

Research paper

Cannabis decriminalization and the age of onset of cannabis use[☆]Jakub Červený^a, Pavla Chomynová^{b,c}, Viktor Mravčík^{b,d,c}, Jan C. van Ours^{e,f,g,h,*}^a Department of Economics, CentER, Tilburg University, The Netherlands^b National Monitoring Center for Drugs and Addiction, The Office of the Government of the Czech Republic, Czech Republic^c National Institute of Mental Health, Czech Republic^d Department of Addictology, First Faculty of Medicine, Charles University and General University Hospital, Czech Republic^e Erasmus School of Economics, Erasmus University Rotterdam, The Netherlands^f Department of Economics, University of Melbourne, Australia^g Tinbergen Institute, Amsterdam/Rotterdam, The Netherlands^h CEPR, London, United Kingdom

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ABSTRACT

Background: In the Czech Republic in 2010 a law was introduced decriminalizing personal possession of small quantities of several illicit drugs, including cannabis.

Methods: We use 2012 survey data to examine the effect of a change in cannabis policy on the age of onset of cannabis use. We estimate the effect of the policy change using a mixed proportional hazards framework that models the transition to first cannabis use.

Results: The change in cannabis policy did not affect the transition to first cannabis use.

Conclusion: We find no evidence of cannabis decriminalization affecting the age of onset of cannabis use.

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Introduction

Cannabis has been and still is an illegal drug in almost all countries across the world. The main argument for prohibition of cannabis is the potential health risk associated with cannabis use. However, negative health effects of cannabis use are no robust finding. For example, van Ours and Williams (2015) conclude from an overview of the literature that there do not appear to be serious harmful health effects of moderate cannabis use. Only heavy use by individuals who are susceptible to mental health problems may have negative effects on the mental well-being of these individuals. This does not imply that cannabis use is harmless (see also Hall, 2015). The age of onset of cannabis use is important as there is robust evidence that early cannabis use for example reduces educational attainment.

Despite the prohibition policy, cannabis use has increased over the past decades and there is a debate on whether this policy is sensible (see for example Caulkins, Hawken, Kilmer, & Kleiman, 2012; Cawley & Ruhm, 2011; Pudney, 2010). The cannabis policy debate is often emotional, with strong views of both proponents and opponents (van Ours, 2012). Those who are in favor of legalization tend to ignore the negative health effects of cannabis use. Those who are against legalization ignore the fact that legal substances such as alcohol and tobacco also have bad health effects (see for example Hall & Lynskey, 2009; Nutt, King, & Phillips, 2010; Taylor et al., 2012). The debate on legalizing cannabis has gained momentum in recent years. Uruguay and several U.S. states have legalized cannabis use, allowing consumption and regulating supply. Other U.S. states and other countries have decriminalized the possession of small quantities of cannabis or made access to cannabis for medical reasons easier.

Whether easier access leads to an increase in cannabis use is not clear. Research on the relationship between cannabis policy and cannabis use varies from general comparative cross-country studies to in-depth analysis of differences in cannabis use of individuals who are subject to different policy regimes. Among the general comparative studies is Reinerman, Cohen, and Kaal (2004) who compare representative samples of experienced cannabis users in decriminalized-cannabis-use Amsterdam and criminalized-cannabis-use San Francisco finding no evidence to support

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claims that criminalization reduces use or evidence that decriminalization increases use. Reuter and Trautmann (2009) find that drug policies have limited effects on drug problems. Drug policies seem to be influenced by the drug situation rather than the other way around. A study by the European Monitoring Centre for Drugs and Drug Addiction (2011) explores whether a significant change in the prevalence of cannabis use among the population aged 15–34 can be observed after a legislative change regarding cannabis use. Analyzing data from eight countries that changed their cannabis policy in the past ten years (Italy, UK, Slovakia, Denmark, Finland, Portugal, Bulgaria and Greece) it is concluded that cannabis legislation did not affect cannabis use. Pacula and Sevigny (2014a) argue that perceived harms or risks, changes in social norms, changes in ability to access cannabis and changes in the organization of supply may all influence the effect of cannabis decriminalization on cannabis consumption. Pacula and Sevigny (2014a, 2014b) argue that a more liberal cannabis use policy does not necessarily translate into a higher incidence of cannabis use. The effects depend on whether or not cannabis supply is also affected. If not, cannabis decriminalization leading to increased demand will increase cannabis price thus dampening the effects of cannabis consumption. Empirically, there is also an issue of timing of events. Once cannabis is formally decriminalized it make take some time before this decriminalization is implemented.

Another strand of studies on the relationship between cannabis policy and cannabis use focuses on the U.S. in which some states have medical marijuana dispensaries which make access to cannabis easy (In the U.S. cannabis is usually referred to as marijuana). The findings in these studies are not uniform. Some studies conclude that easier access to cannabis through the dispensaries has a positive effect on cannabis use while other studies find no effect whatsoever. Pacula, Kilmery, Grossman, and Chaloupka (2010) conclude that in states where medical marijuana laws were introduced cannabis use increased. Wall et al. (2011) find that states with medical marijuana laws have higher rates of cannabis use. Chu (2015) concludes that cannabis arrest rates significantly increased after medical marijuana laws were passed. However, Cerdá, Wall, Keyes, Galea, and Hasin (2012) conclude that cannabis abuse and cannabis dependence rates among cannabis users are very similar in states with and without medical marijuana laws. Harper, Strumpf, and Kaufman (2012) find medical marijuana laws not to have increased cannabis use. Anderson, Hansen, and Rees (2015) and Anderson and Rees (2014) also find no evidence that medical marijuana dispensaries increased cannabis use. Wagenaar, Lynne-Landsman, and Livingston (2013) find that neither the prevalence rate nor the frequency of cannabis use seem to have been affected by the dispensaries.

Finally, there are studies on the effect of decriminalization on the uptake of cannabis use. Williams and Bretteville-Jensen (2014) analyze Australian data exploiting variation of the timing of decriminalization over Australian States finding that cannabis decriminalization affected the uptake of cannabis among youngsters in the first five years following the policy change. In the Netherlands, consumption of cannabis is quasi-legalized since the mid 1970s. Small quantities of cannabis can be bought in cannabis shops, retail outlets which are referred to as coffeeshops. These coffeeshops are subject to strict rules. Some of the fundamental rules are: no sale of hard drugs, no advertising, no sale to youngsters below 18 years of age, no sale above 5 g per transaction and no more than 500 g of cannabis on the premises. Palali and van Ours (2015) find that individuals who grew up within 20 km of a cannabis shop have a lower age of onset of cannabis use.

In our paper, we focus on the Czech Republic where in 2010 a legislative change was introduced decriminalizing cannabis possession. The question we address in our paper is how this policy change affected the uptake of cannabis use. This is

particularly interesting and important as many of the negative effects of cannabis use are related to an early age of onset. For example, Lynskey et al. (2003) conclude that individuals who used cannabis by age 17 had higher odds of other drug use and alcohol dependence than their co-twins, who did not use cannabis before age 17. In our analysis, we exploit information on the age of onset to model transitions to first cannabis use. For this, we use data from a 2012 survey. We find that the policy change did not affect the age of onset of cannabis use. To investigate the robustness of our findings we also use data from a 2008 survey as a counterfactual analysis finding that indeed the “cannabis policy change that did not happen” did not affect the age of onset of cannabis use either.

Background

Change in cannabis policy

Shortly after the fall of communist regime in 1989, the Czech penal code was revised to remove repressive practices of the previous regime. Illicit drug possession was not a crime from 1990 to 1998. With the development of drug problems during the 1990s, social and political concerns originated for a more repressive approach in the Czech drug policy. As a result, the penal code was amended defining the possession of drugs for personal use as a criminal offense and introducing the term “greater than small” quantity as a threshold distinguishing between a criminal offense and an administrative offense. The interpretation of the term “greater than small” was left to judicial practice. The “greater than small” quantity became a focus of debate on illicit drug regulation and prosecution in the Czech Republic (Radimecky, 2007; Zabransky, 2004; Zeman, 2007).

In 2001, the government decided to differentiate drugs in the penal code according to their health and social risks – initially in three, and finally in two groups – cannabis and other drugs (Zabransky (2004)). Due to a complex re-codification of the old penal code, this decriminalization of cannabis possession was implemented as late as January 2010. The penalties for possession of cannabis and for growing cannabis for personal use were substantially reduced. Table 1 provides a summary overview. For example, possession of “greater than small” quantities of cannabis could result in a jail sentence of up to one year from 2010 onward while before 2010 this could have been a jail sentence of up to two years. Similarly, growing of cannabis for personal use in “greater than small” quantities before 2010 could have been punished with 1–5 years in prison while from 2010 onward this was up to 6 months. For small quantities, the maximum penalty for possession of cannabis of € 550 did not change. However, for the growing of small quantities of cannabis for personal use the penalty changed from 1 to 5 years in prison to a maximum fine of € 550. Under the new law, possession of less than 15 g (or five plants) of herbal cannabis and 5 g of hashish was not considered a criminal offense. Substantial changes were also introduced with regard to cannabis cultivation. Before the policy change, growing for cannabis even for personal use could have been treated as drug production and punishable with penalties from 1 to 5 years in prison. The new law introduced in 2010 no longer considered growing of small quantities as drug production and amended the maximum penalty as a fine up to CZK 15,000 (€ 550).

To summarize, cannabis possession was legal between 1990 and 1998, illegal between 1998 and 2010, and decriminalized for personal possession since January 2010. The focus of our analysis is on the effect of the decriminalization law passed in 2010. The 2010 intervention began in 2001 but was not fully implemented until 2010. In our analysis, we investigate whether the formal change in cannabis law had an effect on the uptake of cannabis use.

Table 1
Penalties for possession of cannabis and growing of cannabis for personal use.

	Before 2010	From 1.1.2010 onward
<i>Panel A. Possession of cannabis</i>		
Small quantities	Maximum fine of CZK 15,000 (€ 550)	Maximum fine of CZK 15,000 (€ 550)
Quantities greater than small	Up to 2 years in prison	Up to 1 year in prison
Significant scale	1–5 years	6 months to 5 years
Substantial scale	Was not defined	2–8 years
<i>Panel B. Growing of cannabis for personal use</i>		
Small quantities	1–5 years ^a	Maximum fine of CZK 15,000 (€ 550)
Quantities greater than small	1–5 years ^a	Up to 6 months
Significant scale	2–10 years ^a	Up to 3 years
Substantial scale	8–12 years ^a	6 months to 5 years
Large scale	10–15 years ^a	Not defined

Source: Ministry of Justice.

Note: Growing of cannabis for personal use could be regarded as a “possession crime”, especially if the scale was small and intention for personal use was clear (see Panel A.).

^a Applied if treated as drug production.

As Csete (2012) remarks, the new cannabis policy aligned the Czech Republic with a growing number of EU countries that effectively decriminalized some cannabis offenses. In July 2013, the Constitutional Court annulled substantial parts of the aforementioned regulation as it was found contradictory to the Constitution of the Czech Republic and the Charter of Fundamental Rights and Freedoms, according to which any criminal offense (and thus also the definition of greater-than-small quantity of a narcotic or psychotropic substances) may only be defined by a law (Mravcik et al. (2013)). As a consequence, the Supreme Court decreased the threshold limit for herbal cannabis from 15 to 10 g; see also Mravcik (2015).

Fig. 1 shows lifetime prevalence of cannabis use from 2008 to 2012. There is a substantial variation from close to 35 percent in 2008 to about 25 percent in 2011. Lifetime prevalence of cannabis use is relatively high in Czech Republic. It was 27.4 percent in 2012 compared to the European average of 17.6 percent. Once an individual has used cannabis, by definition he or she will always be an ever user of cannabis. A change in lifetime prevalence only occurs at the margin, by older individuals leaving the sample because of death or emigration or younger individuals starting to use cannabis. Therefore, lifetime prevalence can only change slowly over time. The fluctuations in Fig. 1 are “noise” rather than “signal”, most likely introduced by changes in the sampling frame. Fig. 1 also shows changes in cannabis use in the last 12 months and

last 30 days. These numbers do not show large fluctuations. The prevalence of use in last 12 months is decreasing, falling from 15.3 percent in 2008 to 9.2 percent in 2012. Apart from 2008, cannabis use in last 30 days is relatively stable at a level of around four percent.

Methods

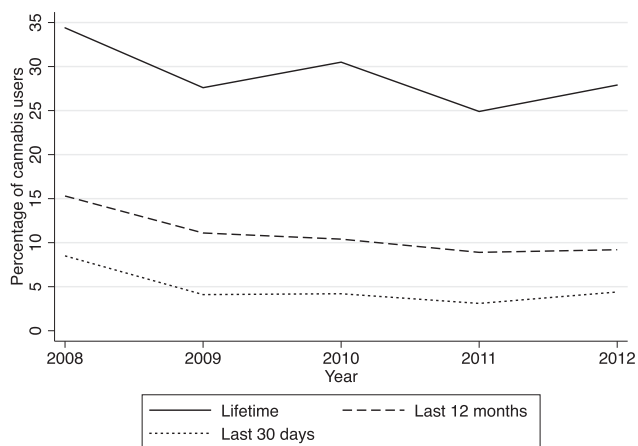
Data

In our analysis, we use data from two surveys carried out in the Czech Republic from October to December 2008 and from September to November 2012 by the Czech NMC, the National Monitoring Center for Drugs and Addiction. The main goals were to provide information on the extent of substance use and attitudes towards psychotropic substances and to determine the extent of selected health risk behaviors associated with illicit drugs in the Czech population. The questionnaires are based on the European Model Questionnaire, a set of standard questions recommended for general population surveys by the European Monitoring Center for Drugs and Drug Addiction (EMCDDA). For our paper, we use information on the age of onset of cannabis use which is available only in the 2008 and 2012 surveys. To ensure the anonymity of the respondents, the names and addresses were not recorded. The data were collected by means of face-to-face interviews with respondents in randomly selected households using a paper questionnaire (PAPI). Both samples were obtained by multi-stage stratified sampling procedures and are nationally representative for the Czech population aged 15–64 years with regard to gender, age, region and level of education. All individuals participating in the study had to be of Czech nationality. Further information about the sampling design, weighting and stratification is provided in the Appendix.

When studying the effect of a policy change on the uptake of cannabis use, it makes sense to focus on younger generations. Furthermore, for the 2012 sample we need to exclude individuals who might have started using cannabis during the 1990–1998 period when cannabis was legal. Therefore, in the remainder of our paper we focus in individuals of age 25 or younger at the time of the survey. The appendix provides the definitions of the relevant variables in our analysis and presents descriptive statistics.

Cannabis use dynamics

Starting to use cannabis is a phenomenon that is highly age-related. Individuals most often decide on the use of cannabis when they are in the age range 15–25. Individuals who have never used



Source: National Monitoring Center for Drugs and Addiction

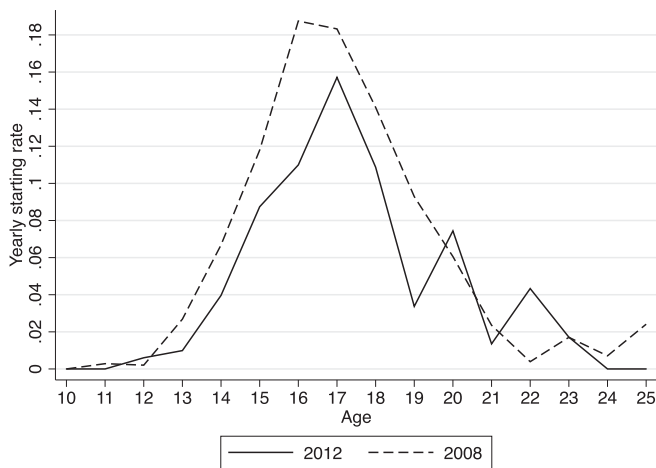
Fig. 1. Cannabis use trends in the Czech Republic individuals age 15–64; 2008–2012.

Source: National Monitoring Center for Drugs and Addiction.

cannabis by age 25 are very unlikely to start using cannabis later on in life (van Ours (2005)). In many countries cannabis use among younger generations is substantially higher than among older generations simply because cannabis was a rare commodity when older generations grew up (see for example European Monitoring Centre for Drugs & Drug Addiction, 2011).

In the following empirical analysis, we focus on the starting rate of cannabis use. We use the age of first cannabis use to calculate the starting rate by age, from age 10 onward, taking into account that some individuals have never used cannabis. For these individuals we assume that the duration until cannabis use is right-censored at their survey age. Panel A of Fig. 2 plots the evolution of the unconditional starting rate over the age of the individuals. Cannabis use starts at age 11 but only a few percent of the individuals do this at such a young age. There are differences between the starting rates in the samples of 2008 and 2012. The starting rates in 2008 are higher than in 2012. The peak in the starting rates of 2008 is at age 16, while this is age 18 for the sample of 2012. From age 21 onwards the starting rates are very low. Panel B of Fig. 2 shows the related cumulative starting probabilities of cannabis use. Clearly, the cumulative starting probabilities level off after age 20. For the 2008 sample the cumulative starting probability by age 20 is 62 percent, for the 2012 sample this is 48 percent.

Panel A. Cannabis use starting rates



Panel B. Cannabis use cumulative starting probabilities

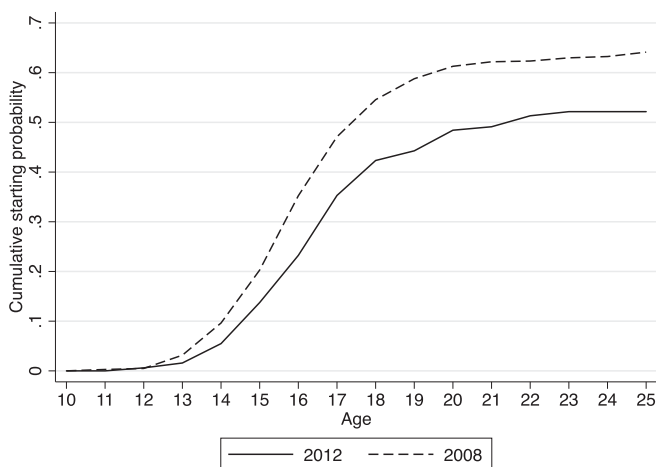


Fig. 2. Cannabis use starting rates and cumulative starting probabilities by age.

Set-up of the analysis

The focus of our analysis is on the effect of cannabis decriminalization on the uptake of cannabis. Since individuals were asked about the age of their first use of cannabis and also their age at the time of survey, we are able to determine the time-frame in which they might have been affected by the new policy. Using retrospective information to establish a calendar year effect is less sensitive to sampling procedures as the information comes from one survey. Of course, retrospective information is subject to recollection errors but this is unlikely to be important since we focus on a sample of young individuals for whom events concerning cannabis use have happened only recently.

To estimate the effect of the policy change, we use a mixed proportional hazard framework which allows the rate of transition from one state to the other to be affected by individual observed and unobserved characteristics as well as the duration of stay in a state (Heckman and Singer (1984)). In our case, the state of origin is never having used cannabis while the destination state is cannabis use. The transition rate is equivalent to the age-specific starting rate of cannabis use. The duration of stay in the first state is equivalent to the age of the individual from age 10 onwards. Thus, the starting rate for cannabis use at age t conditional on observed characteristics x , the age at which the new cannabis policy was introduced t_p and unobserved characteristics u , is specified as follows:

$$\theta(t|x, t_p, u) = \lambda(t) \exp(x'\beta + \delta I(t > t_p) + u) \tag{1}$$

where $\lambda(t)$ represents individual age dependence and β is a vector of parameters. The observed characteristics we include in the analysis are gender, education, birth-cohort and region of residence. The birth-cohort variable accounts for potential trends in the uptake of cannabis across birth-cohorts but does not account for secular trends over time. The parameter δ describes how the hazard rate shifts at the age when the new law was introduced in the year 2010 and thus measures the effect of the policy change on the uptake of cannabis. Age dependence is flexibly modeled using a step function:

$$\lambda(t) = \exp\left(\sum_k \lambda_k I_k(t)\right) \tag{2}$$

where $k(= 1, \dots, K)$ is a subscript for age-intervals and $I_k(t)$ are time-varying dummy variables for subsequent age-intervals. We assume that individuals are being exposed to cannabis from age 10 onwards. The first age interval is 10–14, subsequent age intervals are annually specified from age 15 to age 20, and the last interval refers to ages over 21. We estimate a constant and normalize $\lambda_0 = 0$. Note that we are able to make a distinction between age dependence and policy effect because the 2010 policy affected individuals at a different age. Nevertheless, we are aware of the fact that the effects of the policy change may have been contaminated by other policy changes that occurred around 2010.

The conditional density function for the completed durations of non-use can be written as:

$$f(t|x, t_p, u) = \theta(t|x, t_p, u) \exp\left(-\int_0^t \theta(s|x, t_p, u) ds\right) \tag{3}$$

We assume that the random effects u come from a discrete distribution G with two points of support (u_1, u_2), representing two types of individuals who differ in unobserved characteristics. We also investigated whether we could identify a third type of individuals but were unable to do so. The associated probabilities

are denoted as follows: $\Pr(u = u_1) = p_1$, $\Pr(u = u_2) = p_2$, where p_j ($j = 1, 2$) is assumed to have a logistic distribution:

$$p_n = \frac{\exp(\alpha_n)}{\sum_n \exp(\alpha_n)}, n = 1, 2 \quad (4)$$

with α_1 normalized to zero. Because we include a constant we also normalize $u_1 = 0$. We remove the unobserved heterogeneity distribution through integration:

$$f(t|x, t_p) = \int_u f(t|x, t_p, u) dG(u) \quad (5)$$

In the estimation we take into account that we do not know the birthday of the individual nor the exact day at which an individual started using cannabis. So, if an individual indicated having used cannabis for the first time at age 17, this could be at the 17th birthday or the day before the 18th birthday. The resulting log-likelihood function equals:

$$\mathcal{L} = \sum_{i=1}^N \log\{d_i(F(t+1) - F(t)) + (1-d_i)F(t+1)\} \quad (6)$$

where K denotes dataset consisting of $i = 1, \dots, N$ individuals, d_i denotes an indicator whether an individual started using cannabis and F is the distribution function related to f .

To check the robustness of our findings we also estimate the same model on 2008 data. By way of counterfactual analysis we introduced in 2006 a “policy change that did not occur”. This is about three years before the survey, similar to the 2010 policy change that occurred about three years before the 2012 survey.

Results

Baseline estimates

Table 2 reports the parameter estimates obtained by using the method of Maximum Likelihood. Column (1) show the estimates based on the 2012 data, column (2) present the results of the counterfactual analysis based on the 2008 data and column (3) presents estimates based on the joint 2008–2012 dataset. The top row of the table shows the effect of the decriminalization law on the starting rate of cannabis use. In the 2012 estimate, the effect is positive but statistically not different from zero at conventional levels of significance. For 2008 and the joint estimate for 2008 and 2012 the estimated effect of the decriminalization law

Table 2
Parameter estimates starting rate of cannabis use.

	2012		2008		2008–2012	
	(1)		(2)		(3)	
<i>Panel A. Personal characteristics</i>						
Effect decriminalization (δ)	0.51	(1.2)	−0.01	(0.1)	−0.29	(1.1)
Men	0.45	(1.2)	0.46*	(2.2)	0.36*	(2.3)
Survey 2012					−0.80***	(3.8)
<i>Education</i>						
Secondary	−0.26	(0.5)	−0.36	(1.5)	−0.31	(1.5)
Secondary w. grad.	−0.90**	(2.0)	−0.74**	(3.2)	−0.76***	(3.6)
Vocational	−2.11***	(4.2)	−0.80	(1.4)	−0.63	(1.5)
University	−1.27	(0.9)	−0.20	(0.6)	−0.40	(1.2)
<i>Panel B. NUTS 2 Region</i>						
Central Bohemia	0.19	(0.1)	0.52*	(1.9)	0.26	(1.1)
Southwest	0.13	(0.2)	−0.57*	(1.8)	−0.46*	(1.9)
Northwest	0.21	(0.2)	−0.17	(0.7)	−0.34	(1.4)
Northeast	0.82	(1.2)	−0.16	(0.6)	−0.29	(1.3)
Southeast	−0.51	(0.9)	−0.26	(0.9)	−0.49**	(2.2)
Central Moravia	0.30	(0.5)	−0.28	(0.9)	−0.28	(1.1)
Moravia-Silesia	−1.00	(1.4)	−0.20	(0.7)	−0.45**	(2.0)
<i>Panel C. Age effects</i>						
Age 15	2.22**	(2.4)	2.28***	(10.2)	2.27***	(8.1)
Age 16	3.23**	(3.5)	3.07***	(13.4)	3.09***	(10.7)
Age 17	3.84**	(3.7)	3.95***	(13.1)	3.82***	(11.3)
Age 18	4.95***	(3.8)	4.36***	(10.0)	4.33***	(10.4)
Age 19	5.58***	(4.4)	4.44***	(8.2)	4.36***	(9.3)
Age 20	4.91***	(3.9)	4.28***	(6.1)	3.97***	(7.1)
Age 21	5.33***	(4.8)	3.35***	(3.8)	3.54***	(5.3)
Birth-Cohort	−0.10	(0.9)	0.13***	(3.5)	0.08**	(2.4)
<i>Panel D. Unobserved heterogeneity</i>						
u_2	−4.60***	(7.2)	−2.87***	(4.7)	−2.85***	(5.9)
α_2	0.46**	(2.2)	−0.22	(0.6)	−0.09	(0.3)
p_2 (%)	61.4		44.5		47.8	
Observations	438		1086		1524	
−Log likelihood	709.4		1385.8		2116.3	

Constants not reported; absolute t statistics in parentheses.

* $p < 0.10$.

** $p < 0.05$.

*** $p < 0.001$.

Table 3
Parameter estimates effects of the decriminalization policy on the starting rate of cannabis use; sensitivity analysis.

2012	–Log L	N	2008	–Log L	N	2008–2012	–Log L	N			
<i>Panel A. Baseline</i>											
0.51	(1.2)	709.4	438	–0.01	(0.1)	1385.8	1086	–0.29	(1.1)	2116.3	1524
<i>Panel B. Men age ≤ 30</i>											
–0.13	(0.4)	656.5	334	0.09	(0.2)	1307.6	857	–0.30	(0.8)	1979.8	1191
<i>Panel C. Women age ≤ 30</i>											
–0.48	(1.6)	568.6	371	–0.32	(1.2)	1060.6	815	0.09	(0.2)	1653.5	1186

Absolute t statistics in parentheses; N = number of observations.

is negative and insignificant. The remainder of Table 2 shows how personal characteristics affect the uptake of cannabis use. Men have a higher starting rate than women but only for 2008 analysis and the joint analysis this effect is significantly different from zero. In 2012 those with a vocational education have the lowest starting rate of cannabis use by approximately $(\exp(-2.11) - 1) \times 100 \approx 88$ percent compared to those with only primary education, while in 2008 it is 55 percent. Birth-cohort has no effect in the 2012 analysis and a positive effect in the 2008 and joint 2008–2012 analysis. There are also some differences between regions. Finally, there is clear age dependence in the starting rate while unobserved heterogeneity is present. In all samples, we find that the distribution of unobserved heterogeneity in the starting rates can be described by a discrete distribution with two points of support. There is one type of individuals that has a substantial lower starting rate than the other type. This implies that some individuals with a very low starting rate are unlikely to ever start using cannabis. The distribution of the types is different for the two surveys. In 2012, 61 percent have low starting rate, compared to 45 percent in 2008 and 48 in the joint estimate. We attribute these differences to the difference in sampling design in 2008 and 2012.

Sensitivity analysis

The main conclusion from Table 2 is that there is no significant effect of the decriminalization policy on the starting rate of cannabis use. To investigate the robustness of this finding we excluded birth-cohort as an explanatory variable. This did not affect our main findings. We also investigated the importance of regional within-country mobility by estimating the model excluding the regions as explanatory variables. This does not change our main findings either.

Table 4
Cannabis related arrests and charges.

Year	Production, trafficking and selling	Possession for personal use	Total
<i>Panel A. Number of persons arrested</i>			
2008	608	138	746
2009	661	125	786
2010	744 ^a	152	896
2011	885 ^a	178	1063
2012	870 ^a	372	1242
<i>Panel B. Number of persons charged</i>			
2008	392	121	513
2009	520	116	636
2010	573 ^a	97	670
2011	769 ^a	111	880
2012	742 ^a	127	869

Source: The Czech drug situation annual reports, Ministry of Justice.

^a Includes unauthorized cultivation of plants containing a narcotic or psychotropic substance.

Table 3 shows additional parameter estimates of the effects of the decriminalization policy when distinguishing men and women. For reasons of comparison Panel A repeats the main parameter estimates of Table 2. As the sample is relatively small, we increased the sample size up to age 30 or less. Panel B shows the parameter estimates for men. For the 2008 and 2012 sample, as well as for the joint sample, the effect of the policy remains statistically insignificant. Panel C presents the parameter estimates for women. Again we find that neither for the actual policy change in the 2012 sample nor for the joint estimate on the pooled 2008 and 2012 dataset there is a significant effect on the age of onset of cannabis use.

How to explain our findings?

Despite the fact that cannabis was de-iure illegal between 1999 and 2010 and decriminalized since 2010, the period of prohibition left de-facto enforcement of the law up to judicial practice, mainly due to the unclear definition of the term “greater than small” (Belackova, Maalsté, Zabransky, and Grund (2015)). To illustrate how the law was enacted in practice, we provide information about cannabis-related drug offenses and arrests summarized in Table 4. The first column shows that the number of persons arrested for production, trafficking and selling increased from 608 in 2008 to 885 in 2011. Similarly, the second column shows that the number of arrests for possession for personal use increased between 2008 and 2012, and almost doubled between 2011 and 2012. The 2010 decriminalization law somehow created confusion and was sometimes mistakenly presented as legalization by media. As a reaction, the Czech police prioritized the fight against drug-related crime. This is also reflected by the increasing number of persons charged for production, trafficking and selling, where only 64% of individuals arrested in 2008 was in fact charged, compared to 85–86% in 2011 and 2012.

However, despite the increasing number of arrests for possession for personal use, the actual number of persons charged remains relatively stable over 2008–2012 period. The fact that charges remain stable between 2010 and 2012 can possibly be explained by the introduction of the 2010 decriminalization law. Individuals arrested after 2010 perhaps possessed amounts smaller than the newly introduced thresholds and therefore had to be cleared.

In further search for an explanation of our findings in the previous sections of the paper, we exploit two opinion questions related to cannabis use. One potential explanation of why the age of onset was not affected by the decriminalization policy is that potential consumers may have found the access to cannabis as easy as before. In both 2008 and 2012 surveys respondents were asked the question “How difficult do you think it would be to obtain cannabis within next 24 h?”¹ In 2008, 96.4 percent of the

¹ Note that these results are based on responses from individuals aged 15–64, as the response to this part of questionnaire was not mandatory and therefore many participants ignored it.

respondents indicated that it was easy or very easy to obtain cannabis within 24 h. In 2012, after the policy change, this was 95.7 percent. Apparently the policy did not change the availability of cannabis. This is not surprising as almost every respondent indicated that cannabis was easily obtained.

We also examined the perception of the risk of being caught by the police when obtaining cannabis. In both surveys respondents were asked a question “Have you felt threatened the last time you obtained cannabis?”. There is a difference in response, 21 percent of cannabis users felt threatened by the police before the decriminalization law was introduced. After the introduction of the law this number decreased to 9 percent. This finding suggests that the introduction of decriminalization in 2010 had an effect on perception of law enforcement but the importance of this was probably too small to influence the cannabis uptake behavior of youngsters. Alternatively, it is possible that the effect of the change in cannabis policy is contaminated by other policy changes around 2010 such as the National Drug Policy Strategy approved in May 2010 aiming for a reduction of drug use among youngsters.

Conclusions

In 2010, as part of a new drugs policy, the Czech Republic decriminalized the possession of small quantities of cannabis. We study the effect of this decriminalization policy on the age of onset of cannabis use among youngsters. We estimate the policy effect using a mixed proportional hazards framework that models the transition to cannabis use and allows us to distinguish between the effect of observed and unobserved personal characteristics as well as the effect of the change in cannabis policy. We find that the policy change did not affect the age of onset of cannabis use.

We suggest several explanations of our main findings but in the end we can only speculate about the reasons why the decriminalization did not affect the uptake of cannabis. It could be that initially the interpretation of the law by youngsters was wrong, causing decriminalization to be confused with legalization. As a response, the police increased monitoring cannabis related activities which resulted in increasing numbers of cannabis-related arrests. Another potential explanation is that after decriminalization cannabis lost its status as a “forbidden fruit” and hence was no longer appealing for new users to try. Alternatively, the uptake of cannabis did not change because supply of cannabis was not affected. Cannabis consumers found it as easy to access cannabis after the decriminalization as they did before the policy change. Furthermore, it might have been the case that the decriminalization changed the law but not the perceived risks related to cannabis use. Finally, it is worth mentioning that the lack of statistically significant results might also be caused by a lack of power due to relatively small sample sizes.

All in all, the lack of evidence of an effect of cannabis decriminalization on the age of onset of cannabis is a fortunate finding for those who worry about negative health effects related to early onset of cannabis use.

Whether the findings of our study carry external validity is unclear. As mentioned in the introduction, similar research on Australian data finds contradictory results to those presented in this paper. The lifetime prevalence of cannabis use in Czech Republic prior to decriminalization was substantially higher than the average in other countries. It is conceivable that cannabis use was already at its peak and therefore did not change significantly even after a less stringent policy was introduced.

Conflict of interest

The authors report no conflict of interest.

Appendix: Definition & descriptives of variables

Definition of variables

Cannabis: Have you ever tried cannabis (marijuana or hashish)? If so, indicate at what age did you try cannabis for first time.

Did you use cannabis within the last year? If so, did you use cannabis within the last 30 days?

Cannabis opinions: How difficult do you think it would be to obtain cannabis within next 24 h? Impossible, very difficult, relatively difficult, relatively easy, very easy, don't know (only 2012 survey) – When you obtained cannabis last time, have you felt threatened while doing it? By a police, by a seller/dealer, by a side that did not take part in transaction, other threats, did not feel any threat.

Education: Dummy variables: *Secondary:* Special schools including technical schools, specialized in construction, chemistry, engineering etc. Without graduation. *Secondary with graduation:* Grammar schools; higher vocational, higher specialized education, without university diploma/degree. *Higher vocational:* Higher vocational education. *University:* University degree. Reference group: Primary – compulsory up to age 15.

Birth-Cohort: (Birth year – 1900)/10.

Regions: Dummy variables: Central Bohemia, Southwest, Northwest, Northeast, Southeast, Central Moravia, Moravia-Silesia; Reference group: Capital Prague.

Table A1 provides an overview of the means of the variables we use in our analysis. As shown, the 2008 sample has 1086 individuals, while the 2012 sample consists of 438 individuals. As shown, the composition of the samples according to region and education are about the same, but there are differences in terms of prevalence of cannabis use. For example, in the 2008 survey 57 percent of the respondents of age 25 and younger indicated to have ever used cannabis while in the 2012 survey this was only 45 percent. In the 2008 survey, 36 percent of individuals used cannabis within last year, while in 2012 it was 22 percent. The share of individuals reporting cannabis use in last 30 days is also higher in 2008, reaching 21 percent compared to 11 percent in 2012.

Table A1
Means of variables.

	2008	2012
<i>Panel A. Personal characteristics</i>		
Age	20.56	20.26
Men	0.47	0.50
Birth cohort	9.14	8.77
<i>Cannabis use</i>		
Lifetime	0.45	0.57
Last year	0.22	0.36
Last 30 days	0.11	0.21
<i>Education</i>		
Primary	0.31	0.43
Secondary	0.17	0.26
Secondary w. grad.	0.40	0.27
Higher vocational	0.04	0.01
University	0.08	0.03
<i>Panel B. NUTS 2 region</i>		
Prague	0.12	0.12
Central Bohemia	0.10	0.11
Southwest	0.11	0.11
Northwest	0.09	0.10
Northeast	0.14	0.14
Southeast	0.20	0.17
Central Moravia	0.11	0.12
Moravia-Silesia	0.13	0.13
Observations	438	1086

Survey design

General Population Survey on Drug Use and Attitudes towards Drug Use in the Czech Republic in 2008 – Quota sampling:

1. Voting district selection (around 14 000 for the whole Czech Republic). Quotas were assigned to reach targeted number of respondents.
2. Household selection. Using random walk with given guidelines which household to choose.

5613 individuals contacted, 4506 agreed to be interviewed. Most people who declined to be interviewed indicated lack of time or disinterest in the survey as a reason. After restricting the sample to age 25 years or younger 1086 individuals remain.

Czech Republic National Survey on Substance Use 2012 – Stratified random sampling:

1. City and town selection (23 strata). Regional stratification was based upon NUTS2 classification and size of a residence, together with a registry of towns and cities collected in 2011 national census.
2. Street selection within a city or town. In each city/town a street was randomly selected as initial point for questioning. In total, 177 initial points was selected, together with extra 50 for additional purposes.
3. Household selection. Every third household of every third inhabited residence was included.
4. Respondent selection. Respondent was selected according to the Kish selection grid.

6210 households contacted, 2383 had unknown eligibility status (none present or opened the door). 3827 had known eligibility status. Based on Kish tables, a respondent was selected (always 1 per household) - 1693 were not eligible for the survey (no permanently living respondent, different age group, language barrier, incompetent to answer, refused to participate when selected). There are 2134 completed questionnaires (6210–2383–1693 = 2134). After restricting the sample to age 25 years or younger 438 individuals remain.

Both datasets include sampling weights to account for non-response. Weights are based on the following variables: age, gender, education, NUTS2 region, size of residence and economic status.

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