Decriminalisation of Cannabis; the effects on the drug market via the dark web

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ABSTRACT

The rise of the internet the drug market partly moved to the dark web, and the rise of discussion regarding decriminalisation of drugs. That's what leads to this paper, where research has been performed to find if there is a dependency between drug law and the number of drug transactions. This paper explains research performed on existing data on the dark web. It covers how the statistical analysis on the available data has been performed. This research shows that there are significant differences between the number of transactions between countries. Whereas it does not show that there is a dependency between policy and number of transaction. It does show which countries have a high number of transactions compared to other countries.

Keywords

drug traffic, legalisation, decriminalisation, Cannabis, marijuana, dark web, EU

1. INTRODUCTION

Drug legalisation or decriminalisation has been a topic in several member states of the European Union (EU) [12].

Even though these discussions do not always lead to new legislation, they do provide reasons to investigate the direct and indirect consequences, if it would proceed.

The legalisation of certain drugs happens on a national level, however, the drug market is an international market. Research has been performed, on the effects of drug legalisation and drug price, which have shown that drug legalisation, leads to a lower drug price in comparison to when they are criminalised drugs [15]. Besides the economic effects of legalising Cannabis [8], there are also effects on the number of drugs consumed, this partly depends on the policy on how Cannabis is legalised [14].

With the rise of the internet, and especially the dark web, the drug market partly moved online. Especially the dark web is a big contributor to the drug market. Since it is online, trading is no longer bound by geographic borders.

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In 2013 one of the largest drug market places on the dark web was brought down by the FBI [1]. By doing so the FBI managed to make multiple arrest among which the owner of the infamous "Silk Road" and approximately 173,991 Bitcoins with an estimated value of $ 33.6 million at that time. In January 2021 German police managed one of the worlds largest drug marketplaces was taken down called "Dark market" [5]. This market had almost 500.000 users and hosted more than 2.400 sellers. These examples show that the drug market on the dark web is a big market where millions of dollars are spend.

The combination of both recent take-downs of market places on the dark web and the rising discussion about decriminalisation or legalisation of drugs lead to the topic of this research. This research aims to find out if there is a relationship between the drug policies in certain countries and the number of drugs sold via the dark web. This paper discusses the analysis of available data on the dark web, and the possible dependencies between the policies in member states of the EU and the drug market via the dark web. The paper explains the steps taken throughout the research and how the results can be interpreted.

2. RELATED WORK

There are several data sets available on drug marketplaces on the dark web. And especially how certain gaps can be filled by this research. This section will briefly mention some of the research that has been performed using the database that this research is going to use. Whereas these research papers do not necessarily relate to the decriminalisation of Cannabis, they do give an insight into how the data can be processed, and what has already been researched with this data. A few types of research will be highlighted that are relevant to the research that will be performed.

The first paper that is relevant for this study, is a research that also focuses on country-specific data analysis. This research conducted by Sutanrikuli, Czajkowska and Grossklags, gives a very interesting insight into a relation between drug sales and country [16]. It shows that there likely is a connection between drug traffic and the GDP, which is very useful for the research I'll be performing, as it is seen there is a relation between country and drug traffic.

A lot can be learned from the analysis approach used in research, as this uses the same ideas and principles that will be used in this research, it also gives some insight into theories that need to be taken into account when analysing the data set. This research raises the question if the number of drugs sold is linked to the GDP. Whereas GDP is on a national level, this research does not take into account the factor of drug policy in that respective country.

One of the papers that is especially of interest, concerns different ways of enforcing drug laws. Where it discusses the enforcement of laws drug related, the research performed can be enhanced by analysing data on the dark web and how it relates to the different drug policies.

For this research both computer science and social sciences will be combined, as it involves a quantitative data analysis but also studies the effects of the legalisation of Cannabis. This means that it can give very useful insights to also look into research that has already been performed on the effects of decriminalisation of Cannabis.

Several types of research are available regarding the price of drugs, for example as a result of the prohibition of drugs [15]. Where this research focuses on the pricing of drugs in the physical market, as a result of drug policy. This leaves a gap in both the effects on the dark web as well as on the number of drugs sold.

Besides research on the economic effects of the decriminalisation of drugs, research has also been performed on the effects on the physical drug market [8]. The final interesting research was performed by Kleiman and Ziskind, which describes positive and negative effects on the legalisation of Cannabis [14].

What can be seen at the papers discussed above is that extensive research has already been performed on drug policies and some factors it might contribute to. However, the research explained in this paper adds on to these findings, by analysing data from the dark web and how policies affect the number of transactions.

3. PROBLEM STATEMENT

As discussed in the introduction, there has been a lot of discussion on the decriminalisation of Cannabis, and the drug market has partly moved online over the last years.

In an increasingly amount of countries the discussion about legalising or decriminalising Cannabis is taking place. In those discussions mostly the direct and indirect consequences are discussed on a national level, e.g. the people's health and the effects on the drug market. However, little is known about the effects on a global level, especially on the dark web.

For the purpose of this research, it has been decided to focus solely on the drug market in the European Union on the dark web. What needs to be noted is that because of the data set being used [7], this research will solely focus on data gathered from 2011 up to and including 2015. Even though this data is not recent, it contains data from different online markets and forums. In section 4 will go in-depth on how this research will be performed and why this data set was chosen.

This data set [7] was chosen as it is a very extensive dataset containing one of the biggest marketplaces at that time, namely Silk Road [1] and Agora. The data set was also used in previous research [16, 18, 6], this means that previous research and approaches can be used to build on during this research.

A different data set being looked at concerned the Dream Market and specifically the category Cocaine [11]. However, since this data set only focused on Cocaine it is more useful to choose a data set that offers different types of drugs as well. What can be seen when looking into different types of data sets, is that several researchers use different kinds of data sets for different needs. However in many of these types of research the focus lies on big markets. For example the research performed by Broséus, J., Rhumorbarbe, D., Mireault, C., Ouellette, V., Crispino, F., and Décary-Hétu, D. [9]. They created a data set that covers several big marketplaces, like Agora and Silk Road.

From these observations the decision to use the data set [7] was made. As it both covers big marketplaces as well as it was used in several relevant studies.

Since there are currently no member states of the European Union that have legalised drugs, this research will focus on the decriminalisation of Cannabis and other types of drugs.

To give a broader insight on the effects of decriminalisation of drugs, the following research question will be answered in this research:

Did the decriminalisation of drugs in some member states have an effect on the drug market on the dark web in the European Union between 2011 and 2015?

To answer this question, there are several questions that need to be answered first. When the first three questions have been answered, the analysis of the data can start which leads to the last questions needed to be answered before the research question can be answered.

1. Which member states of the European Union had decriminalised Cannabis during the period 2011 to 2015?
2. What data is appropriate to use for the research on how decriminalised drugs affect the drug market via the dark web?
3. How can the data available be analysed in such a way that significant differences between countries will be detected?
4. Is there a difference between the number of transactions of drugs sold between 2011 and 2015 via the dark web per member state of the EU?
5. Can a dependency be found between drug policy and the sale rate of drugs via the dark web?

4. RESEARCH METHOD

This research will begin with an elaborate literature review, the first two research questions can be answered by a literature review, whereas research question 3 will need some literature review but also a mathematical and computer science approach to the processing of the data.

For the literature review on research question 1, there will be a small review of news articles available on the decriminalisation of Cannabis in the EU, all published before 2016. After this is used to make an overview of member states that have decriminalised Cannabis, this will be used in a literature review where several research papers will be looked at, which discuss the situations in these member states that have decriminalised Cannabis. Thorough research will be done to ensure that when the data analysis starts, the correct countries are classified as countries that have decriminalised drugs or not.

It has been decided to use the Darknet market archives data set [7], as this data set contains information of 85 Darknet markets and 35 forums. The most important aspect that this data set contains, is that it includes the country of origin. This can be very useful for this research. However, choosing the data set is not enough to start analysing data, this is why research question 2 needs to be answered first.

To answer research question 2, first, a literature review will be done on available knowledge on the effects of decriminalisation of drugs on the drug market. After this literature has been done, decisions have to be made on what data is important for this research. There is a lot of data available, so filtering this data is crucial for the research to succeed. If redundant data is used, this will slow down the entire process of analysing the data.

For research question 3, the first method that will be applied is a study to see which algorithms can be used to analyse the data, more importantly, research will be done in which mathematical formulas can be used to show if there are any significant differences to be detected. In this phase the programming starts, where a small program will be developed that can process the data and help to answer the other research questions.

This leads to research question 4, to answer this question, the data analysis will start. From all the information gathered in questions 2 and 3, the beginning of a program has been made that will be used to analyse the data selected. From this the quantities of drugs sold will be added, there will already be made a distinction between types of drugs to make sure that the program can be used to answer research question 5.

For research question 5, a statistical analysis will be performed, for this analysis, the following hypotheses have been defined.

$H1_0$: The number of drug transactions via the dark web does not depend on the legislation in that specific country.

$H1$: The amount of drug transactions via the dark web does depend on the legislation in that specific country.

The significant level will be $\alpha = 0.05$, this to ensure that with a high certainty H0 can either be rejected or not. To properly analyse the data an ANOVA test will be used and dummy variables to represent the different categories which are defined in research question 1.

Once all sub-research questions have been answered, the research question can be answered. The sub-research questions give enough insight to ensure both a proper analysis and an answer to the research question.

To summarize the process of the research, the following steps will be taken:

1. Countries will be divided into categories based on their drug policies.
2. The data set will be processed such that only relevant columns and entries will remain.
3. A small program will be written to gather all the needed information that enables a statistical review of the data.
4. The results per country will be analysed if the results are similar or if there are differences between the countries.
5. An ANOVA test will be performed to test if there is a dependency between the policy and the number of drugs sold via the dark web.

5. RESULTS

To answer the first research question a literature review has been performed, from this literature review, it appeared that there are different levels of legalisation of Cannabis. [4, 17] For this purpose EU member states are divided in two categories, which are briefly explained below. For the member states, Croatia is counted as a full member, even though Croatia joined in 2013. In the analysis, the UK still belongs to the EU, as the data used is from 2013-2015.

Category 1, consists of all countries where either a fine is given for drug use, or jail can be used as punishment.

Category 2, consists of the countries that have either not mentioned drugs explicitly or countries where drugs are regulated by the state. An example of this is the Netherlands, where soft drugs like Cannabis are regulated through coffee shops.

Table 1 shows, besides the other results that will be explained later in this section, the division of the categories among the countries.

A notable country is Malta, which decriminalised Cannabis on 15 April 2015 [10], this means the data used [7], can be used to see if there is a direct effect on the drug market via the dark web. However, because of the data available, it is not possible to analyse the drug market via the dark web for Malta. As there are no drug transactions originating from Malta in this data set.

Now that it is known which countries have decriminalised Cannabis, the next research question can be answered. Which makes sure no redundant data will be used, and that entries that are not relevant for this study will not be used.

The data set used [7] has several columns, to use the proper data for this analysis, it has been decided to use the following columns:

1. Product Category: this column lists for every transaction what kind of drug was sold.
2. Ships From: this column is used to determine which country the drugs are shipped from. This will be used in the entire data analysis to answer RQ 4,5 and the main research question.
3. Sale date: This data can be used to determine if there is a direct effect of the decriminalisation of drugs in a certain country.
4. Key: The keys will be used to uniquely identify each transaction.

From the data set [7] being used, there are a few important notes that need to be taken into consideration. The category "Ships From", also contains "EU", which does not provide specif information on which member state it ships from. This means that there might be data missing for certain unknown countries. There is also a list of countries in the EU that are not represented by the data. It can be that in these countries either the dark web is not being used, the data is incomplete, or these countries are labelled as EU in the data set.

Country	Category	Total number of transactions	Ratio calculated by using Formula 1
Austria	2	1582	184.3
Belgium	2	10190	905.1
Bulgaria	1	144	20.0
Croatia	1	0	0
Cyprus	1	0	0
Czech Republic	2	2196	208.4
Denmark	2	4034	712.8
Estonia	1	0	0
Finland	1	2069	378.1
France	1	8651	130.4
Germany	2	110594	1362.4
Greece	1	0	0
Hungary	1	0	0
Ireland	2	1215	262.7
Italy	2	1737	28.6
Latvia	1	237	119.3
Lithuania	1	11	3.8
Luxembourg	1	9	16.0
Malta	1	0	0
Netherlands	2	78311	4633.6
Poland	2	1481	39.0
Portugal	2	65	6.3
Romania	1	4	0.2
Slovakia	2	880	162.3
Slovenia	2	894	433.4
Spain	1	6738	145.1
Sweden	1	12376	1269.7
United Kingdom	1	84667	1307.3

Table 1. Data per member state

The following countries are not present in the data set, they are used in the analysis, but further research will be done, to see if an explanation can be found as to why they are not present.

1. Croatia
2. Cyprus
3. Estonia
4. Greece
5. Hungary
6. Malta

For the analysis of the data obtained from the database [7], there are a few considerations that must be made before comparing countries. Due to the different sizes and population of the different countries, the population as of 2015, will be used to calculate the ratio of transactions per million citizens [2].

The following formula was used to calculate the ratio per country:

$Formula1 = (totaldrugs/citizens) * 1.000.000$

Where total drugs is the total amount of drugs per country and the citizens are the number of citizens as of 2015.

When each of these values has been calculated, the data will be used to analyse which countries have the most or least amount of drug transactions per million citizens. As reference data, the total number of transactions in the EU will be used.

The total ratio was calculated as follows by using:

$Totalratio = 346391/508191200 * 1000000 = 681.6$

Variable	Value
Total ratio	681.6
Mean	560.4
Median	173.3
Standard deviation	991.4

Table 2. Values gathered from the data in Table 1, per million citizens

Country	Number of transactions	Ratio
The Netherlands	78311	4633.6
Germany	110594	1362.4
United Kingdom	84667	1307.3
Sweden	12376	1269.7
Belgium	10190	905.1

Table 3. Countries with highest transaction/1.000.000 citizens

To show how big the differences are between countries that have a high ratio and countries that have a low ratio as calculated by using Formula 1. Table 3 gives an overview of the 5 countries that have the highest ratios.

The 5 countries that have the lowest ratios are shown in Table 4.

When comparing Table 3 with 4, it can be seen that the differences between the high ratios and the low ratios can be large. For example the ratio calculated for the Netherlands is more than 23.000 times as large as the ratio calculated for Romania. There will also be an analysis performed on the countries that have zero transactions in total, this analysis will be used to see if there is a clear indication of why these countries are not listed in the data set.

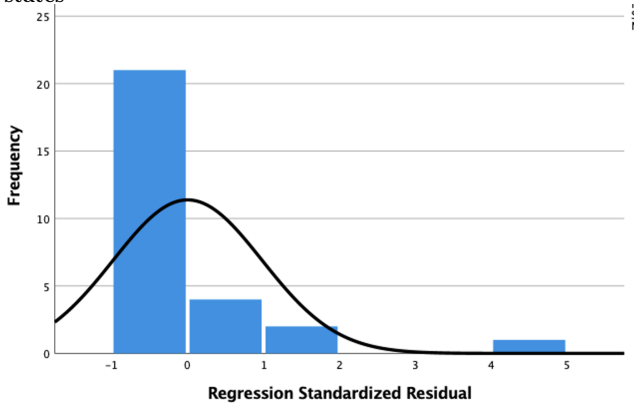
Country	Number of transactions	Ratio
Romania	4	0.2
Lithuania	11	3.8
Portugal	65	6.3
Luxembourg	9	16.0
Bulgaria	144	20.0

Table 4. Countries with lowest transaction/1.000.000 citizens

Table 1 gives an overview of all the member states, their category, the total number of transaction and the calculated ratio. This information is used during the statistical analysis.

Firstly Figure 1 shows a plot from the gathered data, and 2 gives an overview of the statistical values. The mean, median standard deviation and variance represent the values for specific countries, this means that an average EU country has this specific mean.

Figure 1. Plot of the drug/citizen ratio of EU member states



Some countries that stand out, for these countries a literature review has been done. The country with the highest ratio is the Netherlands.
Besides the quite liberal Cannabis laws in the Netherlands, the Netherlands is known as a country where most crime is "Transit crime" [13]. This can explain why the Netherlands has a relatively high ratio compared to the rest of the countries analysed.

The other countries that stand out, are the countries that have zero transactions originating from them. There could be several explanations for this. These countries can be classified as EU, instead of the respective country. Another explanation could have been internet access in these countries, however, as can be seen on the world data bank [3], this is not the case for these countries.

The countries where internet access was below 60% are Romania Bulgaria and Italy. This means that this can partially explain the low ratios in Romania (0.2), Bulgaria (20.0) and Italy(28.6).

The following hypothesis have been defined:

$H1_0$: The number of drug transactions via the dark web does not depend on the legislation in that specific country.
$H1$: The number of drug transactions via the dark web does depend on the legislation in that specific country.

The analysis has been performed on the entire data set, thus including the countries that have zero transactions.

Since we're only testing the dependence on one variable: "Legislation", a one-sided ANOVA test has been performed.

The results from this statistical analysis are the following: There were no statistically significant differences between group means as determined by one-way ANOVA (F(1, 26) = 2.736, p = .110)") and Figure 1 shows the other statistical values relevant for this research and a plot of the calculated ratios. Table 5 shows the F-statistic, and the significance (p-value) found after performing the one-way ANOVA test.

It also shows that $H1_0$ cannot be rejected in favor of H1 with a = 0.05, which means that it cannot be proven that there is a dependency between the drug-policy and the number of drugs shipping from the respective country.

6. DISCUSSION

In the literature review performed during this research it appeared that the member states have very different types of drug policies. This means that the decision on the requirements for the categories influences the analysis. However, the distinction specified is perceived as the appropriate way to research the effects.

When analysing the data, it appeared that the standard deviation is quite high, this means that the data set is very diverse. When comparing the Mean and the total ratio, we see that the total ratio is higher than the mean. This means that there is at least one country that has a higher ratio than we can gather from this data set.

Overall the values show that especially the Netherlands has a very high ratio in comparison to the other countries.

These differences between the countries substantial and that means that is likely that these differences have a cause, other than coincidence. Factors like GDP, have been found to have an effect on the drug market via the dark web [16]. This paper looks how the factor of policy possibly influences these differences, however what has been found from the analysis is that this is not a major factor.

There are a few limitations to this research and the paper. The first limitation to this research is the data available on drug markets on the dark web. The data set used is extensive, however, there are missing periods in this data set.

Another limitation to this research is the fact that it is only focused on the European Union. The data set used is extensive however, more extensive research more countries could be included in the analysis.

The third limitation to this research is the fact that it only focuses on data collected from 2013-2015. In this period there was only one country that decriminalised Cannabis, namely Malta, however Malta was not present in the data set. This means that the direct effects of the decriminalisation of drugs could not be measured.

7. CONCLUSION

Throughout this research several questions have been answered. The first research question was answered by a literature review, this was used to enable the categorisation of countries based on the types of drug policies they had. From this literature review it appeared that the differences between laws in countries are quite big. However by defining the different categories, they were used as dummy variables for the ANOVA testing.

Hypothesis	F-Statistic	Significance (p-value)	Null hypothesis Status
H1	2.736	0.110	Not Rejected

Table 5. Results of ANOVA

After performing the literature review, the data was filtered, such that the analysis performed at a later stage in the research, would be efficient. When the total number of drug transaction per country had been calculated this was used in the calculation of the ratios per country, by using:
$Formula1 = (totaldrugs/citizens)1.000.000$ These ratios were used in combination with the categories to perform the ANOVA one sided test. By the use of the ANOVA test, a proper analysis has been performed on the ratios as calculated in RQ3. The results are shown in tables 1, 2 and 3 and 1 also gives an overview of the distribution of the ratios per country. The results of the ANOVA test, as described in Table 5, show that the $H1_0$ cannot be rejected with $\alpha = 0.05$.

In this research, an analysis has been made on the effects of legislation on the drug market via the dark web. Where the expectation before starting the research, was that there would be an effect, it shows that if there is an effect, it is not a statistically significant effect.

To answer the research question, the conclusion is: It could not be proven at a significance level of 95%, that there was an effect of the drug policies in certain member states. The results have been analysed both statistically and on a policy basis, to ensure a proper analysis of the data. Through this research, more insight has been given into the drug market on the dark web.

What appeared during this research is that more data would benefit the research. Which leads to the recommendation of combining multiple data sets, covering a bigger time-period.

8. FUTURE WORK

For future work, it would be interesting to see the effects of policy change, on the drug market. For this, it would be especially interesting if extensive data can be used on a larger period of time. This data would be specifically covering a country and period where that country either decriminalised drugs or criminalised drugs.

Future research can also be performed on data available for more countries. With more extensive data new research (or continuation of this research), will give a better insight and in this research, there might be factors that appear as dependencies.

Interesting factors one could look at are:

1. A countries international trade rates and the effects on the drug market via the dark web
2. Geographic location of a country and the effects on the drug market via the dark web

Any research is more meaningful with more data, for this in future works it is advised to use newer, more extensive or multiple data sets. Whereas the data [7] used in this research is extensive, it only covers data of a few marketplaces, in a specific period of time. Any contributions to existing data sets can help future research. What could be seen in this research, the data used, was extensive.

However, because of missing time periods and transactions qualified as "EU", this data does have a bias. As it is not certain that the calculated total transactions per countries, are correct.

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