0.047]	[0.043]	[0.089]	[0.089]
Health important	-0.051	-0.055	0.012	0.016
	[0.051]	[0.055]	[0.028]	[0.027]
Nutrition important	0.233***	0.231***	0.103	0.101
	[0.024]	[0.022]	[0.072]	[0.072]
Swiss	0.483***	0.480***	0.174	0.162
	[0.181]	[0.184]	[0.117]	[0.119]
Swiss father	0.151	0.149	-0.063	-0.062
	[0.095]	[0.092]	[0.051]	[0.049]
Swiss mother	0.032	0.041	-0.12	-0.12
	[0.126]	[0.125]	[0.111]	[0.111]
Constant	-2.415***	-2.495***	-2.602***	-2.647***
	[0.149]	[0.130]	[0.158]	[0.163]
Observations	4998	4998	4998	4998

We start the discussion of our results with the regressions in the first and second column, where the dependent variable takes the value of 1 if the individual has at least a secondary education. In both regressions, the estimated

coefficient on having started to smoke marijuana under age 14 is significantly negative. If the regional availability of marijuana are individual religiousness are indeed valid IVs for the age of onset of marijuana consumption, then the IV estimates in the second column suggest that this effect is causal and not due to unobserved heterogeneity. While there is no significant effect for the onset of marijuana consumption between age 15 and 16, we found a surprising result for onset between age 17 and 18: the IV estimations seem to suggest that this relatively late onset of marijuana consumption affects the probability of having at least a secondary education in a significantly positive way.

We now turn to the results for the probability of having a tertiary-level education, either vocational or university-based. Here, the estimated coefficients on onset of marijuana consumption between age 15-16 and between 17-18 are significantly negative in both the simple and the multivariate probit model. The result from the IV estimation again suggests that this is a causal effect. The results suggest that it is important to focus on the time period in youth when the individual started to use marijuana and to analyze the level of education, as the effects differ to a considerable degree.

There are also some interesting results for the control variables. In our sample, female respondents are significantly less likely to end up with at least a secondary and a tertiary education than males. This is a surprising result, and a closer look at the descriptive statistics reveals that more than 23 % of males have a tertiary education, but only 11.5% of all females in the sample. This difference is mainly driven by a much higher percentage of males with a tertiary vocational education, while the percentages of individuals with a tertiary university education are much closer together (8.5% for males and 6% for females).

Another surprising result is the fact that higher age is associated with a higher probability of having both at least a secondary-level as well as a tertiary-level education, despite the fact that we have only individuals in the sample who stated that they are not in full-time training anymore. It suggests that there is no educational expansion taking place in our sample and during the time horizon that we have analyzed.

Being Swiss is associated with a significantly higher probability of having at least a secondary education. Again, a look at the descriptive statistics reveals that this result is driven by a much higher percentage of Swiss citizens with secondary vocational training. The results for having a tertiary education do not show a significant difference between foreign and Swiss citizens. Approximately 15 % of both Swiss and Non-Swiss citizens have a tertiary education, but while 9 % of foreigners have a university degree, only around 7% of Swiss have one.

Finally, a higher level of psychological stability (optimism) is associated with a higher probability of having a tertiary-level education. While this is an interesting result, it should not be seen as a causal effect, as it is quite likely that individuals with a higher level of education have a more positive attitude towards life.

Labor Market Success

In a second estimation, we look at two measures of labor market success, namely, individual employment status and the individual's level of employment.Of course, individual wages would also be an interesting measure of labor market success, but as the Swiss Health Survey does not focus on labor market issues, it contains only information on the household's income. Hence, it would only be possible to calculate hourly wages for one-person households, which would reduce our sample drastically and probably be a selected sample. As information on employment level is available for all individuals, we decided to use this as a measure of labor market success instead. Again, cluster-robust standard errors are given in parentheses (clustering on region of origin). ***, **, and * denote significance levels of 1 %, 5%, and 10%, respectively. Complete estimation results including estimated coefficients on all control variables are provided in Appendix B.

Table 5: Labor Market Outcomes: Regression Results

	unemployed mvprobit	unemployed probit	part-time mvprobit	part-time probit
compulsory schooling	0.007	0.007	-0.203**	-0.207**
	[0.134]	[0.135]	[0.101]	[0.100]
secondary education	-0.247	-0.247	-0.444***	-0.450***
	[0.181]	[0.182]	[0.130]	[0.129]
tertiary education	-0.024	-0.025	-0.334***	-0.336***
	[0.134]	[0.134]	[0.054]	[0.055]
Marijuana under 14	0.958	0.175	1.521***	0.372
	[1.036]	[0.616]	[0.480]	[0.334]
Marijuana 15-16	0.275	0.243	0.226***	0.268***
	[0.215]	[0.161]	[0.072]	[0.098]
Marijuana 17-18	0.017	0.133**	-0.312***	-0.036
	[0.086]	[0.055]	[0.057]	[0.052]
Age	0.015***	0.015***	0.005	0.004
	[0.003]	[0.003]	[0.004]	[0.004]
Female	0.192**	0.193**	1.260***	1.279***
	[0.092]	[0.088]	[0.071]	[0.063]
Married	-0.250***	-0.250***	0.660***	0.670***
	[0.045]	[0.045]	[0.127]	[0.128]
Binge drinking	0.035	0.036	-0.096***	-0.095***
	[0.037]	[0.038]	[0.032]	[0.032]
Body Mass Index	-0.02	-0.02	-0.019***	-0.020***
	[0.013]	[0.013]	[0.004]	[0.004]
Mastery	0.081	0.083	-0.077***	-0.074***
	[0.064]	[0.062]	[0.025]	[0.025]
Optimism	-0.425***	-0.429***	0.023	0.02
	[0.079]	[0.079]	[0.039]	[0.039]
Swiss	-0.033	-0.035	0.141	0.127
	[0.165]	[0.163]	[0.110]	[0.118]
Swiss father	-0.122	-0.121	0.077	0.083
	[0.188]	[0.190]	[0.066]	[0.066]
Swiss mother	-0.105	-0.111	0.051	0.044
	[0.112]	[0.111]	[0.072]	[0.072]
Constant	-0.598	-0.565	-0.768***	-0.754***
	[0.565]	[0.576]	[0.123]	[0.119]
n	4998	4998	4998	4998

We start with a discussion of the results for the probability of being unemployed. As already mentioned before, the unemployment level in our sample is extremely low, with less than 2% of respondents stating that they are currently unemployed. None of the marijuana-onset dummies shows a statistically significant effect on the probability of being unemployed. However, there are some interesting results for the control variables, where older individuals as well as women are significantly more likely to be unemployed, while married respondents and those with a higher level of psychological stability are less likely to be unemployed.

The results change drastically when we estimate the probability of being employed at a level of employment less than 80% as an alternative measure of labor market success. In the multivariate probit estimation, both onset of marijuana consumption under age 14 and between age 15 and 16 leads to significantly higher probabilities of being employed less than 80%, while having started to smoke marijuana between age 17 and 18 significantly decreases the probability. These results again confirm the necessity to explicitly take into account when individuals started to smoke marijuana, as the effects differ considerably.

Again, there are also some interesting results for the control variables. Higher levels of education (as compared to having finished less than compulsory education) are associated with significantly lower probabilities of working less than 80%. In addition, having had a binge drinking episode in the year before the survey took place significantly decreases the probability of being employed part-time, as well as having a higher locus of control. While the first result seems surprising, it goes well in line with previous results on positive wage effects of alcohol consumption on wages (see, for instance, Chatterji and DeSimone (2006) or van Ours (2004)). Not surprisingly, women are significantly more likely to work part time.

5 Conclusion and Outlook

The present paper provides an analysis of the impact of the age of marijuana initiation on educational outcomes and labor market success. We

measured educational success as having finished at least a secondary education and as having finished a tertiary-level education instead of focusing on years of schooling. As measures of labor market success, we used employment status and working less than 80%. Following the concept of critical and sensitive periods for the development of human capabilities in a recent paper by Heckman (2007), we focused on different age periods of marijuana consumption onset. For the empirical analysis, we used the Swiss Health Survey 2002 (Schweizerische Gesundheitsbefragung), an unusually rich data set that combines information on educational background, health-related behavior and further individual- and regional-level background information. In order to deal with the possible endogeneity of marijuana consumption, we estimated a multivariate probit model and used an instrumental variables approach where we employed a regional supply-side instrument (the number of drug-related offences per capita at the time when the individual started to use marijuana) and an individual-level instrument (the individual's level of religiousness).

Our results suggest that there are indeed remarkable differences in effects for the different age periods of onset and for the different outcomes of interest. While onset of marijuana consumption under age 16 seems to decrease the probability of having at least a secondary-level education, onset of consumption between age 15 and 18 seems to decrease the probability of having a tertiary-level education. Additionally, even after controlling for educational level, we find that onset of marijuana use under age 16 significantly increases the probability of working less than 80%. However, onset of consumption aged 17 and 18 signficantly increases the probability of having at least a secondary-level education and decreases the probability of working less than 80%. These results show that it is important to distinguish between different levels of education and to focus on the age at which the individual started to smoke marijuana. However, we can only conjecture about possible reasons for these different effects depending on the age at onset, especially for the differences in educational outcomes. A possible reason could be that marijuana consumption decreases school performance at age periods that are especially important in order to enter secondary or tertiary education afterwards. For

example, bad grades in school because of marijuana consumption could lead to subsequent problems to find an apprenticeship place. Even harder to explain are the positive effects of onset of marijuana consumption between age 17 and 18 on the probability of having at least a secondary education and the negative effect on the probability of working part time. Without more detailed data, we cannot offer a credible explanation for this result.

Future research could include an analysis of the effects for differences in intensity or duration of past marijuana consumption. Also, longitudinal and more detailed data could offer the possibility to analyze the transmission channel for the effects that we have found.

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A Descriptive Statistics

Table 6: Summary Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
1 = at least secondary education	.8758801	.3297515	0	1
1 = tertiary education	.1935224	.3950986	0	1
1 = unemployed	.0177027	.1318817	0	1
1 = working less than 80%	.3542547	.478335	0	1
1 = marijuana onset under 14	.003621	.0600718	0	1
1 = marijuana onset between 15 and 16	.0818749	.2742016	0	1
1 = marijuana onset between 17 and 18	.09656	.2953875	0	1
Age	31.7932	6.351435	15	40
1 = female	.5322873	.4990066	0	1
Level of religiousness	2.09314	1.249859	1	7
BMI	23.21221	3.621252	10.44897	44.92188
Level of mastery	2.131563	.7470879	1	3
Level of optimism	3.546369	.6044872	1	4
1 = uses sunscren	.8949909	.3065959	0	1
1 = health is important	2.014283	.5363987	1	3
1 = nutrition is important	.6841682	.4648931	0	1
1 = Swiss citizen	.8758801	.3297515	0	1
1 = Father swiss	.7668477	.4228809	0	1
1 = Mother swiss	.7777107	.4158263	0	1
Region Central	.1723999	.3777657	0	1
Region Leman	.1563066	.3631823	0	1
Region Mittelland	.2655401	.4416648	0	1
Region Northwest	.1327701	.3393602	0	1
Region Zurich	.0762422	.2654119	0	1
Region East	.1321666	.3387058	0	1
Region Ticino	.0645745	.2457983	0	1
1 = mun.under 100	.1084289	.3109526	0	1
1 = mun.between 1000-1999	.1130557	.3166928	0	1
1 = mun.between 2000-4999	.2317441	.4219889	0	1
1 = mun.between 4000-9999	.1772279	.3818999	0	1
1 = mun.between 10000-19999	.1532891	.3603022	0	1
1 = mun.between 20000-49999	.0901227	.2863863	0	1
1 = mun.between 50000-99999	.0257493	.1584025	0	1
1 = mun.over 100000	.1003822	.3005392	0	1

B Additional Estimation Results

B.1 Educational Outcomes

Table 7: Educational Outcomes: Full Regression Results

	secondary mvprobit	secondary probit	tertiary mvprobit	tertiary probit
Marijuana under 14	-1.725***	-0.962***	0.454	0.111
	[0.236]	[0.331]	[0.977]	[0.479]
Marijuana 15-16	-0.126	0.012	-0.290**	-0.158**
	[0.109]	[0.087]	[0.115]	[0.063]
Marijuana 17-18	0.323***	0.169***	-0.171*	-0.099*
	[0.111]	[0.046]	[0.104]	[0.060]
Age	0.078***	0.079***	0.049***	0.050***
	[0.006]	[0.006]	[0.003]	[0.003]
Female	-0.125**	-0.124***	-0.677***	-0.672***
	[0.050]	[0.048]	[0.044]	[0.046]
Body Mass Index	-0.001	0	-0.026***	-0.025***
	[0.005]	[0.005]	[0.007]	[0.007]
Mastery	0.02	0.022	0.007	0.01
	[0.040]	[0.039]	[0.019]	[0.019]
Optimism	0.08	0.085	0.142***	0.143***
	[0.057]	[0.058]	[0.021]	[0.021]
Uses sunscreen	0.406***	0.414***	0.202**	0.202**
	[0.047]	[0.043]	[0.089]	[0.089]
Health important	-0.051	-0.055	0.012	0.016
	[0.051]	[0.055]	[0.028]	[0.027]
Nutrition important	0.233***	0.231***	0.103	0.101
	[0.024]	[0.022]	[0.072]	[0.072]
Swiss	0.483***	0.480***	0.174	0.162
	[0.181]	[0.184]	[0.117]	[0.119]
Swiss father	0.151	0.149	-0.063	-0.062
	[0.095]	[0.092]	[0.051]	[0.049]
Swiss mother	0.032	0.041	-0.12	-0.12
	[0.126]	[0.125]	[0.111]	[0.111]
Region Leman	-0.058*	-0.055	0.228***	0.223***
	[0.034]	[0.034]	[0.023]	[0.024]
Region Mittelland	-0.075**	-0.072***	0.078***	0.072***
	[0.031]	[0.024]	[0.010]	[0.012]
Region Northwest	0.078*	0.078*	-0.024	-0.029
	[0.042]	[0.042]	[0.018]	[0.020]
Zurich	-0.108**	-0.099**	0.021	0.018
	[0.050]	[0.049]	[0.021]	[0.023]
Region East	-0.045***	-0.042***	-0.156***	-0.157***
	[0.008]	[0.007]	[0.002]	[0.003]
Region Ticino	0.079***	0.084***	-0.198***	-0.196***
	[0.030]	[0.029]	[0.014]	[0.015]
municipality betw. 1000 and 1999	0.051	0.057	0.051	0.049
	[0.081]	[0.076]	[0.040]	[0.038]
municipality betw. 2000 and 4999	-0.015	-0.007	0.103**	0.101**
	[0.097]	[0.092]	[0.048]	[0.049]
municipality betw. 5000 and 9999	0.089	0.098	0.196***	0.193***
	[0.107]	[0.104]	[0.040]	[0.045]
municipality betw. 10000 and 19999	0.121	0.119	0.304***	0.302***
	[0.126]	[0.124]	[0.060]	[0.057]
municipality betw. 20000 and 49999	0.097	0.099	0.475***	0.468***
	[0.123]	[0.115]	[0.076]	[0.080]
municipality betw. 50000 and 99999	0.172**	0.176**	0.567***	0.556***
	[0.086]	[0.089]	[0.117]	[0.117]
municipality over 100000	0.246	0.247	0.618***	0.606***
	[0.180]	[0.175]	[0.051]	[0.050]
Constant	-2.415***	-2.495***	-2.602***	-2.647***
	[0.149]	[0.130]	[0.158]	[0.163]
n	4998	4998	4998	4998

B.2 Labor Market Success

Table 8: Labor Market Outcomes: Full Regression Results

	unemployed mvprobit	unemployed probit	part-time mvprobit	part-time probit
compulsory schooling	0.007	0.007	-0.203**	-0.207**
	[0.134]	[0.135]	[0.101]	[0.100]
secondary education	-0.247	-0.247	-0.444***	-0.450***
	[0.181]	[0.182]	[0.130]	[0.129]
tertiary education	-0.024	-0.025	-0.334***	-0.336***
	[0.134]	[0.134]	[0.054]	[0.055]
Marijuana under 14	0.958	0.175	1.521***	0.372
	[1.036]	[0.616]	[0.480]	[0.334]
Marijuana 15-16	0.275	0.243	0.226***	0.268***
	[0.215]	[0.161]	[0.072]	[0.098]
Marijuana 17-18	0.017	0.133**	-0.312***	-0.036
	[0.086]	[0.055]	[0.057]	[0.052]
Age	0.015***	0.015***	0.005	0.004
	[0.003]	[0.003]	[0.004]	[0.004]
Female	0.192**	0.193**	1.260***	1.279***
	[0.092]	[0.088]	[0.071]	[0.063]
Married	-0.250***	-0.250***	0.660***	0.670***
	[0.045]	[0.045]	[0.127]	[0.128]
Binge drinking	0.035	0.036	-0.096***	-0.095***
	[0.037]	[0.038]	[0.032]	[0.032]
Body Mass Index	-0.02	-0.02	-0.019***	-0.020***
	[0.013]	[0.013]	[0.004]	[0.004]
Mastery	0.081	0.083	-0.077***	-0.074***
	[0.064]	[0.062]	[0.025]	[0.025]
Optimism	-0.425***	-0.429***	0.023	0.02
	[0.079]	[0.079]	[0.039]	[0.039]
Swiss	-0.033	-0.035	0.141	0.127
	[0.165]	[0.163]	[0.110]	[0.118]
Swiss father	-0.122	-0.121	0.077	0.083
	[0.188]	[0.190]	[0.066]	[0.066]
Swiss mother	-0.105	-0.111	0.051	0.044
	[0.112]	[0.111]	[0.072]	[0.072]
Region Leman	-0.168***	-0.175***	0.039**	0.024
	[0.060]	[0.056]	[0.019]	[0.023]
Region Mittelland	-0.046	-0.051	0.138***	0.124***
	[0.051]	[0.047]	[0.017]	[0.023]
Region Northwest	-0.217***	-0.220***	0.028	0.017
	[0.065]	[0.061]	[0.025]	[0.030]
Zurich	-0.102*	-0.111**	-0.007	-0.02
	[0.053]	[0.049]	[0.024]	[0.027]
Region East	-0.129***	-0.132***	0.106***	0.102***
	[0.031]	[0.030]	[0.017]	[0.018]
Region Ticino	0.377***	0.376***	-0.02	-0.02
	[0.065]	[0.062]	[0.016]	[0.016]
municipality betw. 1000 and 1999	-0.028	-0.031	-0.059	-0.068
	[0.192]	[0.191]	[0.093]	[0.090]
municipality betw. 2000 and 4999	0.002	-0.001	-0.180***	-0.190***
	[0.172]	[0.175]	[0.054]	[0.049]
municipality betw. 5000 and 9999	0.075	0.071	-0.076	-0.088
	[0.208]	[0.205]	[0.052]	[0.058]
municipality betw. 10000 and 19999	0.148	0.151	0.023	0.023
	[0.250]	[0.247]	[0.053]	[0.051]
municipality betw. 20000 and 49999	0.056	0.057	0.038	0.026
	[0.253]	[0.248]	[0.054]	[0.059]
municipality betw. 50000 and 99999	0.237	0.232	0	-0.018
	[0.257]	[0.252]	[0.078]	[0.089]
municipality over 100000	0.343*	0.339*	0.215***	0.199***
	[0.187]	[0.188]	[0.073]	[0.073]
Constant	-0.598	-0.565	-0.768***	-0.754***
	[0.565]	[0.576]	[0.123]	[0.119]
n	4998	4998	4998	4998