

Snowdon, Christopher

Working Paper

Joint venture: Estimating the size and potential of the UK cannabis market

IEA Discussion Paper, No. 90

Provided in Cooperation with:

Institute of Economic Affairs (IEA), London

Suggested Citation: Snowdon, Christopher (2018) : Joint venture: Estimating the size and potential of the UK cannabis market, IEA Discussion Paper, No. 90, Institute of Economic Affairs (IEA), London

This Version is available at:

<https://hdl.handle.net/10419/313990>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



IEA Discussion Paper No.90

JOINT VENTURE

Estimating the Size and Potential of
the UK Cannabis Market

Christopher Snowdon
June 2018

 **iea**

Institute of
Economic Affairs

With some exceptions, such as with the publication of lectures, IEA Discussion Papers are blind peer-reviewed by at least one academic or researcher who is an expert in the field. As with all IEA publications, the views expressed in IEA Discussion Papers are those of the author and not those of the Institute (which has no corporate view), its managing trustees, Academic Advisory Council or senior staff.

Contents

About the author	04
Summary	06
Introduction	08
Previous estimates of the size of the UK's cannabis market	10
Prevalence and quantity in 2016/17	13
Consumption by people aged 16-59	15
Consumption by people aged 60+ years	17
Consumption by people aged 11-15 years	19
Total cannabis consumption in the UK (2016/17)	21
Value of cannabis market	24
Cannabis revenues post-legalisation	25
The effect of legalisation on demand	31
The black market after legalisation	34
Total savings	37
Conclusion	39
References	40

Christopher Snowdon is the Head of Lifestyle Economics at the Institute of Economic Affairs. His research focuses on social freedoms, prohibition and policy-based evidence. He is a regular contributor to the Spectator Health blog and often appears on TV and radio discussing social and economic issues.

Snowdon is the editor of the Nanny State Index and the author of five books: *Killjoys* (2017), *Selfishness, Greed and Capitalism* (2015), *The Art of Suppression* (2011), *The Spirit Level Delusion* (2010) and *Velvet Glove, Iron Fist* (2009). He has also written more than a dozen reports for the Institute of Economic Affairs including 'Drinking, Fast and Slow', 'The Proof of the Pudding: Denmark's Fat Tax Fiasco', 'Cheap as Chips', 'Sock Puppets' and 'Vaping Solutions'.

Summary

- This report aims to provide estimates of:
 - (a) the size and value of the UK's illicit cannabis market in 2016/17
 - (b) the size and value of the market if cannabis were legalised and regulated
 - (c) the annual tax revenue that a legal cannabis market would yield
- Our best estimate suggests that 255 tonnes of cannabis were sold in the UK in 2016/17 at a cost of £2.6 billion to three million consumers.
- Assuming a pre-tax retail price of £4 per gram and a price elasticity of -0.7, legalisation could cause demand to rise from 255 tonnes to at least 321 tonnes per annum. Total THC consumption would rise by less than this and could even fall if regulation mandated maximum THC levels.
- A commercialised marijuana market which capped THC levels at 15 per cent would virtually eradicate the black market, but some unlicensed cannabis would remain. If licensed cannabis made up 95 per cent of market, it would produce annual tax revenues of £495 million (with VAT plus a 10 per cent tax), £557 million (VAT plus a 20 per cent tax) or £690 million (VAT plus a 30 per cent tax). The total market size in these three scenarios (including the unlicensed share) would be 339 tonnes, 329 tonnes and 321 tonnes respectively.
- The highest suggested duty rate of 30 per cent would mean that 36 per cent of the retail price of an average gram of cannabis was tax. This is a lower share of tax than is paid on an average bottle of spirits, litre of petrol or pack of cigarettes in the UK. Although the government could tax cannabis at a higher rate than 30 per cent, this would risk reigniting the black market.

- Savings to the NHS and other public services are beyond the scope of this report, but previous studies have suggested that they would amount to at least £300 million per annum. When these savings are added to excise tax revenues of £690 million plus new streams of income tax, business tax and VAT created by the legal industry, claims about cannabis legalisation providing a £1 billion windfall to the Treasury seem pessimistic. It is likely that tax revenues alone would exceed this. Meanwhile, lower prices would leave cannabis consumers with more money in their pocket, allowing hundreds of millions of pounds to flow into other areas of the economy.

Introduction

The purpose of this report is to calculate the size of the UK cannabis market and to estimate its value and potential tax revenues if it were legalised. With Canada, Uruguay and a growing number of US states abandoning drug prohibition, there is a real chance of European countries following suit.

In Britain, enthusiasm for reform has been dampened by the emergence of sinsemilla ('skunk'), high potency marijuana that is associated with mental health issues. Until around ten years ago, cannabis was considered to be a relatively 'soft' drug. Tony Blair's government reclassified it as a Class C drug in 2004 and there was significant political support for its legalisation. But by the time Gordon Brown returned it to Class B status in 2008, public perception of cannabis had begun to change. It was increasingly associated with dependency, psychosis and schizophrenia.

Cannabis underwent an image change because cannabis itself had changed. Whereas cannabis resin accounted for around 70 per cent of seizures in the 1990s, this fell to 43 per cent in 2005 and then to 31 per cent in 2008. By 2016, it had fallen to just six per cent (Potter et al. 2018). Sinsemilla is dominating the market. A study of 995 cannabis seizures by police forces in London, Kent, Derbyshire, Merseyside and Sussex found that 929 were sinsemilla (ibid.).

This is significant because skunk is typically high in tetrahydrocannabinol (THC), which is associated with psychosis, and low in the non-intoxicating antipsychotic drug cannabidiol (CBD). THC is the main psychoactive substance in cannabis that makes the user feel stoned, but it can also cause side effects such as paranoia which tend to be mitigated by CBD. With high levels of THC and low levels of CBD, skunk poses a threat to the mental health of a small but significant minority of users. Although the

number of cannabis users fell by a third between 2006 and 2014, demand for treatment of cannabis-related mental health problems increased by more than 50 per cent (Englund et al. 2017: 1).

It is therefore no wonder that cannabis has developed a bad reputation and yet the dominance of hazardous, high strength cannabis in the illicit market makes the case for legalisation stronger, not weaker. Opposing legalisation on the grounds that skunk has taken over the market is akin to opposing the end of alcohol prohibition because moonshine had taken over the market. Moonshine virtually disappeared after alcohol was re-legalised in the USA in 1933 and the same would happen to the worst strains of sinsemilla if cannabis were re-legalised and regulated.

Legalising cannabis could alleviate the mental health issues associated with cannabis in two ways. First, by generating tax revenue that could be spent on mental health services. Second, by allowing safer, regulated cannabis to displace the more dangerous strains that have taken over the market.

Previous estimates of the size of the UK's cannabis market

Estimating the size of any illegal market is fraught with difficulties. For obvious reasons, no official sales data are available and it is necessary to make a number of assumptions based on patchy evidence. To calculate the size of the cannabis market we need to know how many people consume the product, how much they typically consume, and how much they pay for it. To predict the size of the market if cannabis were legalised, we then need to make assumptions about what would happen to the price, availability and quality of the product, and how consumers would respond to these changes.

Surveys are the only source of evidence for much of this but surveys are notoriously unreliable, especially when respondents are being asked to admit to illegal activities. We have some evidence of what happens in legal cannabis markets thanks to recent experiments in the USA, but these are in their infancy and may not translate to the UK. The words 'likely' and 'plausible' will appear regularly throughout this report and I will make it clear when assumptions and best guesses are being made. It is up to the reader to decide if they are realistic.

Despite the inevitable uncertainties, several estimates of the UK's cannabis market have been published in the last twenty years. The most thorough research was produced by Pudney et al. (2006) for the Home Office, and Bryan et al. (2013) for the Institute for Social and Economic Research. Pudney et al. (2006: 46) estimated that 360 tonnes of cannabis, with a value of £900 million, were sold in England and Wales in 2003/04. Extrapolated to the whole UK, this amounted to 416.2 tonnes and £1,040 million, equivalent to £1,570 million in 2018 prices (ibid.: 79).

Pudney et al. (2006) used a broad range of evidence, including surveys of school children and people who had been arrested, to get consumption estimates for hard-to-reach groups. In 2013, the Home Office used Pudney et al.'s work as the basis for a fresh report. After changing some of the assumptions, it estimated that the cannabis market in England and Wales had been worth £1,431 million in 2004, an increase of more than 50 per cent on the previous estimate, largely due to prices rising (Vincent et al. 2013: 110). The authors estimated that the market then shrank to £1,059 million by 2010 as the number of cannabis consumers declined (ibid.: 113).

Some of the authors of the Pudney report went on to produce a report for the Institute for Social and Economic Research which, again, used the 2006 report as the starting point. That study (Bryan et al. 2013) suggested that 216 tonnes of cannabis were sold in England and Wales in 2009/10 with a value of £1,380 million, equivalent to £1.7 billion in 2018 prices. The amount sold was thought to have fallen by 40 per cent since 2003/04 as a result of the decline in the number of users and the increased potency of the product. By 2010, 'skunk' made up around 80 per cent of market and was being sold at a higher price than the cannabis resin it displaced, hence the market being more valuable despite less product being sold.

HM Treasury was asked by the Liberal Democrats to run a cost-benefit analysis of cannabis legalisation during the coalition years. Its report was never officially published but it surfaced in 2015. Taking Bryan et al.'s figure of 216 tonnes per annum as a given, it concluded that a large black market would remain after legalisation, but predicted that legalisation would 'generate notable tax revenue' and 'lead to overall savings to public services' (HM Treasury 2015: 1). The National Crime Agency (2018) currently estimates that the cannabis market is worth 'almost' £1 billion a year, with 270 tonnes needed to 'satisfy annual UK user demand', but no source is given for this.

A 2011 report from the Independent Drug Monitoring Unit (IDMU), commissioned by CLEAR Cannabis Law Reform, arrived at much higher figures. It suggested that the legal cannabis market was worth £5.9 billion per annum, with an annual average of 1,037 tonnes being sold between 2004 and 2011 (Atha and Davis 2011: 10). The authors used a methodology that combined seizure and arrest figures and it is probably a significant overestimate. Seizures are a poor proxy for sales and are more likely to reflect the priorities of the police force than the quantity available on the

street. The authors of the IDMU report acknowledge that police activity was stepped up after reclassification of cannabis in 2004 (ibid.: 6) and their figures, which show an improbable doubling in the amount of cannabis sold between 2006 and 2012, are at odds with evidence showing a significant decline in the number of users over this period.

Two other reports suggest that the cannabis market is (or was) larger than the Home Office believes. In 2009, using a demand-side methodology similar to Pudney et al's, a report by RAND Europe for the European Commission estimated that 450.4 tonnes of cannabis were consumed in the UK in 2005, with the market worth £1.5 billion (Kilmer and Pacula 2009: 17). Finally, a recent study by Parey and Rasul (2018) used the novel approach of taking the sale of rolling papers and roll-your-own tobacco as a proxy for cannabis consumption. It concluded that 735 tonnes were sold in 2008/09 at a cost of £2.94 billion.

Prevalence and quantity in 2016/17

Since drug seizures and arrests do not necessarily reflect consumption, most researchers who estimate the size of illicit markets prefer a demand-side approach based on what people say they consume. This is the approach favoured in the present report, with the Crime Survey for England and Wales providing data on prevalence and frequency of consumption. But survey evidence is far from perfect. Drug users are under-represented in surveys because they are more likely to be out of the house, in temporary accommodation or in prison when the Office for National Statistics comes knocking. Those who take part in surveys may be unwilling to admit to drug use to anybody, let alone a government official, and those who admit to being users are likely to under-report their level of consumption (as drinkers do).

A study from the USA used urine tests to show that around a third of young cannabis users did not identify themselves as such in a survey (12.7 per cent said they used the drug while 17.1 per cent tested positive for it) (Harrison et al. 2007: 61). This has been confirmed by other studies which find under-reporting rates of between 20 per cent and 35 per cent.

In this report, all prevalence estimates are adjusted upwards by twenty per cent. This is the 'best estimate' used in a RAND report from 2013 (Kilmer et al. 2013: 15) and is similar to the 22 per cent used by Light et al. (2014: 14) who averaged out the results of previous studies.

Once we have our estimate of the number of users, we need to know how much cannabis they consume. Pudney et al. (2006: 54) rightly note that attempts to measure average quantities consumed by drug users 'introduce the largest element of uncertainty into the estimation process'. Based on

a 'range of fragmentary evidence', they estimated that intensive cannabis users consumed 1.2 grams of cannabis per day of use and non-intensive users consumed 0.55 grams per day of use (ibid.: 66). This is somewhat less than was suggested in a study from Cannabis Consumer Update which estimated that regular cannabis smokers in Canada consume 11 grams a week (1.6g per day) (Freeman 2016), but it is slightly more than the estimate used by RAND Europe which assumed that frequent users consume one gram per day (Kilmer and Pacula 2009: 13). In this report, we use Pudney et al's estimate, which is based on frequent users consuming three joints per day of use and occasional users consuming just under half as much per day of use.

Consumption by people aged 16-59

According to the Crime Survey for England and Wales (2017: 3-4), 2.2 million people aged 16-59 years used cannabis on at least one occasion in 2016/17. This represents 6.6 per cent of this age group and is lower than the 2006/07 figure of 8.2 per cent. In 1996, it was 9.4 per cent. The number of cannabis users therefore seems to have fallen by a third in the last two decades although the rate of past year use has been basically flat since 2009/10 (see Table 1).

Table 1: Cannabis use among 16-59 year olds (2016/17)

	Past year use	Past month use
2003/04	10.6%	6.4%
2010/11	6.7%	3.7%
2016/17	6.6%	3.2%

Until recently, the Crime Survey for England and Wales did not ask about frequency of use and so researchers had to use other survey data to estimate the quantity of cannabis consumed by each user. This has now changed, however, and the crime survey has more detailed information. Of the 2,177,000 cannabis users in 2016/17, 1,047,000 had used the drug in the past month, including 37 per cent who were classed as frequent users (at least once a month) (2017: 10). Of these frequent users, 41 per cent used it less than once a week and 27 per cent used it daily or almost daily (2017: 13).

Combining the figures from the crime survey with the consumption estimates used by Pudney et al. (2006), annual consumption by 16-59 year olds is as follows:

Frequent users (1.2g per day of use)

- 9%** use it every day (195,930): $195,930 \times 1.2\text{g} \times 365 = 85,817,340\text{g}$ (85.8 tonnes)
- 8%** use it 3-5 days a week (174,160): $174,160 \times 1.2\text{g} \times (4 \times 52) = 43,470,336$ (43.5 tonnes)
- 11%** use it once or twice a week (239,470): $239,470 \times 1.2\text{g} \times (1.5 \times 52) = 78 = 22,414,392$ (22.4 tonnes)
- 9%** use it 2-3 times a month (195,930): $195,930 \times 1.2\text{g} \times (2.5 \times 12) = 30 = 7,053,480$ (7 tonnes)
- = 158,755,548 grams (159 tonnes)**

Infrequent users (0.55g per day of use)

- 44%** use it once or twice a year (957,880): $957,880 \times (0.55\text{g} \times 1.5) = 790,251$ grams
- 5%** once every couple of months (108,850): $108,850 \times (0.55\text{g} \times 6) = 359,205$ grams
- 14%** once a month (304,780): $304,780 \times (0.55\text{g} \times 12) = 2,011,548$ grams
- = 3,161,004 grams (3 tonnes)**

TOTAL for England and Wales: 161,916,552 grams (162 tonnes).

In line with Pudney et al. (2006), I generate a figure for the whole UK by adjusting these estimates for England and Wales upwards by 13.5 per cent to reflect population size and different levels of consumption in Scotland and Northern Ireland. This gives us a total of 183,775,287 grams (184 tonnes) which is adjusted upwards by twenty per cent to account for underreporting. This gives a grand total of **220,530,344 grams (221 tonnes)** for 16 to 59 year olds.

Consumption by people aged 60+ years

People over the age of 59 have tended to be neglected in UK estimates, perhaps because there is no data for them in the crime survey. Pudney et al. (2006) assumed that people over 65 have zero drug consumption, but the statistics do not support this and older people are particularly likely to use marijuana for medical reasons. According to the Adult Psychiatry Morbidity Survey, past year use of cannabis by people in England aged 55-64, 65-74 and over 74 is 2.5 per cent, 0.3 per cent and 0.1 per cent respectively. No data is available for past month use, but the same survey suggests that there are signs of cannabis dependence among 1.0 per cent of those aged 55-64, 0.3 per cent of those aged 65-74 and 0.1 per cent of those aged over 74 (NHS Digital 2016).

Assuming that those who show signs of dependence are regular users - and assuming that prevalence rates are similar across the whole UK - the number of regular users in each age group is as follows:

Number of people aged 60-64: 3,534,200 = 35,342

Number of people aged 65-74: 6,488,600 = 19,466

Number of people aged 75+: 5,325,400 = 5,325

Total frequent cannabis users aged 60+ = 60,133

Assuming each of these frequent cannabis consumers uses 1.2 grams per day, their total annual cannabis consumption amounts to 26,338,254 grams or 26.3 tonnes. Adjusted upwards by twenty per cent to account for underreporting, this amounts to 31,605,905 grams or 31.6 tonnes.

The figures in the Adult Psychiatry Morbidity Survey imply that approximately all of the cannabis users over the age of 65 show signs of dependence, but 1.5 per cent of 60-64 year olds use cannabis without showing signs of dependence. If the pattern of consumption of these 53,013 people is similar to that of non-daily users in the 16-59 year demographic, they will be consuming 38.4 grams per annum, producing a combined total of 2,036,398 grams (2.0 tonnes).

Therefore, total consumption for people aged 60 and over, after adjusting for underreporting amounts to **34,049,582 grams (34 tonnes)**.

Consumption by people aged 11-15 years

It is assumed that cannabis consumption by those aged ten years and under is essentially zero, but 7.9 per cent of 11-15 year olds in England have used cannabis in the past year, according to official figures (NHS Digital 2017). As might be expected, prevalence rises with age, from 0.4 per cent of 11 year olds to 18.5 per cent of 15 year olds. Of the past year cannabis users, two per cent say that they take the drug most days (0.16 per cent of all 11-15 year olds) and six per cent say they take it at least once a week (0.47 per cent of all 11-15 year olds). Fifteen per cent say they take it once or twice a month (1.19 per cent of all 11-15 year olds). The majority (77 per cent) say they only use cannabis up to a few times a year.

There were 3,625,100 11-15 year olds in the UK in 2017. If the estimates above are correct, and if English figures are typical of the whole UK, there were 286,383 cannabis users in this age group, of whom 5,800 consumed the drug most days. 17,038 consumed it at least once a week and 42,957 had used it once or twice in the past month. The vast majority (83 per cent) were aged 14 or 15.

It is difficult to estimate how much cannabis is consumed by these teenagers, but it is reasonable to assume that daily consumption is significantly lower than for adults. At around £10 per gram, the cost alone makes it unlikely that many 11-15 year olds would be able to consume 1.2g per day. For the purposes of this calculation I use Pudney's estimate for 'non-intensive' users of 0.55g per session (Pudney 2006: 68). If 'most days' means four days per week, frequent users consume 663,520 grams per annum. If 'at least once a week' means 1.5 days per week, regular users consume 1,328,964 grams per annum. If 'once or twice a month'

means 1.5 times per month, monthly users consume 425,274 grams per month. And if past year users use the drug three times a year, infrequent cannabis users consume 121,283 grams per annum.

If these (conservative) assumptions are correct, children aged 11-15 years consume 2,539,041 grams of cannabis per annum (2.5 tonnes). Adjusted upwards by twenty per cent to compensate for underreporting, this gives us a final estimate for this age group of **3,046,849 grams**. This is just over three tonnes and is less than two per cent of total UK cannabis consumption.

Total cannabis consumption in the UK (2016/17)

Taken together, the figures for all three age groups amount to grand total of 255,183,098 grams (255 tonnes) in 2016/17.

Cannabis consumed by people aged 11-15 years: 3,046,849 grams

Cannabis consumed by people aged 16-59 years: 220,530,344 grams

Cannabis consumed by people aged 60+ years: 31,605,905 grams

Total: 255,183,098 grams

After including all age groups and adjusting for under-reporting, I estimate that there are 3,091,835 cannabis users in the UK who consume a mean average of 82.5 grams per annum, or 1.6 grams per week. Across the entire population, per capita consumption is 3.9 grams per annum.

I estimate that 60 per cent of the nation's cannabis is consumed by frequent users and a third of it is consumed by daily users. The most frequent users - those who smoke marijuana most days - consume 118 tonnes of cannabis per annum (46 per cent). These 261,863 people consume a mean average of 271 grams per annum. Annual consumption among less frequent users is estimated to be 38.4 grams per annum.

My estimate of 255 tonnes per annum is lower than the estimate of 416 tonnes provided by Pudney (2006) and is at the lower end of the broad estimate offered by RAND Europe for 2005 which ranged from 201.3 tonnes to 937.1 tonnes (Kilmer and Pacula 2009: 19). This is largely because the cannabis market has shrunk significantly in the last fifteen years.

My estimate is somewhat higher than the 216 tonnes suggested by Bryan et al. (2013), but that estimate only related to England and Wales. If we adjust Bryan et al.'s estimate upwards by 13.5 per cent (in line with Pudney's methodology), it becomes 245 tonnes. Our estimate is therefore only slightly higher than Bryan et al.'s and slightly lower than the 270 tonnes cited by the National Crime Agency. This is not proof of veracity, however, since many of the assumptions behind all three estimates are similar.

Compared to North America, the per capita consumption figures for Britain in this report are low. For example, it has been estimated that Colorado residents consumed 121.4 tonnes of cannabis in 2014 (Light et al. 2014). This amounts to a per capita consumption rate of 22 grams per person, much higher than my UK estimate of 3.9 grams. Similarly, the Rand Corporation estimated that 175 tonnes of cannabis were sold in Washington State in 2013 (before legalisation), a per capita rate of 23 grams. However, cannabis use is much more prevalent in these US states than it is in the UK. Approximately nine per cent of Coloradans are past month users of cannabis compared with 3.2 per cent of adults in England and Wales. In Washington State, 21 per cent of 18-25 year olds have smoked cannabis in the past month, compared with 7.6 per cent of 16-24 year olds in England and Wales (admittedly a slightly apples-and-oranges comparison given the different definitions of young people).

Estimates of cannabis consumption in Canada are also much higher than the estimate given for the UK in this report. Although its population is barely half that of the UK, Canada is thought to have consumed 700 tonnes of marijuana in 2015, well over twice my estimate for the UK and equating to 19 grams per person per annum (MacDonald and Rotermann 2017). This is consistent with evidence that a greater proportion of Canadians smoke cannabis. Past year use in Canada is 12 per cent, double the UK estimate (Government of Canada 2017). Of these cannabis consumers, 18 per cent used the drug every day while only 9 per cent of British cannabis users were daily consumers (Crime Survey for England and Wales 2017). Given that heavy consumers purchase a disproportionately large quantity of any product, estimates of 700 tonnes in Canada and 255 tonnes in the UK are not as incongruous as they might seem.

Nevertheless, the figure of 255 tonnes is more likely to be an underestimate than an overestimate for two reasons. Firstly, the figures have been adjusted for underreporting of prevalence (i.e. people falsely claiming that they do not consume cannabis), but not for underreporting of frequency

of consumption. It is well known that people significantly underreport the number of calories and amount of alcohol they consume. The same is likely to be true of at least some cannabis smokers. For example, it is easy to imagine that a respondent to a survey who claims to smoke cannabis 'once or twice a week' is being coy (or, perhaps more likely, forgetful) and consumes the drug more often. If large numbers of frequent users claim to be infrequent users, our figure of 255 tonnes is likely to be an underestimate.

Secondly, I have adjusted for under-reporting of drug use by those surveyed by the Office for National Statistics, but I have not adjusted for under-representation of drug users in the survey itself. The Crime Survey for England and Wales is likely to underreport the number of drug users because they are harder to reach than the average member of the public. The survey is conducted face to face in the individual's home, and those who take drugs may be more likely to be out of the house when the official arrives and may be more likely to have no fixed abode. As the Home Office (2013: 106) notes, 'drug users who cause the most harm to themselves and society are unlikely to be involved in a household survey, due to their chaotic lifestyles.' In an attempt to address this element of the under-reporting problem, some researchers have used other sources to get data on 'hard to reach' individuals, such as interviews with people who have been arrested. While this method has merit, people who have been arrested are not typical cannabis consumers and their consumption does not necessarily reflect that of the average marijuana smoker. Since we have no idea how underrepresented cannabis smokers are in the face-to-face surveys (if at all), I have decided against making adjustments to the data that would be wholly arbitrary. The existence of this source of potential underreporting should nonetheless be borne in mind.

Value of cannabis market

Estimating the value of the cannabis market is a simple matter once the volume of sales has been estimated. The number of grams sold needs to be multiplied by the mean average price of a gram. Prices have risen in the last twenty years as cannabis has become more potent, hitting a low of £2.50 per gram in 2003 before rising to £6.40 in 2010; adjusted for inflation this is a rise from £3.87 to £8.17.

Prices have continued to rise. They vary depending on the quality of the product, the amount purchased, and the geographical location, but the UN's World Drug Report (2017) estimates that the street price in Britain is around £10 per gram. Cannabis user forums confirm that £10 is the best estimate. On this basis, 255 tonnes is worth £2.55 billion.

Cannabis revenues post-legalisation

Before estimating the size of the market after legalisation, we must envisage the kind of legal market we have in mind. The model in the US and Canada has been to place marijuana somewhere between tobacco and alcohol in the regulatory continuum and the UK might be expected to do likewise if it re-legalised the product. Sales would be restricted to those who are 18 and over. Cannabis would be sold in specialist licensed premises (not in supermarkets, for example) and advertising would be limited in content and availability without being banned. A licence would also be required for growing and importing cannabis which would be issued, or denied, on the basis of fitness and propriety. To ensure that the market was competitive, there would be no limit on the number of licences made available to growers, wholesalers and retailers. All adults would be permitted to grow a certain quantity of marijuana at home for their personal use, but unlicensed sale would be prohibited. For the purposes of this report, I will also assume that medical marijuana would not be prescribed by the NHS.

If cannabis were legalised and regulated, regulators could set maximum limits on THC and minimum limits on CBD to reduce the risk of mental health problems. As mentioned, high THC, low CBD cannabis is a product of prohibition and makes psychosis, cognitive impairment and dependence much more likely relative to lower THC and/or high CBD cannabis. Increasing CBD content by regulation would make cannabis safer while having no negative effect on consumers since CBD does not make cannabis less pleasurable to smoke (Englund et al. 2017: 2). Moreover, licensed sale would make it more difficult for people under the age of 18 to access the drug. Under the current system, teenagers find it easier to buy cannabis than alcohol (North 2017).

A further benefit of legalisation is the ability to tax cannabis, thereby allowing governments to cut taxes in other areas. Done properly, cannabis is a win-win-win: criminals lose a lucrative industry, consumers get a better product at a lower price, and the burden on the general taxpayer is reduced.

Recent experience in the USA shows that tax revenues from cannabis can be considerable. Eight US states have legalised, or are preparing to legalise, the sale of marijuana with a combination of general sales taxes and specific cannabis taxes. As the following list shows, effective tax rates range from 20 to 45 per cent.

Colorado (population: 5.6 million)

Legalised: January 2014

State sales tax: 2.9 per cent on medical marijuana only

Local sales tax: various, e.g. 3.65 per cent in Denver

Local marijuana tax: various, e.g. 3.5 per cent in Denver

State marijuana tax: 15 per cent

Effective sales tax (total): approximately 29 per cent

Revenue: \$247 million in 2017

Washington (population: 7.4 million)

Legalised: July 2014

State sales tax: 6.5 per cent

Local sales tax: various, e.g. 3.6 per cent in Seattle

Local marijuana tax: N/A

State marijuana tax: 37 per cent

Effective sales tax (total): approximately 47 per cent

Revenue: \$315 million in 2017

Oregon (population 4.1 million)

Legalised: October 2015

State sales tax: N/A

Local sales tax: various, up to 3 per cent

Local marijuana tax: N/A

State marijuana tax: 17 per cent

Effective sales tax (total): approximately 20 per cent

Revenue: \$78 million in 2017

Alaska (population 740,000)

Legalised: October 2016

State sales tax: N/A

Local sales tax: up to 7.5 per cent
 Local marijuana tax: N/A
 State marijuana tax: \$50 per ounce
 Effective sales tax (total): approximately 20 per cent
 Revenue: \$1.7 million in 2017

Nevada (population: 3 million)

Legalised: July 2017
 State sales tax: 4.6 per cent
 Local sales tax: various, up to 3.55 per cent
 Local marijuana tax: N/A
 State marijuana tax: 15 per cent excise on growers plus 10 per cent on retailers
 Effective sales tax (total): 20-25 per cent
 Revenue: \$30 million in first six months

California (population: 39.5 million)

Legalised: January 2018
 State sales tax: 7.5 per cent
 Local sales tax: various, up to 3 per cent
 Local marijuana tax: N/A
 State marijuana tax: 15 per cent
 Effective sales tax (total): 30-45 per cent
 Revenue: Projected to be \$1 billion per annum

Massachusetts (population: 6.8m)

Legalised: July 2018
 State sales tax: 6.25 per cent
 Local sales tax: various, up to 3 per cent
 Local marijuana tax: N/A
 State marijuana tax: 10.75 per cent
 Effective sales tax (total): approximately 20 per cent
 Revenue: \$44-82 million expected in first year

Maine (population: 1.3 million)

Legalised: pending
 State sales tax: 5.5 per cent
 Local sales tax: N/A
 Local marijuana tax: N/A
 State marijuana tax: 21.5 per cent on wholesalers plus 10 per cent on retailers

Effective sales tax (total): approximately 20 per cent
Revenue: \$85 million expected in first year

These eight states have a combined population of 68 million, only slightly larger than that of the UK, and combined cannabis tax revenues (actual or anticipated) of \$1.8 billion (£1.3 billion). For the reasons given below, UK tax revenues are likely to be significantly lower.

Cannabis tax revenues depend on the pre-tax retail price, the quantity sold and the size of the tax(es). If cannabis were legalised in the UK, it would immediately attract a twenty per cent sales tax (VAT) and is likely to be given a specific duty along the lines of alcohol, tobacco and petrol. Since the primary aim of cannabis reform is to replace unregulated black market cannabis with a regulated product, it is crucial that taxes are not set so high that an illicit trade remains viable. A legalisation plan supported by the Liberal Democrats explicitly calls for 'direct price fixing, or maximum and minimum price controls' to keep cannabis 'at or near current illicit market prices' (Rolles et al. 2016: 19). This would be a mistake. As HM Treasury (2015) notes, if regulated products are only slightly cheaper, operators in the illicit trade are able to lower their prices to compete with them. Colorado, Washington State and California have all seen black markets persist as a result of high cannabis prices which have been primarily caused by excessive taxation.

It is easy to ensure that the price of the regulated product is considerably lower than the current black market price of £10 per gram. The legal market will have the benefits of open competition, economies of scale and legitimate distribution networks. Bryan et al. (2013: 55) estimate that commercial cannabis can be produced for around £260 per kilogram, although compliance costs double this to £520. When 'distribution costs, producer's profit margin and the retail mark-up' are added, the price-to-consumer is £1,450 per kilogram or £1.45 per gram.¹

The pre-tax retail price of marijuana in the USA since 2014 has rarely gone as low as £1.45 per gram (\$2.00), but it may do in the future. The wholesale price of legal marijuana in states such as Colorado fluctuates wildly but has generally been between \$1,100 and \$1,500 per pound (\$2.43-\$3.31 per gram) and is likely to fall as more US states legalise and

1 They assume compliance costs and retailer margin are both the same as production costs, distribution costs are 50 per cent of production costs and producer's margin is 11 per cent of production costs.

new competitors enter the market. Analysts believe that the wholesale price could easily drop to \$500 per pound in the long term and Britain is well placed to be a global player since it already produces 95 tonnes of marijuana for the medical market (Transform 2018).

Even at \$1,200 per pound the pre-tax legal prices are well below black market prices. Converted to UK prices and metric measures, \$1,200 per pound is less than £2 per gram. At \$500 per pound, the wholesale cost of a gram of cannabis is just 78p. Since the street price for a gram of cannabis in Britain is around £10, there is ample room for retailers, distributors and tax collectors to take their cut without the price to consumers approaching current black market prices.

With full legalisation, industrial production and market competition, the pre-tax retail price of regulated cannabis in Britain could comfortably fall below £4 per gram, but we shall use £4 per gram as a conservative estimate in the calculations below. £4 per gram is roughly equivalent to the retail price of an average pre-tax gram of cannabis in the legal US market and is similar to the price expected in Canada after legalisation.

At £4 per gram, sales would amount to just over a billion pounds if the UK market remains at 255 tonnes per annum after legalisation. VAT levied at 20 per cent would yield the government £0.80 per gram, raising the cost to £4.80 per gram and netting the government £204 million per annum.

Most US states have added a specific marijuana duty of at least 15 per cent on top of the sales taxes. These sales taxes are, admittedly, substantially lower than British VAT, but the UK government is unlikely to legalise cannabis without accompanying it with an excise tax and there is a Pigouvian justification for some form of tax. Tax yields at different duty rates are shown in Table 2, based on annual sales of 255 tonnes and a pre-tax retail price of £4.00 (totalling £1,020 million). Note that VAT is charged on duty.

Table 2: Cannabis tax yields under different scenarios

Cannabis duty rate	Cannabis duty yield	VAT yield	Total tax yield	Retail price per gram
Zero	£0	£204 million	£204 million	£4.80
10 per cent	£102 million	£224 million	£326 million	£5.28
15 per cent	£153 million	£235 million	£388 million	£5.52
20 per cent	£204 million	£245 million	£449 million	£5.76
30 per cent	£306 million	£265 million	£571 million	£6.24

As Table 2 shows, cannabis duty could be set at the relatively high rate of 30 per cent and retail prices would still be more than a third lower than current black market levels. The government could choose to tax cannabis more heavily, as it does with tobacco and alcohol, but this would make it more likely for the illicit trade to persist.

At the highest duty rate of 30 per cent, taxation would make up 36 per cent of the retail price. This is a lower share of tax than is paid on an average bottle of spirits, litre of petrol or pack of cigarettes.

The effect of legalisation on demand

The figures above make the simplistic assumption that the UK market would remain at its current size under legalisation and that the black market would be completely eradicated. This is unrealistic. Predicting the effect of legalisation on demand requires new assumptions which add another layer of uncertainty.

There are three reasons to expect consumption to rise after legalisation: prices will fall, availability will increase, and a legal deterrent will be removed. On the other hand, teenagers already find it very easy to buy cannabis in many parts of the country and prosecutions for possession are so rare that it is doubtful whether the law is an effective deterrent. Strict enforcement of laws banning the sale to under-18s could be more effective than total prohibition in reducing consumption by minors. Moreover, it is possible that legalisation will remove the ‘forbidden fruit’ appeal of cannabis.

It is clear that fewer people are using cannabis today than in the recent past. Various explanations for this decline have been offered and it is interesting to note that it mirrors a decline in smoking and drinking observed among millennials over the same period. Anecdotally, it appears that some cannabis users abandoned the drug when skunk began to dominate the market, and there is empirical evidence showing that people stop using cannabis if they have experienced unpleasant side effects such as paranoia, which is more likely with skunk (Sami et al. 2018). Cannabis’s increased potency and tarnished reputation has likely deterred younger people who might have become regular users of milder strains. Thanks to skunk, cannabis in the UK has a ‘white cider’ image - it has become associated with the homeless, reclusive and mentally ill. This is not the perception in

the USA or Canada and it is quite plausible that a legal, regulated product with a more favourable image and lower price could attract new consumers.

Evidence from jurisdictions that have legalised or decriminalised cannabis shows that a surge in underage use is unlikely. Rates of cannabis use by 12 to 17 year olds in Colorado fell by a quarter after legalisation, from 12 per cent to 9 per cent, having been rising previously (Ingraham 2017b). Washington State saw marijuana use by 12 to 17 year olds fall to a 22 year low after legalisation (Ingraham 2017a).

Between 2015/15 and 2015/16, there was a slight rise in past month use by 12 to 17 year olds in Oregon and a slight decline in Alaska. Colorado and Washington State saw non-trivial declines in use among this age group, but all four states saw past month use rise among 18-25 year olds (by between 0.45 and 4.3 percentage points). There was little change among those aged 26 or older (National Survey on Drug Use 2017).

These fragments of evidence do not warrant bold predictions about what could happen in Britain. It should be remembered that the legal age for purchasing cannabis in the USA is 21 rather than 18. Prices in Colorado and Washington State remained relatively high after legalisation. The most likely scenario is that there will be a modest decline in the number of underage users and a modest increase in the number of adult users.

But will there be an increase in sales to existing users? There is little reason to think that cannabis smokers struggle to satisfy their demand in the UK's current black market, but they might choose to consume more cannabis if prices fell. The decline in the amount of cannabis sold in the last fifteen years is partly the result of rising prices and increased strength. Users can afford less of it, but they also need less of it because of its potency. It is plausible that a cheaper and less potent product will sell to existing cannabis users in greater volumes.

Bryan et al. (2013: 60) suggest that cannabis has an intensity elasticity of -0.3, a participation elasticity of -0.4 and an overall price elasticity of -0.7. This is close to the price elasticity of between -0.67 and -0.79 reported by Davis et al. (2016) and suggests that a ten per cent reduction in price leads to a seven per cent increase in consumption.

Table 3 shows the effect on demand and revenues under three different tax scenarios. As tax rates rise, demand falls slightly and tax revenues

grow. At tax rates of up to 30 per cent, there is no sign of a Laffer Curve effect in which higher taxes result in lower revenues. These revenues range from £511 million to £719 million per annum.

Table 3: The effect of lower prices on cannabis demand

	Current black market (baseline)	10% (plus VAT)	20% (plus VAT)	30% (plus VAT)
Average price (g)	£10	£5.28	£5.76	£6.24
Change in price	-	-47%	-42%	-37%
Change in consumption (PE of -0.7)	-	32.9%	29.4%	25.9%
Consumption per annum	255 tonnes	339 tonnes	329 tonnes	321 tonnes
Value of market	£2,550 million	£1,790 million	£1,895 million	£2,003 million
Tax revenue	£0	£511 million	£579 million	£719 million

It should be noted that it is possible that the legalisation of cannabis, along with the implicit assurances that come with regulation, may increase consumption independently of changes in price. Pacula and Lundberg (2014: 10) note that ‘a 10 percent decrease in the perceived harm of marijuana would generate a 28.7 percent increase in annual prevalence of marijuana use among youth, a change substantially larger than the results of a small change in the monetary price, legal risks or law enforcement.’ This could mean that the figures above are underestimates. However, whilst cannabis would indeed become safer under the regulatory regime suggested above, it is not clear that consumers perceive cannabis to be especially risky at present and cannabis would by no means be portrayed as harmless under legalisation. On the contrary, we expect legalisation to be accompanied by health messaging that underlines the risks of THC consumption.

The black market after legalisation

Legal cannabis will be different from the typical black market product in two important respects: it will be lower in THC and higher in CBD. This is necessary to minimise the risk of mental health problems that have been associated with skunk. The Netherlands sets a cap of 15 per cent on THC levels and the same limit has been suggested in Colorado. This is a reasonable, if arbitrary, maximum and is slightly higher than the median average of cannabis currently sold in the UK.² Minimum CBD levels are arguably more important. A THC:CBD ratio of 2:1 has been suggested although this, again, is somewhat arbitrary.

High THC strains do not necessarily exist due to consumer demand. One characteristic of black markets is their tendency to suit sellers rather than buyers. Highly concentrated products are easier to hide and distribute, and they offer sellers greater profits per gram. This is why strong spirits were traded under Prohibition in preference to beer and it is why heroin is traded rather than opium today. The move towards skunk in Britain is a relatively new phenomenon. Cannabis resin, with much lower THC levels, dominated the market until the first decade of this century. Skunk displaced resin as the illicit market moved away from importing cannabis to growing it indoors with hydroponic lights. Cross-breeding of plants then created more potent strains with high levels of THC.

2 Potter et al. (2018) found that median THC content in skunk was 14.2 per cent, similar to the mean average of 14.7 per cent identified in a sample from Manchester by Oliver Sutcliffe (North 2017).

It is reasonable to assume that there is latent demand for the kind of marijuana that was considered normal until relatively recently, especially if consumers are educated about the risks of high THC/low CBD cannabis. But it is possible that some existing consumers may continue buying high THC cannabis on the black market or will choose to grow it themselves. Bryan et al. (2013: 61) suggest that unlicensed marijuana would make up 20-35 per cent of the market under legalisation but this was based on the assumption that THC levels would be capped at 10 per cent, thereby criminalising around 80 per cent of the cannabis currently on sale, and that legal prices would be relatively high.

In this report, I suggest that prices should be at least a third lower than the current average and that THC levels should be capped at 15 per cent. Under this regulatory system, there is little reason to think that a black market would exist to any great extent. People would be free to grow their own cannabis plants, just as they are free to brew their own beer or grow their own tobacco, but the financial and opportunity costs would likely exceed the costs of buying the licensed product. There would be little incentive to illegally import cannabis and it is likely that domestic cultivation would be confined to a relative handful of marijuana aficionados.

The authors of the 2015 Treasury report argue that Bryan et al. *underestimate* the size of the black market after legalisation because if tax makes up 70 per cent of the retail price, as Bryan et al. suggest, cannabis would have a similar tax-to-price ratio as tobacco and would fuel a comparable illicit trade (HM Treasury 2015: 8). Britain's illicit trade in tobacco is large, with around 40 per cent of rolling tobacco avoiding UK duty, but this is mainly because tobacco is imported illegally after being bought legally at lower prices in other countries. Notwithstanding my proposal of a much lower effective tax rate than that suggested by Bryan et al., the cannabis market would be very different to the tobacco market. In this report, we assume that cannabis either remains illegal in other countries or, if legal, is taxed at a similar rate. Either way, there would be nowhere from which to import cheaper cannabis.

The Treasury also suggested that a black market could persist 'if it is harder to come by a regulated cannabis shop than an illicit dealer' and if under-18s bought 'unregulated cannabis from an illicit dealer' (ibid.). But under the regime recommended in this report, licensed retailers would exist in every town. Availability would not be a problem and whilst underage consumption would still exist, minors would most likely access cannabis

as they currently access alcohol and tobacco, sourcing it from legal suppliers via an intermediary. Although this may be socially undesirable, it has no effect on the figures in Table 2.

In sum, a commercialised marijuana market in which THC levels were limited to 15 per cent and taxation did not exceed 40 per cent of the retail price would virtually eradicate the black market. There would be a relatively small amount of cannabis grown at home for personal use and there would be some residual demand for cannabis with very high levels of THC which could only be sourced from the black market, but this unlicensed market is unlikely to make up more than five per cent of the total. This can be no more than a guess, however, and so Table 4 models different scenarios, ranging from 2.5 per cent to ten per cent of the current market remaining unlicensed after legalisation. If my best guess of five per cent is correct, annual tax revenues range from £495 million (with a 10 per cent tax) to £690 million (with a 30 per cent tax).

Table 4: The impact of unlicensed cannabis sale on tax revenues

Share of unlicensed cannabis	10% (plus VAT)	20% (plus VAT)	30% (plus VAT)
Zero	£511 million	£579 million	£719 million
2.5 per cent	£503 million	£567 million	£705 million
5 per cent	£495 million	£557 million	£690 million
7.5 per cent	£487 million	£545 million	£676 million
10 per cent	£478 million	£534 million	£662 million

Total savings

The aim of this report has been to estimate the size of the cannabis market and its potential tax revenues before and after legalisation. Calculating the wider economic benefits of reform is beyond its scope but there is little doubt that they would be substantial. Legalisation will create new jobs and businesses in the legitimate, tax-paying economy and there will be savings to the criminal justice system.

Bryan et al. (2013: 112) estimate that cannabis legalisation would save £291 million a year in England and Wales in police enforcement costs alone, despite their expectation of a much larger black market than is predicted in the present report. They say that spending on mental health services could rise or fall depending on how legalisation affects the nation's overall consumption of THC. In my view, per capita THC consumption is unlikely to rise significantly and could easily fall, but CBD consumption is almost certain to rise, with a net benefit to the public's health which would result in lower expenditure on mental health services.

A legal cannabis industry in Britain would have sales of around £2 billion per annum, making it twice the size of the cider industry and three times the size of the bingo industry. In other words, it would be a relatively niche but non-trivial economic player. Bryan et al. made no attempt to estimate how much additional revenue would be raised in income tax, corporation tax and business rates but it could run into the hundreds of millions of pounds.

Amsterdam's cannabis cafés earn the Dutch government €400 million in taxes despite there being no tax on marijuana itself (Rolles 2014: 1). In 2015, the legal marijuana industry created 18,000 full-time jobs in Colorado, a state with a population that is less than a tenth of the UK's (Ingraham

2016). In this report, we have not considered the potential financial benefits of Dutch-style 'drug tourism', nor have we considered Britain as a potential exporter of cannabis. One or the other of these is a possible source of revenue depending on how many other countries choose to legalise marijuana.

There would be costs as well. Bryan et al. (2013: iv) suggest that £45 million per annum would need to be spent on health promotion and regulation, but the scenario in Bryan et al.'s study that its authors find most plausible still results in an annual net saving to government of £253 million in England and Wales alone. A more recent study by Ramanauskas (2018) estimates that cannabis legalisation would save the UK government £498 million in criminal justice costs and £29 million in direct NHS costs. If legalisation led to fewer anti-depressants, sleeping pills and painkillers being prescribed, it estimates that NHS savings could exceed £300 million.

With those savings added to excise tax revenue of £690 million per annum plus new streams of income tax, business tax and VAT created by the legal industry, claims about cannabis legalisation providing a £1 billion windfall to the Treasury seem pessimistic. It is likely that tax revenues alone would exceed this. Meanwhile, lower prices would leave cannabis consumers with more money in their pockets, allowing hundreds of millions of pounds to flow into other areas of the economy.

Conclusion

Calculating the size of any illegal market is fraught with difficulties, but our best estimate suggests that 255 tonnes of cannabis were sold in the UK in 2016/17 at a cost to end users of £2.6 billion. If the market were legalised and regulated to ensure maximum THC levels, minimum CBD levels and strict age controls, tax on the product alone could realistically produce revenues of £690 million per annum. Combined with direct and indirect taxes on marijuana farmers, retailers and other associated workers, annual tax revenues would likely exceed £1 billion. The British government would save in excess of £300 million in criminal justice and health expenditure. Cannabis consumers would have access to a safer product and see prices fall by more than a third, thereby saving them hundreds of millions of pounds per annum.

References

- Atha, M. and Davis, S. (2011) Taxing the UK Cannabis Market. Independent Drug Monitoring Unit. <https://s3.eu-west-2.amazonaws.com/assets.clear-uk.org/taxukcan.pdf>
- Bryan, M., Del Bono, E. and Pudney, S. (2013) Licensing and regulation of the cannabis market: Towards a cost-benefit analysis. Institute for Social & Economic Research.
- Davis, A., Geisler, K. and Nichols, M. (2016) The price elasticity of marijuana demand: evidence from crowd-sourced transaction data. *Empirical Economics* 50(4): 1171-92.
- Englund, A., Freeman, T., Murray, R. and McGuire, P. (2017) Can we make cannabis safer? *Lancet*, 1 March [https://doi.org/10.1016/S2215-0366\(17\)30075-5](https://doi.org/10.1016/S2215-0366(17)30075-5)
- Freeman, S. (2016) Half of Canadian pot smokers surveyed spend on average \$100 on weekly buzz: report. *Financial Post*, 14 December.
- Government of Canada (2017) Canadian cannabis survey 2017 - Summary. <https://www.canada.ca/en/health-canada/services/publications/drugs-health-products/canadian-cannabis-survey-2017-summary.html>
- Harrison, L. D., Martin, S. S., Enev, T., and Harrington, D. (2007) Comparing drug testing and self-report of drug use among youths and young adults in the general population (DHHS Publication No. SMA 07-4249, Methodology Series M-7). Rockville, MD: Substance Abuse and Mental Health Services Administration, Office of Applied Studies.

HM Treasury (2015) Potential fiscal impacts of introducing a regulated cannabis market in the UK. Unpublished but available from: <https://www.tdpf.org.uk/sites/default/files/Treasury-cannabis-regulation-CBA.pdf>

Home Office (2013) Understanding organised crime: estimating the scale and the social and economic costs. Research Report 73 (Mills, H., Skodbo, S. and Blyth, P.). October.

Ingraham, C. (2016) Marijuana industry created more than 18,000 new jobs in Colorado last year. *Washington Post*, 27 October.

Ingraham, C. (2017a) Teen marijuana use falls to 20-year low, defying legalization opponents' predictions. *Washington Post*, 7 September.

Ingraham, C. (2017b) Teen pot use drops sharply in Colorado. *Washington Post*, 11 December.

Kilmer, B. and Pacula, R. L. (2009) Estimating the size of the global drug market: A demand-side approach. European Communities.

Kilmer, B., Caulkins, J., Midgette, G., Dahlkemper, L., MacCoun, R. and Pacula, R. (2013) Before the Grand Opening: Measuring Washington State's Marijuana Market in the Last Year Before Legalized Commercial Sales (Appendix B). RAND Drug Policy Research Center.

Light, M., Orens, A., Lewandowski, B. and Pickton, T. (2014) Market Size and Demand for Marijuana in Colorado. Colorado Department of Revenue.

MacDonald, R. and Rotermann, M. (2017) Experimental Estimates of Cannabis Consumption in Canada, 1960 to 2015. Statistics Canada. 18 December.

<https://www.statcan.gc.ca/pub/11-626-x/11-626-x2017077-eng.htm>

National Crime Agency (2018) Drugs. <http://www.nationalcrimeagency.gov.uk/crime-threats/drugs>.

National Survey on Drug Use (2017) National Survey on Drug Use and Health: Comparison of 2014-2015 and 2015-2016 Population Percentages (50 States and the District of Columbia) <https://www.samhsa.gov/data/sites/default/files/NSDUHsaeShortTermCHG2016/NSDUHsaeShortTermCHG2016.htm>

NHS Digital (2016) Adult Psychiatric Morbidity Survey: Survey of Mental Health and Wellbeing, England, 2014. 29 September. <https://digital.nhs.uk/catalogue/PUB21748>

NHS Digital (2017) Smoking, Drinking and Drug Use Among Young People in England - 2016. 2 November.

North, P. (2017) Street Lottery. Volte-Face, 18 October. <http://volteface.me/publications/street-lottery/>

Pacula, R. and Lundberg, R. (2014) Why Changes in Price Matter When Thinking About Marijuana Policy: A Review of the Literature on the Elasticity of Demand. *Public Health Reviews* 35(2): 1-18.

Potter, D. J., Hammond, K., Tuffnell, S., Walker, C. and Di Forti, M. (2018) Potency of Δ^9 -Tetrahydrocannabinol and Other Cannabinoids in Cannabis in England in 2016: Implications for Public Health and Pharmacology. *Drug Testing and Analysis*, 27 February. <https://doi.org/10.1002/dta.2368>

Pudney, S., Badillo, C., Bryan, M., Burton, J., Conti, G., Iacovou, M. (2006) Estimating the size of the UK illicit drug market (in Measuring different aspects of problem drug use: methodological developments (2nd edition)). Home Office.

Ramanauskas, B. (2018) Potential savings from the legalisation of cannabis. Taxpayers' Alliance. May.

Rasul, I. and Parey, M. (2018) Measuring the Market Size for Cannabis: A New Approach Using Forensic Economics. *Economica* (In press).

Rolles, S. (2014) Cannabis policy in the Netherlands: moving forwards not backwards. Transform. <https://www.tdpf.org.uk/sites/default/files/Netherlands.pdf>

Rolles, S., Barton, M., Eastwood, N., Lloyd, T., Measham, F., Nutt, D. and Sumnall, H. (2016) A framework for a regulated market for cannabis in the UK. London: Liberal Democrats.

Sami, M., Notley, C., Kousimtsidis, C., Lynskey, M. and Bhattacharyya, S. (2018) Psychotic-like experiences with cannabis use predict cannabis cessation and desire to quit: a cannabis discontinuation hypothesis.

Psychological Medicine, 23 March. <https://doi.org/10.1017/S0033291718000569>

Transform (2018) New UN report reveals UK is world's biggest producer of medical cannabis. 5 March: <https://www.tdpf.org.uk/blog/press-release-new-un-report-reveals-uk-world%E2%80%99s-biggest-producer-medical-cannabis>

United Nations (2017) World Drug Report 2017. <https://www.unodc.org/wdr2017/index.html>

Vincent, I., Mills, H. and Blyth, P. (2013) The scale of the illicit drugs market (Annex 2 in *Understanding organised crime: estimating the scale and the scope and the social and economic costs*, ed. Mills, H., Skodbo, S. and Blyth, P.) Home Office.

Young, B. (2013) Average pot user consumes 123 joints per year, state estimates. *Seattle Times*, 25 September.

The Institute of Economic Affairs
2 Lord North Street
London SW1P 3LB
Tel 020 7799 8900
email iea@iea.org.uk

