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ABSTRACT

Is Cannabis a Stepping Stone for Cocaine?*

This Paper uses a unique dataset, collected among inhabitants of Amsterdam, to study the dynamics in the consumption of cannabis and cocaine. If people start using these drugs they are most likely to do so at age 18-20 for cannabis and age 20-25 for cocaine. An analysis of the starting rates shows some evidence of cannabis being a 'stepping stone' for cocaine. The fact that some individuals use both cannabis and cocaine has, however, to do mostly with (unobserved) personal characteristics and not with the use of cannabis causing the use of cocaine.

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1   Introduction

Drug consumption is causing many problems like addiction, diseases, family conflicts and criminality. In the drug business important distinctions are between soft drugs and hard drugs and between legal and illicit drugs. Hard drugs seriously harm the health of the user while soft drugs cause far fewer health problems. Soft drugs like cannabis are illicit in most but not all countries. Hard drugs like cocaine and heroin are illegal in all countries.

It is not clear why some individuals start using soft drugs or hard drugs while other individuals abstain. In this respect the causal relationships between the various drugs are important. These relationships have not been studied in great detail. Yet, the drug policy of a country may be based on specific assumptions with respect to the causal relationship between the use of soft and hard drugs known as the 'stepping stone' or 'gateway' hypothesis. If soft drugs are a stepping stone to hard drugs then a strict policy aimed at preventing the use of soft drugs would be wise. If there is no causal relationship between the use of soft and hard drugs, soft drugs policy could be less strict. It could even be that a liberal soft drugs policy prevents the stepping stone from occurring.

The current paper is on the dynamics of drug consumption. It follows a line of research that has not been used frequently and analyses individual starting rates with respect to cannabis and cocaine. The focus is on the 'stepping stone' hypothesis.

In the analysis data are used that were collected in Amsterdam (the capital of the Netherlands) during four surveys in the period 1987-97. The situation in Amsterdam is interesting from a research point of view since the Netherlands is one of the few countries with a liberal attitude towards the use of soft drugs like cannabis. Dutch law aims at separating

the market of soft drugs and hard drugs. The basic idea is that a liberal policy towards soft drugs prevents soft drug users to start with hard drugs. Indeed, if soft and hard drugs are substances that are consumed contemporaneously or intertemporally by the same individual without the existence of a causal relationship the Dutch policy might be a sensible one. However, if the stepping stone hypothesis is con...rmed and there is indeed a gateway from soft drugs to hard drugs then the Dutch policy does not make much sense. In that case a liberal policy towards soft drugs would in the end stimulate the use of hard drugs.

The paper is set up as follows. Section 2 gives an overview of empirical and theoretical studies on drug use. Section 3 provides stylized facts about the Dutch drug policy and drug use. Section 4 considers the dynamics of drug use and presents estimation results of starting rates. Section 5 addresses the issue of whether the starting rates for cannabis and cocaine are interrelated. Section 6 concludes.

2   On the use of soft and hard drugs

2.1   Empirical studies

Economists study di¤erent aspects of the consumption of illicit drugs. One of them is the price sensitivity of drug use. Other aspects are the e¤ect of government policy on drug use, the e¤ect of drug use on individual labor market performance or the relationship between di¤erent types of use. Studies that analyze the price sensitivity of drug use often take prevalence (last month, last year or lifetime) as the dependent variable. An example of such a study is Chaloupka and Sa¤er (1999) who ...nd for the annual prevalence of heroin a price elasticity of -0.90 and for the annual prevalence of cocaine a price elasticity of -0.55. Grossman and Chaloupka (1998) ...nd that the frequency of use of cocaine by American

youth is also price sensitive. Another recent example of an empirical study is Grossman and Chaloupka (1998) in which the consumption of cocaine is found to be quite sensitive to its price. There are also differences in cocaine consumption between U.S. states because of differences in policies with respect to marijuana and alcohol.[1]

The illegal nature of the drug business makes it hard to collect data for empirical analysis. Because of this, some studies use historical data from a period in time when drug consumption was not illegal. Examples of historical studies are Van Ours (1995) and Liu et al. (1999) that use data from the early twentieth century. Van Ours studies the colonial period in which the Dutch controlled current day Indonesia and had a government monopoly on opium[2]. Liu et al. (1999) studies the opium monopoly of the Japanese in Taiwan in the early twentieth century. Both studies find that opium consumption is quite price sensitive. Other studies focus on legal drugs like tobacco (see for example Becker et al. (1994)) to make inferences about the possible price sensitivity of illicit drugs. Some studies focus on the potential harmful effects of legal and illegal drugs. MacDonald and Pudney (2000) for example find that the use of hard drugs increases the probability of being unemployed.

There are some studies focus on the relationship between different types of drugs. Pacula (1998a and 1998b) for example finds that the lagged price of beer has a positive effect on current cannabis consumption. From this she concludes that there is a gateway effect. The empirical problem with this analysis is that in the analysis it is not possible to make a distinction between an actual gateway effect and the influence of unobserved individual characteristics. The study of Ferguson and Hor-

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[1]See also Chaloupka and Saffer (1999).

[2]Van Luijk and Van Ours (2001) studies the effect of opium policy on opium consumption in late nineteenth century Indonesia.

4

wood, L.J. (2000) has a similar drawback. They estimate a proportional hazard model in which prior use of cannabis a¤ects the use of hard drugs. However, they do not distinguish between the e¤ect of unobservable individual characteristics and the causal e¤ect from cannabis to hard drugs. Pudney (2001) uses British data and ...nds that after taking individual heterogeneity into account there is hardly any relationship between the various types of drug use. A Dutch study on the relationship between various types of drug use is by Cohen and Sas (1999) who claim that they do not ...nd indications of the stepping-stone hypothesis to be valid.

2.2 Theoretical framework

People may start using soft and hard drugs for a variety of reasons. They may even act rational when they start using a drug to which they may get addicted. Orphanides and Zervos (1995) give an interesting explanation of this phenomenon. They argue that addiction is the unintended occasional outcome of experimenting with an addictive good known to provide certain instant pleasure and only probabilistic future harm. Consumption of addictive goods is not equally harmful to all individuals. Some individuals do not know their addictive tendency. If they experiment and recognize their tendency too late they are drawn into addiction. Therefore, addiction is voluntary but not intentional. If individuals belief that the risk of addiction is high they may optimally choose not to experiment with the addictive good. This may explain why even though the ratio of casual users to addicts may be lower for heroin or cocaine than for alcohol, a larger fraction of the population tends to be addicted to alcohol than to heroin because most potential heroin addicts optimally abstain from experimentation, thereby never risking addiction.

There is a clear analogy between experiments with addictive goods and job search. In the job search literature job finding is usually modeled as a sequential process. Job seekers are confronted with a flow of job offers and conditional on getting a job offer they decide immediately to accept it or not. If they accept it, job search has come to an end. If they reject the job offer, search continues until finally the job seeker is confronted with an acceptable job offer. The analogy is that people are confronted with offers to use drugs. They may not be actively searching but they may bump into an offer to use a drug and then have to decide whether or not to accept the offer and start consumption. If the person rejects the offer to consume he or she continues to be a non drug-user until the next offer comes in. It may be that individuals do not search actively and are never confronted with an offer to start using drugs. It may also be that some individuals will never accept any offer.[3] The starting rate of drug use consists of two components: the offer arrival rate and the acceptance probability. Let me first consider the offer arrival rate. It may be that a person is actively searching for a drug but more likely it is the social environment that determines the offer arrival rate. This offer arrival rate may change as the person grows older. He or she may be confronted with drugs at school or when going out to make fun. It is likely that the offer arrival rate increases as the person reaches the legal drinking age at which he or she is considered to be old enough to drink alcohol. Concerning the acceptance probability it holds that this is determined by the balance of perceived and true costs and benefits. The costs include fear of addiction, the price of the drug, fear of punishment, disutility of belonging to the group of drug users et cetera. The benefits

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[3] In the empirical analysis I will take account of this type of individuals by allowing for the possibility that there is a group of people that will never start consuming a particular drug.

6

concern the direct pleasure of using the drug, the pleasure of belonging to a particular scene, et cetera. Costs and bene...ts of drug use are individual-speci...c. Two persons may face objectively identical events and yet make a di¤erent choice. As a person grows older costs may increase because drug use may a¤ect career perspectives. Bene...ts of drug use may decrease because individuals may derive more pleasure from other types of consumption. Thus the acceptance probability may decline as a person grows older.

In this framework it is relatively easy to introduce the stepping stone hypothesis. The stepping stone claim is that the use of one drug may increase the starting rate for the use of the next drug. This could go either through the o¤er arrival rate or through the acceptance probability. If an individual uses a particular soft drug this may increase the probability that this individual comes into contact with a supplier of a hard drug. The acceptance probability for a hard drug may change after an individual has experienced a soft drug. Note that from a policy perspective it is not important to distinguish between the e¤ect on the o¤er rate or the acceptance probability. It is the net e¤ect on the starting rate that is important. In the analysis below I describe this in more detail.

3 Drugs in the Netherlands

3.1 The opium law

The Netherlands has a special type of drug policy. The main aim is to protect the health of individual users, the people around them and society as a whole.[4] There are clinics for the treatment of addicts and

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[4]See Ministry of Health, Welfare and Sport (1997) from which I derived most of the information in this section. An international perspective on Dutch drug policy

care services, which aim to reach as many addicts as possible to assist them in efforts to rehabilitate, or to limit the risks caused by their drug habit. Methadone programs enable addicts to lead reasonably normal lives without causing nuisance to their immediate environment, while needle exchange programs prevent the transmission of diseases such as AIDS and hepatitis B through infected needles. The services also provide counseling.

Regulations on drugs are laid down in the Opium Act, which draws a distinction between hard drugs and soft drugs. The distinction that is drawn relates to the health risks involved in drug use. Hard drugs are those substances which can seriously harm the health of the user and include heroin, cocaine an synthetic drugs such as ecstasy. Soft drugs, i.e. the cannabis derivatives marihuana and hashish cause far fewer health problems. The possession of hard drugs is a crime. However, since 1976 the possession of a small quantity of soft drugs for personal use is a minor offence.

As in many other countries, the expediency principle is applied in Dutch policy on investigations and prosecutions. The highest priority is given to the investigation and prosecution of international trafficking in drugs; the possession of small quantities of drugs for personal use is accorded a much lower priority. Anyone possessing less than 0.5 grammes of hard drugs will generally not be prosecuted, though the police will confiscate the drugs and consult a care agency. The expediency principle is applied to the sale of cannabis in "coffee shops" in order to separate the users' market for hard and soft drugs and keep young people who experiment with cannabis away from hard drugs. The sale of small quantities of soft drugs in coffee shops is therefore technically an offence,

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is given in Boekhout van Solinge (1999).

but prosecution proceedings are only instituted if the operator or owner of the shop does not certain criteria. These criteria are that no more than ...ve grammes per person may be sold in any one transaction, no hard drugs may be sold, drugs may not be advertised, the co¤ee shop must not cause any nuisance, no drugs may be sold to persons under the age of 18, which may not be admitted to the premises. The mayor may order a co¤ee shop to be closed.

The Dutch policy on soft drugs is based on the assumption that the soft drugs are no gateway to hard drugs. The idea is that if soft drugs are easy accessible and can be bought in an environment where hard drugs are di¢cult to get the fact that a person starts using a soft drug does not in‡uence the o¤er arrival rate for hard drugs. On the other hand if the provision of soft drugs is through illegal channels there is a major increase in the o¤er arrival rate for hard drugs.

3.2 Drug use

The most recent information about drug use in the Netherlands is from a 1997 national study among the population of 12 years and older. The ...gures are based on self-reported data of about 22,000 respondents. Information about the most frequently used types of drugs is reported in Table 1. To put the numbers into perspective Table 1 also gives information about the use of alcohol and tobacco and compares the numbers with similar information for the USA.

Overall in the Netherlands lifetime prevalence of alcohol is about 90%, while for tobacco it is almost 70%. Of the other illicit or quasi-illicit drugs cannabis is the most popular one. Lifetime prevalence for cannabis is about 16%, while for cocaine this is 2.1% and for heroine it is 0.3%. For the USA lifetime prevalence for alcohol is smaller than in the

Netherlands while tobacco is about the same. Lifetime prevalence for cannabis, cocaine and heroine is substantially higher in the USA than it is in the Netherlands.

Across the Netherlands levels of drug use are by far the highest in Amsterdam, even conditional on the population density.[5] For example, lifetime cocaine use in Amsterdam is 9.3%, which is substantially higher than the 1.0% that holds for rural areas. Despite these di¤erences age of initiation with cocaine is very similar, with 24.6 in Amsterdam and 25.7 in rural areas. Lifetime use of cannabis in Amsterdam was 36.3%, versus 10.5% in rural areas and the national average being 15.6%.[6] For cannabis the age of initiation is 20.3 in Amsterdam and 19.5 in rural areas.

For tobacco there is a big di¤erence between on the one hand last-year and last-month prevalence and on the other hand lifetime prevalence. Apparently many people have stopped smoking or do not smoke that often. For alcohol this di¤erence is smaller. Last year and last month prevalence for alcohol and tobacco is lower in the USA than the Netherlands. For cannabis and cocaine last year and last month prevalence in the USA is in between the numbers for the Netherlands and Amsterdam. For heroine the numbers for last month prevalence are too small to report in the USA and the Netherlands as a whole. Last month prevalence of heroine in Amsterdam was 0.2%. Because of their limited number, heroin users are omitted from the analysis in the remaining part of the paper.

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[5] Abraham (1999) shows that there is a positive relationship between population density and drug use.

[6] This …gures are comparable to the 16% in France (1995), 13.9% in Germany (1993) and the 22.0% in the UK (1996).

4 The dynamics of drug use

4.1 Data

The data used in the analysis are collected in Amsterdam. Out of the population of 700.000, Amsterdam has around 5000 hard-drug users. Around 2000 are of Dutch origin, 1350 have roots in former colony of Surinam, the Netherlands Antilles and Morocco. Around 1750 users come from other European countries, mainly Germany and Italy. Amsterdam has around 300 recognized, so-called "co¤ee-shops" were soft drugs can be purchased.

The data are from four subsequent but separate surveys by CEDRO, the Center for Drug Research of the University of Amsterdam (see Abraham et al. (1999) for a more detailed description). The surveys were carried out in 1987, 1990, 1994 and 1997. There are some di¤erences between the surveys, but the information used in this paper is collected consistent through time. The data on drug use are based on self-reported information, which is the norm for analyses of drug consumption.

To illustrate the type of data that were collected I give a short description of the data collection procedure for the 1997-survey and only report on the other surveys if the procedure was substantial di¤erent from the one of the 1997-survey. The survey population is de...ned as all persons in the Municipal Population Registry of Amsterdam, recorded on January 1st 1997 and age 12 and older. In the 1997 survey, almost 8,000 people were approached by letter and asked to participate in a face-to-face interview in a survey about life styles and the use of medical and other drugs. At the end, 3,798 respondents were interviewed. In former years the response was of the same order. The ...eldwork started in April 1997 and lasted till April 1998. The 1987 and 1990 surveys were

paper-written. In 1994 two interview methods were applied, a written and a computer assisted version. The sample was randomly subdivided into two equal sized samples. It turned out that the interview method did not a¤ect the answers to the questions. In 1997 only the computer assisted method was used.

The gross sample consists of 16,982 observations. I reduced this sample by using a number of criteria. To have some homogeneity concerning the calendar time I only consider individuals who were born after 1949. Furthermore, I ignore very early starting ages and only consider individuals that report a starting age for the use of cannabis or cocaine higher than age 11. Because some studies ...nd individuals from ethnic minority groups to underreport drug consumption I focus on individuals born in the Netherlands with a Dutch nationality. Finally, to make sure that individuals have a completed education I only consider individuals that were at the time of the survey older than 25 years. These selections lead to a dataset of 4,244 people aged 26-47 years. More detailed information about the data is presented in the appendix.

4.2   Stylized facts

This section considers starting rates for cannabis and cocaine separately. The starting rates are transition rates from non-use to use for each particular year of age, conditional on not having started to use up to that age. These starting rates are the focal point of part of the empirical analysis the results of which are presented below. The information presented is from four Amsterdam surveys of which the details are presented in the appendix.

Figure 1 presents the starting rates for cannabis and cocaine as measured in the Amsterdam surveys. The starting rate for cannabis peaks

12

at 18-20 years. If one does not start using cannabis before the age of 25 the likelihood of starting at a higher age is very small. For cocaine starting rates are very small, around 1-1.5% for the age groups involved. People start using from age 18 and there is no clear peak at a particular age. The use of cannabis and cocaine hardly increases after age 25. At age 25 the cumulative starting probability for cannabis is 39% and for cocaine 8%. At age 40 the cumulative starting probability for cannabis is 42% and for cocaine 11%.

Table 2 shows average and conditional lifetime prevalence rates, which are informative about multiple drug use.[7] On average 14.1% of the people on our sample use cocaine, but for cannabis users lifetime prevalence for cocaine is 26.8%. Whereas the average lifetime prevalence for cannabis is 51.1%, of the cocaine users 97% also use or have used cannabis.

Table 3 shows the timing of consumption for cannabis and cocaine. It appears that 92% of the individuals ...rst consume cannabis and then cocaine, while for only 1.4% it is the other way around. About 6% of the people start using cannabis and cocaine at the same age.

Figure 2 shows the annual starting rate for cocaine conditional on prior use of cannabis. From this ...gure it appears that about 2% of the cannabis users starts using cocaine almost simultaneously. The conditional starting rate is at its peak four years after the individual started using cannabis. After that the conditional starting rate for cocaine declines.

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[7] The average lifetime prevalence rates are di¤erent from those presented in Table 1 because the information in Table 2 is based on the dataset which we analyze in more detail below. This dataset concerns individuals aged 25-47.

13

4.3 Single starting rates

In the analysis of the starting process I use hazard rate analysis, a technique that is frequently used in the analysis of labor market dynamics but this is rarely applied to drug use. Douglas and Hariharan (1994) uses a duration model of the age of starting smoking. They ...nd non-economic variables such as education, marital stress, race and gender to have a much larger impact than price or income on the probability and timing of initiating smoking.[8] As described before Ferguson and Horwood (2000) use the prior experience of cannabis as an explanatory factor in a proportional hazards duration model of the age of onset of use other illicit drugs.[9]

The starting point in the current analysis is the mixed proportional hazard model with a ‡exible baseline hazard. Di¤erences between individuals in the rate by which they start using a particular drug is characterized by the observed characteristics x, the elapsed duration of time they are exposed to potential use and unobserved characteristics v. I take age 12 to be the time at which this potential exposure to drugs starts.

The starting rate for cannabis, at time t conditional on observed characteristics x and unobserved characteristics v is speci...ed as

$$\mu_1(t \mid x; v) = \lambda_1(t) \exp(x^{0}\beta_1 + v) \tag{1}$$

where $\lambda(t)$ represents individual duration dependence and v represents individual speci...c unobserved heterogeneity. I model ‡exible duration

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[8] Douglas (1998) also looks at the quit rate from smoking, ...nding that the quit rate increases with future cigarette price and rises with the duration of smoking.

[9] As will be clear later on the analysis in the current subsection di¤ers from their study in terms of the speci...cation of the baseline hazard and the introduction of unobserved heterogeneity.

dependence by using a step function:

$$\lambda(t) = \exp(\textstyle\sum_k \alpha_k I_k(t)) \qquad (2)$$

where k (= 1,..,19) is a subscript for age-intervals and $I_k(t)$ are time-varying dummy variables that are one in subsequent age-intervals. I distinguish 20 age intervals of which 19 are of 1 year (age 12, 13, 14, .., 30) and the last interval is open: 30+ years. Because I also estimate a constant term, I normalize $\alpha_1 = 0$. I model unobserved heterogeneity assuming a discrete distribution G(v) that has two points of support v^a and v^b:

$$\Pr(v = v^a) = p$$

$$\Pr(v = v^b) = 1 - p \qquad (3)$$

where p is assumed to have a logit specification: $p = \frac{\exp(\rho)}{1+\exp(\rho)}$: The conditional density function of the completed durations of non-use can be written as

$$f(t \mid x; v) = \mu_1(t \mid x; v) \exp(-\int_0^t \mu_1(s \mid x; v)ds) \qquad (4)$$

where we remove the unobserved heterogeneity by integration:

$$f(t \mid x) = \int_v f(t \mid x; v)dG(v)$$

The likelihood is specified as:

$$L = d \sum \log(f) + (1 - d) \sum \log(1 - F) \qquad (5)$$

where F is the distribution function related to f, d is a dummy variable with a value of one if the transition is completed and a value of zero is the duration of the spell is right censored.

15

For the explanatory variables I use gender, education, birth cohort and year of survey. The birth cohort picks up e¤ects of changes in government policy or price movements while the year of survey controls for possible di¤erences in the interview techniques across the surveys. The estimation results for the starting rates of cannabis are shown in Table 4. The ...rst column show the estimation results when unobserved heterogeneity is ignored, the third column gives the estimation results when unobserved heterogeneity is allowed for. The estimation results improve substantially after allowing for unobserved heterogeneity to a¤ect the starting rates.[10] As it turns out of the estimated two mass points of the distribution of unobserved heterogeneity, one is equal to zero. This means that conditional on the characteristics of the individual there is a group that will never start consuming cannabis. The estimated ® indicates that there is a group of 58% of the individuals that has a positive starting rate for cannabis and a group of 42% with a zero starting rate. The introduction of unobserved heterogeneity a¤ects some of the other parameter estimates. The parameter estimates in the third column of Table 4 indicate that females and individuals with primary education have a lower starting rate for cannabis. Individuals born in the early 1950s have a lower starting rate for cannabis than individuals born in the late 1950s or early 1960s. Individuals born from the late 1960s onwards have the highest starting rates for cannabis.

When it comes to the starting rate for cocaine the potential e¤ect of the previous use of cannabis has to be taken into account. The idea is that as soon as an individual starts using cannabis he or she could be

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[10]The di¤erence in loglikelihood value between column 1 and 3 is 55.5, so a Likelihood Ratio test would indicate that the estimation results have signi...cantly improved. Note however that a formal likelihood ratio test cannot be applied because one of the parameters is not identi...ed in the model without unobserved heterogeneity.

more likely to start using cocaine as well. The period over which this stepping stone e¤ect may occur is not inde…nite. If after a while the individual has not started using cocaine it is irrelevant that the person ever started using cannabis. I call the period during which the stepping stone might occur the 'incubation period'. Then the starting rate for cocaine at time t conditional on x, the starting time of cannabis t_1, the end of the incubation period t_z and unobserved characteristics u can be speci…ed as follows:

$$\mu_2(t \mid x; u; t_1) = \,_2(t) \exp(x^{0-}\,_2 + \pm (t_1 \cdot t \cdot t_z) + u) \qquad (6)$$

where I is an indicator variable with a value 1 if the expression is true and a value 0 otherwise, $\pm$ is the parameter that determines whether cannabis is a 'stepping stone' for cocaine ($\pm > 0$), whether they are substitutes ($\pm < 0$), or whether there is no relationship between the two ($\pm = 0$). For the moment I assume the incubation period to last for 5 years.[11] Later on, in the next section I will investigate the sensitivity of the parameter estimates with respect to the length of this period.

The estimation results for the starting rate of cocaine are shown in the second column of Table 4. This column contains parameter estimates when unobserved heterogeneity is not accounted for. Females and individuals with primary education are less likely to start consuming cocaine than their counterparts. Individuals born in the early 1950s are less likely to start using cocaine but for later cohorts there is not a lot of di¤erence in the starting rate. It turns out that the introduction of unobserved heterogeneity does not improve the estimation results.

Our main parameter of interest, $\pm$; is signi…cantly di¤erent from zero

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[11]Note that $t_1 \cdot t$ implies that if individuals start using cannabis and cocaine at the same age this is due to the stepping stone e¤ect.

17

and is quite large. These results would imply that cannabis is a major stepping stone for the use of cocaine. However, it is possible that this effect is caused by the presence of unobserved characteristics that cause spurious positive correlation between the starting rates for cannabis and cocaine. If these effects are not accounted for they are picked up by $\pm$, thus overestimating the stepping stone effect. To establish whether there is truly a causal relationship between cannabis and cocaine the correlation between unobserved determinants of both starting rates has to be taken into account.

5 Interdependent starting rates?

5.1 Set-up of the analysis

From a dynamic point of view the gateway effect in drug consumption is similar to the effect of policy interventions aimed at reducing unemployment duration. To study the impact of policy interventions on unemployment durations the so called 'timing-of-events' method is used in several studies. The general idea is that treatment effects can be estimated in the context of a bivariate duration model. The 'timing-of-events' approach explicitly makes use of the information contained in the timing of the treatment. A treatment can be started at different points of time during an unemployment spell and variation in the timing of the treatment can be exploited to identify the (causal) treatment effect. A major advantage of this approach is that identification of the treatment effect does neither rely on a conditional independence assumption nor is it necessary to have a valid instrument. Given that economic theory does not suggest a natural instrument, this is a particularly useful feature of

this approach.[12]

Examples of studies that apply this approach are Abbring, Van den Berg and Van Ours (1997) and Van den Berg, Van der Klaauw and Van Ours (1998). In these studies the e¤ect of bene...t sanctions on the transition rate from unemployment to employment is modeled. Selectivity in the imposition of sanctions is accounted for by modeling both the job ...nding rate and the rate by which unemployed get a sanction imposed and allowing for correlation between the unobserved heterogeneity terms in both transition rates. Both studies ...nd a signi...cant positive e¤ect of bene...t sanctions on the transition rate from unemployment to a job. In the study by Van den Berg, Van der Klaauw and Van Ours (1998) it is shown that if unobserved heterogeneity is not accounted for, no e¤ect of sanctions is found. Other examples are the studies by Bonnal et al. (1997), Lubyova and Van Ours (1999) and Lalive, Van Ours and Zweimüller (2000) in which the e¤ect of active labor market policies in France, the Slovak Republic and Switzerland are investigated.

In the current study on drug consumption I also use a bivariate duration approach to establish the possible existence of a gateway e¤ect. Both starting rates are speci...ed as before, but now I take the possible correlation between the unobserved components into account specifying the joint density function of the two durations of non use t_1 and t_2 conditional on x as

$$f(t_1, t_2 \mid x) = \int_u \int_v f_2(t_2 \mid x; u; t_1) f_1(t_1 \mid x; v) dG(u; v) \qquad (7)$$

$G(u; v)$ is assumed to be a discrete distribution 4 points of support

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[12]See Van den Berg (2000) for the use of bivariate models in the estimation of treatment e¤ects. Abbring and Van den Berg (1998) give a formal proof of the identi...cation of the treatment e¤ect in a bivariate duration model. They show that in this framework, identi...cation is achievable without the usual restrictions.

$(u^a; v^a)$; $(u^a; v^b)$; $(u^b; v^a)$; $(u^b; v^b)$: The associated probabilities are denoted as follows:

$$\Pr(u = u^a; v = v^a) = p_1 \qquad \Pr(u = u^a; v = v^b) = p_2$$

$$\Pr(u = u^b; v = v^a) = p_3 \qquad \Pr(u = u^b; v = v^b) = p_4 \qquad (8)$$

where p_n ($n = 1; ...; 4$) is assumed to have a multinomial logit speci...cation:

$$p_n = \frac{\exp(\alpha_n)}{\sum_n \exp(\alpha_n)}$$

and I normalize $a_4 = 0$.

The likelihood-speci...cation is similar to the one presented before, now with four parts of completed and incomplete durations (two of each of the drugs involved).

5.2 Parameter estimates

The parameter estimates are shown in Table 5. When allowing for correlated unobserved heterogeneity I ...nd a discrete distribution with 3 points of support. There is a positive but not perfect correlation between the unobserved components since conditional on their observed characteristics 15% of the individuals has relatively large starting rates for both cannabis and cocaine while 62% of the individuals combines a small starting rate for cannabis and cocaine, which for cocaine is equal to zero. The remaining 23% of the individuals has a relatively high starting rate for cannabis an a zero starting rate for cocaine while none of the individuals has a combination of a positive starting rate for cocaine and a very small starting rate for cannabis. This implies that of the individuals that are likely to start using cannabis 60% will never start using

20

cocaine. This means that a potential stepping stone effect is restricted to the remaining 40%.

After introducing correlated unobserved heterogeneity, gender and education do not affect the starting rate of cocaine. Again, individuals born in the early 1950s have a lower starting rate, but there is hardly a distinction between later birth cohorts.

The introduction of correlated unobserved heterogeneity has a huge impact on the stepping stone effect. The value of $\pm$ drops from 1.34 to 0.29. This indicates that the stepping stone effect may be to a large extent due to unobserved components. Nevertheless, when allowing for these unobserved components to affect the starting rate for cocaine I still find a $\pm$ that is significantly larger than zero. So, there is a potential gateway from cannabis to cocaine but the joint use of cannabis and cocaine is mostly related to unobserved individual characteristics.

5.3   Sensitivity analysis

To investigate the sensitivity of the parameter estimates I performed a number of additional analyses. I investigated whether introducing more mass points in the distribution of unobserved heterogeneity would improve the estimation results but could not identify additional mass points. Furthermore, I investigated whether combining age classes of 1 year into age classes of several years to smooth spikes had an effect. Again, I did not find the parameter estimates to change a lot.

Finally, I investigated to what extent the length of the incubation period is relevant. Table 6 shows estimates of $\pm$ for different incubation periods. In the model without unobserved heterogeneity I find a significant stepping stone effect no matter whether the incubation period is 2 years or 15 years. As soon as I introduce unobserved heterogeneity

these results change. If the incubation period would be less than 4 years no signi...cant stepping stone e¤ect is found. If the incubation period is 15 years the stepping stone e¤ect is substantial even after allowing for correlated unobserved heterogeneity.

To give some indication of the relevance of the use of one drug affecting the starting rate for the next drug I performed some simulations for male individuals with only basic education born in the early 1950s. The results of these simulations are shown in Table 7. The cumulative starting probability for cannabis for this group of individuals was 41% at age 20, 50% at age 25 and 53% at age 30. If the individual does not use cannabis the cumulative starting probability at age 20 is 2.6% for cocaine which increases to 8.4% at age 25 and 13.9% at age 30. If an individual would have started consuming cannabis at age 20 the cumulative starting probability for cocaine at age 25 would be 9.4%, which is only slightly higher that the probability without using cannabis. So the simulations also indicate that the gateway e¤ect of cannabis with respect to cocaine is limited.

6   Conclusions

This paper uses a unique dataset collected among inhabitants of Amsterdam, to study the dynamics in the consumption of cannabis and cocaine. The main issue addressed here is whether cannabis is a gateway for cocaine. A lot of the evidence of soft drugs being a stepping stone or a gateway from soft drugs to hard drugs is only circumstantial. Many people that use cannabis also use cocaine. Most of the people that consume cocaine also use cannabis. I ...nd evidence of a causal relationship between the use of cannabis and cocaine. Nevertheless, the multiple use of both drugs is mostly related to (unobserved) heterogeneity. The Dutch

22

policy to separate the markets of soft drugs and hard drugs is not irrational. This does not necessarily imply that this policy is successful in separating both markets. It could be that the markets for soft drugs and hard drugs are separated anyway. It would be interesting to replicate the analysis for other countries with different drug policies. Whatever the opinion on Dutch drug policy it is clear from this study that the liberal attitude towards soft drugs does not have the detrimental effect of eventually stimulating the consumption of hard drugs.

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7 Appendices

7.1 Information about the dataset

In the analysis the following explanatory variables are used:

- ² Female: dummy variable with value 1 for females and 0 for males

- ² Primary education: Dummy variable with a value of 1 if the individual attended extended primary education after having attended basic education, and a value of 0 otherwise.

- ² Secondary education: Dummy variable with a value of 1 if the individual attended secondary general or vocational education, and a value of 0 otherwise.

- ² Higher education: Dummy variable with a value of 1 if the individual attended higher vocational or academic education, and a value of 0 otherwise. Since there are three dummy variables for education the overall reference group consists of individuals with only basic education.

- ² Cohort 1956-60: Dummy variable with a value of 1 if the individual was born in the period 1956-60 and a value of zero otherwise.

- ² Cohort 1961-65: Dummy variable with a value of 1 if the individual was born in the period 1961-65 and a value of zero otherwise.

- ² Cohort 1966-70: Dummy variable with a value of 1 if the individual was born in the period 1966-70 and a value of zero otherwise.

- ² Cohort post 1960: Dummy variable with a value of 1 if the individual was born after 1970 and a value of zero otherwise.

² Year 1990: dummy variable with a value of 1 if the individual was questioned in 1990 and a value of 0 otherwise.

² Year 1994: dummy variable with a value of 1 if the individual was questioned in 1994 and a value of 0 otherwise.

² Year 1997: dummy variable with a value of 1 if the individual was questioned in 1997 and a value of 0 otherwise.

Table A1 presents some characteristics of the dataset used in the analysis. As shown the average age in the sample is about 33.5 years, while 50% of the respondents is female. About 4% of the sample have only basic education, while about 46% have a higher education. Due to the sample selection the size of birth cohorts is decreasing over time. There is an evenly distribution of respondents over the three surveys. Table A1 also shows that the mean starting ages for cannabis is 19.1 years and for cocaine 23.9 years.[13]

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[13]The sequence is similar in Britain. Pudney (2001) ...nds that here the mean starting age for cannabis is 16.6 and for cocaine 20.2. As it seems British youth on average start about 2-3 years earlier with the use of each of these drugs than Dutch youth does.

Table 1 Prevalence of drugs use in the Netherlands and Amsterdam (%)[a]

	Alcohol	Tobacco[b]	Cannabis	Cocaine	Heroin
Lifetime					
USA	81.9	70.5	32.9	10.5	0.9
Netherlands	90.2	67.9	15.6	2.1	0.3
Amsterdam	88.1	71.4	36.3	9.3	1.7
Last year					
USA	64.1	32.7	9.0	1.9	0.3
Netherlands	82.5	38.1	4.5	0.6	0.1
Amsterdam	79.6	46.4	13.1	2.6	0.5
Last month					
USA	51.4	29.6	5.1	0.7	-[c]
Netherlands	73.3	34.3	2.5	0.2	-[c]
Amsterdam	70.9	41.8	8.1	1.0	0.2

[a] Percentages of the population of 12 years and older

[b] Cigarettes only

[c] Low precision, no estimate reported

Source: National Household Survey 1997 SAMHSA, O¢ce of applied studies Washington D.C. and National survey of licit and illicit drug use in the Netherlands, 1997

Table 2 Conditional lifetime prevalence; individuals aged 26-47 years (%)

	Total	If use of:	
		Cannabis	Cocaine
Alcohol	96.7	99.3	99.3
Tobacco	78.3	91.6	92.3
Cannabis	51.1	100.0	97.0
Cocaine	14.1	26.8	100.0
N	4244	2168	598

Table 3 Timing of consumption; individuals aged 26-47 years (%)

Cocaine before cannabis	1.4
Same age	6.5
Cannabis before cocaine	92.1
Total (%)	100.0
N	570

Table 4 Estimation results correlated starting rates cannabis and cocaine

	Unobserved heterogeneity		
	No		Independent
	Cannabis	Cocaine	Cannabis
Explanatory variables			
Female	-0.25 (5.7)	-0.38 (4.2)	-0.26 (4.7)
Primary education	-0.26 (1.8)	-0.55 (2.1)	-0.99 (6.7)
Secondary education	0.45 (3.2)	-0.05 (0.2)	0.17 (1.2)
Higher education	0.56 (4.0)	-0.31 (1.3)	0.08 (0.6)
Cohort 1956-60	0.07 (1.1)	0.36 (3.0)	0.28 (4.0)
Cohort 1961-65	0.03 (0.5)	0.33 (2.4)	0.22 (2.8)
Cohort 1966-70	0.26 (3.4)	0.19 (1.1)	0.60 (6.6)
Cohort post 1970	0.33 (2.0)	0.25 (0.6)	0.78 (3.3)
Stepping stone e¤ect			
±	-	1.34 (13.0)	-
Mass points			
v^a	-6.16 (18.6)	-7.38 (16.2)	-5.27 (16.4)
v^b ¡ v^a	-	-	¡ 1
Heterogeneity distribution			
®	-	-	0.32 (5.8)
¡ Loglikelihood	8,294.2	3,203.6	8,238.7

[a)] All estimates include dummy variables for the surveys of 1990, 1994 and 1997 and age variables representing duration dependence (the estimates are shown in the appendix); absolute t-values in parentheses.

Table 5 Estimation results correlated unobserved heterogeneity[a]

	Cannabis	Cocaine
Explanatory variables		
Female	-0.21 (3.9)	0.08 (0.9)
Primary education	-0.61 (3.6)	0.23 (1.1)
Secondary education	0.09 (0.6)	0.24 (1.2)
Higher education	-0.00 (0.0)	-0.30 (1.6)
Cohort 1956-60	0.19 (2.7)	0.82 (7.0)
Cohort 1961-65	0.26 (3.5)	1.27 (8.7)
Cohort 1966-70	0.67 (7.7)	1.09 (5.1)
Cohort post 1970	0.60 (2.3)	0.84 (1.3)
Stepping stone e¤ect		
±	-	0.29 (3.5)
Mass points		
v^a	-4.92 (14.5)	-6.34 (14.3)
v^b ¡ v^a	-2.90 (24.1)	¡ 1
Heterogeneity distribution		
$®_1$	-1.43 (26.4)	
$®_2$	¡ 1	
$®_3$	-0.98 (10.5)	
¡ Loglikelihood	11,070.3	

[a] All estimates include dummy variables for the surveys of 1990, 1994 and 1997 and age variables representing duration dependence (the estimates are shown in the appendix); absolute t-values in parentheses.

Table 6 Influence of incubation period on stepping stone effect
(±) as estimated in the starting rate for cocaine

Incubation period (years)	Unobserved heterogeneity	
	No	Correlated
2	0.85 (6.2)	0.05 (0.4)
3	1.01 (8.7)	0.14 (1.4)
4	1.14 (10.7)	0.21 (2.3)
5	1.34 (13.0)	0.27 (3.3)
10	2.09 (18.1)	0.68 (6.9)
15	3.09 (19.6)	1.55 (8.8)

Table 7 Simulation results: cumulative number of users (%)[a]

	Cannabis	Cocaine	
		No cannabis	Cannabis[b]
Age 20	41	2.6	2.8
Age 25	50	8.4	9.4
Age 30	53	13.9	14.1

[a] The simulations are based on the parameter estimates presented in Table 5 and concern male individuals with only basic education, born early 1950s.

[b] The consumption of cannabis is assumed to have started at age 20

Table A1 General characteristics of the dataset

	Mean	Minimum	Maximum	N
Age	33.5	26	47	4244
Female	0.50	0	1	4244
Primary education	0.23	0	1	4244
Secondary education	0.27	0	1	4244
Higher education	0.46	0	1	4244
Cohort 1956-60	0.29	0	1	4244
Cohort 1961-65	0.26	0	1	4244
Cohort 1966-70	0.13	0	1	4244
Cohort post 1970	0.01	0	1	4244
Survey 1990	0.23	0	1	4244
Survey 1994	0.30	0	1	4244
Survey 1997	0.27	0	1	4244
Starting age cannabis	19.1	12	45	2124
Starting age cocaine	23.9	13	45	593

Table A2 Pattern of duration dependence (age dummies) and coefficients of survey dummies

	Unobserved heterogeneity				
	No[a]		Independent[a]	Correlated[b]	
	Cannabis	Cocaine	Cannabis	Cannabis	Cocaine
Age 13	1.16 (3.4)	-	1.17 (3.5)	1.17 (3.5)	-
Age 14	2.06 (6.5)	-	2.08 (6.8)	2.10 (6.7)	-
Age 15	2.76 (8.9)	1.64 (3.5)	2.82 (9.4)	2.86 (9.3)	1.76 (3.8)
Age 16	3.34 (10.9)	1.96 (4.5)	3.48 (11.8)	3.57 (11.8)	2.22 (5.1)
Age 17	3.29 (10.7)	2.77 (7.0)	3.52 (11.9)	3.67 (12.1)	3.20 (8.1)
Age 18	3.66 (11.9)	2.22 (5.4)	4.04 (13.7)	4.27 (14.1)	2.79 (6.8)
Age 19	2.96 (9.5)	2.70 (6.8)	3.43 (11.4)	3.71 (12.0)	3.42 (8.7)
Age 20	3.48 (11.3)	2.15 (5.2)	4.14 (14.0)	4.51 (14.8)	2.98 (7.3)
Age 21	2.66 (8.4)	2.56 (6.3)	3.43 (11.1)	3.82 (12.1)	3.46 (8.7)
Age 22	2.69 (8.5)	2.97 (7.5)	3.60 (11.7)	3.99 (12.5)	4.01 (10.2)
Age 23	2.72 (8.5)	2.77 (6.8)	3.79 (12.2)	4.14 (12.9)	3.93 (9.8)
Age 24	2.06 (6.1)	3.47 (8.7)	3.22 (9.7)	3.54 (10.4)	4.93 (12.7)
Age 25	2.46 (7.6)	2.77 (6.6)	3.78 (11.6)	4.01 (12.1)	4.35 (10.7)
Age 26	1.61 (4.5)	2.48 (5.7)	2.98 (8.3)	3.19 (8.8)	4.17 (9.8)
Age 27	1.64 (4.5)	3.22 (7.8)	3.06 (8.2)	3.28 (8.8)	5.18 (12.9)
Age 28	1.72 (4.7)	2.44 (5.2)	3.19 (8.5)	3.39 (9.1)	4.54 (10.0)
Age 29	1.14 (2.7)	3.64 (8.8)	2.63 (5.9)	2.83 (6.5)	6.48 (16.5)
Age 30	1.76 (4.7)	1.14 (1.6)	3.31 (8.5)	3.51 (9.1)	3.90 (5.7)
Age 30+	0.65 (1.9)	2.01 (4.7)	2.23 (5.6)	2.47 (6.9)	5.30 (12.0)
Survey dummies					
1990	-0.01 (0.2)	-0.12 (0.9)	-0.09 (1.0)	-0.18 (2.2)	-0.17 (1.0)
1994	-0.15 (2.1)	-0.20 (1.4)	-0.19 (2.3)	-0.29 (3.5)	-0.40 (2.4)
1997	0.09 (1.2)	-0.09 (0.6)	-0.20 (2.3)	-0.10 (1.0)	-0.49 (2.8)

[a] See Table 4

[b] See Table 5

Figure 1 Annual starting rates cannabis and cocaine; population 26-47 years (%)
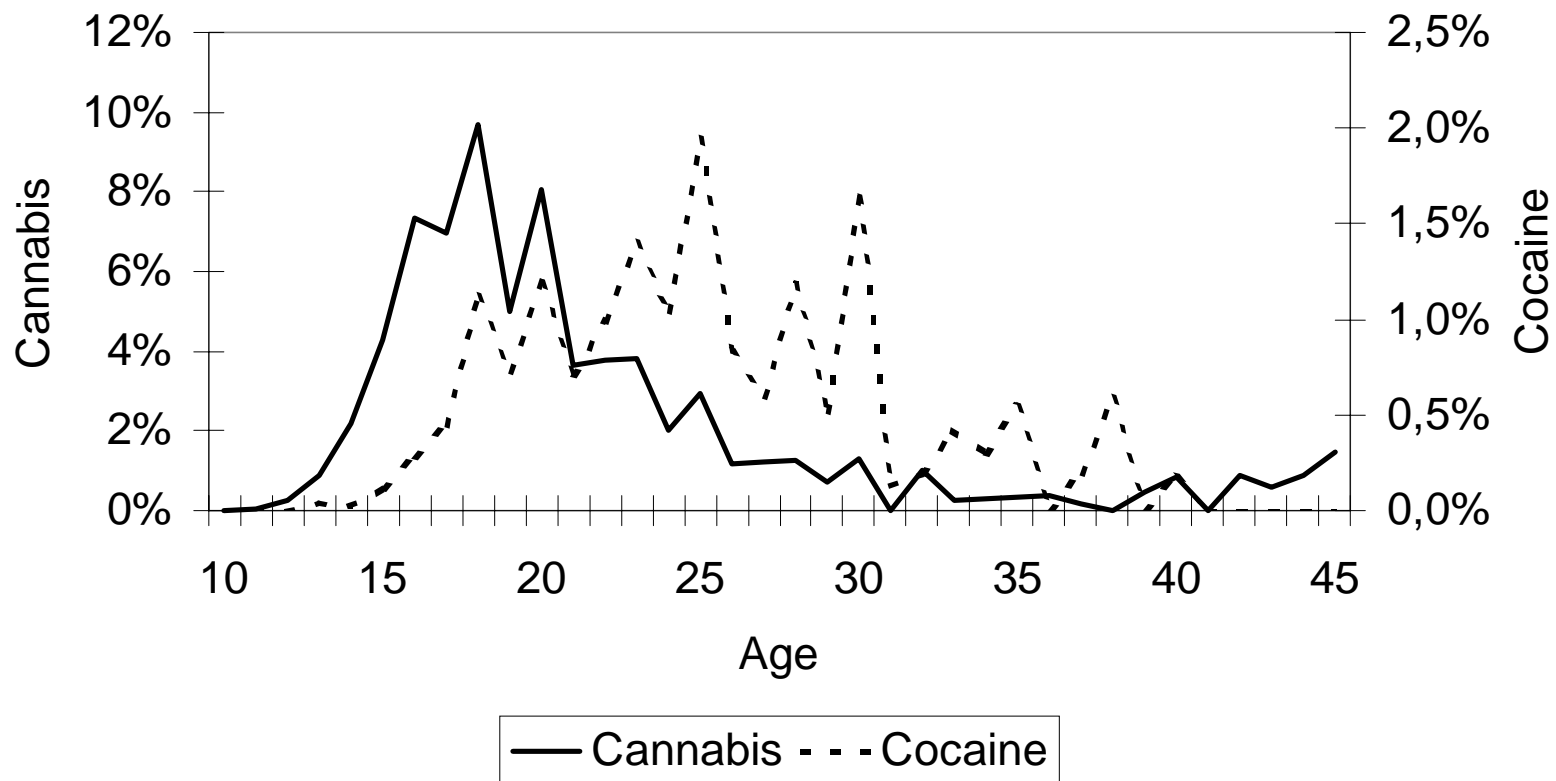
Figure 2 Annual starting rates cocaine conditional on having started consuming cannabis; population 26-47 (%)