Going local on a global platform. A critical analysis of the transformative potential of cryptomarkets for organized illicit drug crime

DOI:

[10.1177/1057567718769719](https://doi.org/10.1177/1057567718769719)

Document Version

Accepted author manuscript

[Link to publication record in Manchester Research Explorer](#)

Citation for published version (APA):

Demant, J., Aldridge, J., Décary-Héту, D., & Munksgaard, R. (2018). Going local on a global platform. A critical analysis of the transformative potential of cryptomarkets for organized illicit drug crime. *International Criminal Justice Review*. <https://doi.org/10.1177/1057567718769719>

Published in:

International Criminal Justice Review

Citing this paper

Please note that where the full-text provided on Manchester Research Explorer is the Author Accepted Manuscript or Proof version this may differ from the final Published version. If citing, it is advised that you check and use the publisher's definitive version.

General rights

Copyright and moral rights for the publications made accessible in the Research Explorer are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

Takedown policy

If you believe that this document breaches copyright please refer to the University of Manchester's Takedown Procedures [<http://man.ac.uk/04Y6Bo>] or contact uml.scholarlycommunications@manchester.ac.uk providing relevant details, so we can investigate your claim.

Going local on a global platform: A critical analysis of the transformative potential of cryptomarkets for organized illicit drug crime

Accepted for publication by *International Criminal Justice Review* (11 October 2017)

Authors and affiliations

Jakob Demant*, University of Copenhagen

Rasmus Munksgaard, University of Copenhagen

David Décary-Héту, University of Montreal

Judith Aldridge, University of Manchester

* Sociologisk Institut

Øster Farimagsgade 5, 1014 København K, CSS - Bygning 16, Opgang i, Building: 16.2.02

jd@soc.ku.dk

Phone: +45 35 32 15 84

Abstract:

There is broad agreement in the literature on the transformative potential of drug cryptomarkets, which allow sourcing on a global market and consequently the circumvention of existing supply chains between producer and end-user. We examine whether the transformative potential of drug cryptomarkets has been realized in two ways: Are cryptomarket drug sellers found in production and transit countries? And do we see the increased use of shipping across international borders over time?

Methods: Using data collected by the DATACRYPTO software tool between 2013 and 2016, we characterize cryptomarket buyer behavior through the product reviews (i.e. sales transactions) posted on 15 cryptomarkets.

Findings: Cryptomarket drug sellers are predominantly based in countries of Europe, North America and Oceania. For both cannabis resin and cocaine sold on cryptomarkets, we find that known production and transit countries are not the primary sources of supplied drugs, but rather key countries of consumption. In the case of MDMA, we observe that the Netherlands, a known production country, is the largest supplier. We further observe tendencies over time towards increased localization of cryptomarkets with regards to product destinations.

Discussion: Though cryptomarkets offer a potentially global platform for drug distribution, they do not tend to be used as such. We explain our results with reference to buyers' preferences regarding safety, risk and convenience, alongside structural limitations for cryptomarket use such as bitcoin availability.

Cryptomarkets as Disruptive Innovation

The structure of international and domestic illicit drug smuggling has changed little in recent decades, as products move from producers to intermediaries and eventually to retail drug dealers who meet their customers face to face. Technological developments like mobile phones and pagers have facilitated a shift at the retail level, with many dealers now operating in closed markets in which they transact only with trusted, known or vouched-for customers (Kerr, Small, & Wood, 2005; May & Hough, 2004, Coomber & Moyle, 2014). With the advent of drug cryptomarkets over the past six years, we are now witnessing a transformative drug market innovation (Aldridge & Décary-Héту 2014). Also known as darknet markets or anonymous online markets (Christin, 2013; Soska & Christin, 2015), cryptomarkets have started to attract the attention of media, drug regulators and drug market participants. These markets offer drug dealers a new distribution channel that has been characterized as anonymous open markets (Aldridge & Décary-Héту 2016), enabling drug sellers to transact with customers across larger geographical areas than they could previously.

Cryptomarkets are hosted on the hidden or dark net, a subsection of the internet where all communications are encrypted and anonymized, thereby protecting both the infrastructure hosting the marketplaces and identity of their users. Cryptomarkets are visually and organizationally similar to online marketplaces such as Amazon and eBay that bring together multiple sellers in one location (Barratt, 2012; Christin, 2013). Vendors pay a bond upon signing up and a commission on each sale (Christin, 2013; Van Hout & Bingham, 2014). Marketplace administrators earn commission and in turn provide escrow payment protection and dispute resolution services, in addition to the technological infrastructure (Martin, 2014b, 2014a). But see Moeller, Munksgaard & Demant (2017) for exceptions. Payments are made using virtual currencies, most commonly bitcoin (Nakamoto, 2008), which provide some anonymity (Bancroft & Reid, 2016; Böhme, Christin, Edelman & Moore, 2015; Europol, 2016). Products are shipped through postal systems.

The original cryptomarket, Silk Road, specialized primarily in the sale of drugs (Christin, 2013). The range of products and services offered on cryptomarkets have diversified in recent years. While the sales on cryptomarkets remain dominated by drugs (Soska & Christin, 2015, p. 42), listings for financial fraud, hacking and identity fraud now make up just over four in ten listings offered for sale. Recent estimates suggest that cryptomarkets generate drug sales of over \$14.2 million per month, a three-fold increase from estimates in 2013 (Kruithof et al., 2016).

Cryptomarkets are international platforms. Indeed, when examining the geographic aspects of cryptomarket supply, Van Buskirk, Naicker, Roxburgh, Bruno & Burns (2016) found vendors located in many countries, including some in which drug production takes place. It is therefore possible that cryptomarkets might provide drug sellers located in these producer countries with access to a worldwide retail market for their products, potentially changing the existing structure of drug markets and shortening supply chains.

Generally, drugs increase in value the further they are from their source (Boivin, 2014). The prime reason for this is the risk associated with trafficking and distribution. Risk thus acts as a “tax” on the product value, as every handler within the chain must be paid for taking his/her risk (Reuter and Kleiman, 1986). Because drugs increase in value the further they are from their production source, cryptomarkets could shorten the distance between drug users and drug producers by cutting out superfluous middle-market actors involved in the trafficking of

illicit substances. The international reach of cryptomarkets has led Martin (2014b, p. 364) to ask whether illicit drugs could now *'simply be posted directly from producers to consumers (both domestically and internationally), [with both being able to] find each other literally at the click of a button'*. The fact that products increase in value as they travel from producer to consumer, further encourages such a transformation because of the profitability of transactions with fewer middle-men (Reuter & Caulkins, 1998, p. 594).

While cryptomarkets might function to shorten drug supply chains in this way, the extent to which this may occur is likely to differ by drug. Will cocaine producers in Columbia, cannabis growers in Morocco, and MDMA producers in the Netherlands all take advantage of cryptomarkets and sell directly to drug users, bypassing multiple layers of now superfluous intermediaries? The transformative potential of cryptomarkets may, moreover, manifest in a variety of forms and does not need to be limited to a producer-to-consumer model of transactions. Aldridge & Décary-Héту (2016) have provided the first empirical support for the transformative potential of cryptomarkets, by describing the sale of drugs at price/quantity levels consistent with purchases made with resale intent. While these findings do not address the question of producer-consumer link, the finding that some wholesale supply activities may be supported within this alternate distribution channel may be consistent with the characterization of cryptomarkets as a disruptive development (Griffiths & Mounteney, 2017).

Previous research

Van Buskirk et al. (2016) observe an over representation of Australian vendors, in spite of high drug prices in Australia. It is suggested, that these vendors order drugs at lower prices on cryptomarkets and subsequently sell them to domestic customers, in effect creating cross-national drug-arbitrage deals similar to those we would expect in domestic drug markets with substantial price differentials (Reuter & Caulkins, 1998). The Australian drug-arbitrage model suggested by Van Buskirk et al. (2016) appears to replicate traditional import patterns. Dolliver et al. (2016) found that countries producing novel psychoactive substances (NPS) and prescription medicines appeared to be supplying these drugs on cryptomarkets, mirroring traditional drug importation routes. However, Dolliver and Kuhns (2016) also observed an increasing geographic dispersion of the supply over time, which seems contrary to the notion of cryptomarkets “disrupting” drug markets by shortening supply chains. The extent to which cryptomarkets may be a disruptive drug market development may be limited. Martin (2014b, p. 364) himself points out that *'Afghani villagers harvesting raw opium may not have sufficient access to the internet technologies and secure postal networks required to conduct exchanges'*, stressing that the ability to participate on cryptomarkets is also limited in many ways. Summarizing previous research, Barratt & Aldridge (2016) conclude that *'international drug trading is not an inevitable outcome of cryptomarket use'*. Indeed, packages of drugs shipped across national borders may be subject to scrutiny by customs increasing the risk of detection (Décary-Héту & Paquet-Clouston, 2016), introducing risks to both buyers and vendors. For the former, it also extends the time between a purchase is made and the time when the drugs can be used.

This study brings empirical evidence to bear on the extent to which cryptomarkets transform or disrupt traditional drug supply chains, versus simply replicate them. We do so by identifying the countries that supply three specific drugs on cryptomarkets, and how distribution patterns change over time. Our analysis has two steps. In the first step, we describe how the cryptomarket-facilitated trading of cocaine, cannabis resin and MDMA are distributed across

countries from which they are sold. These substances were selected because of their well-understood and differing trafficking and production characteristics, allowing us to assess precisely how, where, and for which substances the disruptive potential of cryptomarkets may be manifest. In the second step, we examine the extent to which cryptomarket selling may be understood as local or national, in comparison to global. We conclude by discussing the consequences cryptomarkets may have for organized crime groups involved in drug trafficking.

Data and Methods

This study uses data collected with the DATACRYPTO software tool (see Décary-Hétu & Aldridge, 2015). DATACRYPTO is web crawling and scraping software that logs in to a cryptomarket and downloads all of the available web pages. Once this crawling phase has been completed for a cryptomarket, DATACRYPTO switches to its web scraping mode and extracts selected information from each page it has crawled. Data for this paper were obtained via frequent crawls of cryptomarkets containing information on drug sellers (vendors), the products they sell (listings) and product feedbacks (reviews). This so-called digital trace approach (see Décary-Hétu & Aldridge 2015) is the established methodology for data collection from cryptomarkets and has been applied in several studies (e.g. Soska & Christin, 2015, Aldridge & Décary-Hétu, 2016, Demant et al., 2016, Aldridge & Décary-Hétu, 2014, Broséus et al., 2016b, Dolliver & Kuhns, 2016, Dolliver et al., 2016, Christin 2013). The large and longitudinal dataset for our study was collected through repeated marketplace crawls. Below we focus on shipping information extracted from these marketplace crawls.

Previous studies that have focused on the geographical flow of illegal drugs on cryptomarket have been limited by analyzing products listed for sale by vendors, rather than products sold (Dolliver & Kuhns, 2016, Dolliver et al., 2016, Van Buskirk et al., 2016). Because sales generated by cryptomarket drug listings are far from distributed equally across vendors (Soska & Christin, 2015, Christin, 2013), our understanding of product flows are limited where studies do not connect geographical data to actual sales. We therefore extracted geographical data from transactions and the revenue these generated rather than only from items listed for sale. We use feedbacks left by customers as a proxy for actual transactions. This approach is well established (e.g. Aldridge & Décary-Hétu, 2014, 2016; Christin, 2013; Demant, Houborg, Munksgaard, 2016; Kruithof et al. 2016), and provides reliable data on demand (see Soska & Christin, 2015, p. 46 for an evaluation). Table 1 presents descriptive statistics for our dataset collected from 15 cryptomarkets with data dating back to 2011. Most data collected cover the period from the end of 2013 to mid-2016 wherein the main proportion of data collection took place. The dataset comprises 3,010,288 product reviews that we use to provide an estimate for sales over the period of more than \$500 million. Customer reviews, also known as feedback, are used as a proxy for transactions (sales). Kruithof et al. (2016) suggest customer reviews connected to listings capture 71% to 81% of actual transactions. The actual numbers of transactions and associated revenue generated by vendors – and thus the size of the cryptomarket economy – will therefore be higher than our estimates suggest.

[TABLE 1 ABOUT HERE]

Because our dataset results from repeated marketplace crawls over the years of data collection, some reviews will have been observed multiple times. We therefore removed suspected duplicate reviews of the same product that share the same review text, product rating and date. For cryptomarkets that do not associate dates with customer reviews, we remove suspected

duplicate reviews based on identical text and product rating, leading to an extent of underestimation of transactions and revenue. With regards to prices, vendors who may temporarily stop trading (e.g. vacation) or who are out of stock but wish to keep their listings online - and retain valuable customer feedback - can increase the price of a listing by one order of magnitude or more to deter customers from making purchases. This practice is known as setting a holding price (Aldridge & Décary-Hétu, 2016; Soska & Christin, 2015). To address the problem of holding prices we discard the very few transactions above \$10,000 as employed by Soska & Christin (2015). While both strategies, the removal of suspected duplicated reviews and transactions of \$10,000 or more, result in under-estimations of total cryptomarket sales, this problem is less relevant given that our research questions rely on a comparative and relational analysis.

Vendors may also decrease or increase the price for a variety of reasons (e.g. risk, attracting new customers). We further observed that some vendors will change shipping specifications over time. With both shipping and pricing being attributes subject to change we therefore consider each transaction separately. For each customer review that we treat as a transaction, we assign product information as observed on the date closest to the date-of-review. With exceptions (Silkkitie and Valhalla), most cryptomarkets offer the date on which a review was given. If no date-of-review is available, we use the date on which the review was first observed instead.

We then extracted additional data – specifically price, drug category and shipping information – from each transaction based on customer reviews as a proxy for actual transactions. Drug categories are not always comparable across marketplaces and vendors may also misclassify products intentionally or unintentionally (Aldridge & Décary-Hétu, 2016; Demant et al., 2016; Dolliver, 2015b). To identify the listings of cocaine, cannabis resin and MDMA and ecstasy, we trained a machine learning classifier based on the one applied by Soska & Christin (2015). This classifier was first fed the descriptions of 105,000 listings as well as the category each listing fell in based on a manual classification of the data by research assistants. The classifier was then trained to recognize the words in the descriptions that were correlated to specific categories. Words like the or drug were disregarded. The classifier was then fed all the descriptions of listings in our sample and asked to categorize the listings based on the knowledge it developed from its prior training. The classifier provided us with a 97% accuracy rate when asked to classify a random sample of the 105,000 listings, We expect to have a similar accuracy rate for the population of this paper.

[TABLE 2 ABOUT HERE]

We also cleaned and coded shipping information (inferred using the country or region from which vendors stated a product would be shipped) giving us the country of origin for 2,810,824 transactions and a region of origin for 2,881,583 transactions (Some vendors will give an origin region (e.g. "West Europe") but not a country). Our coding scheme for regions is presented in Table 2. The coding scheme was informed by a deductive and analytically motivated approach. We grouped countries to be reflective of the cryptomarket economy and what is known about international drug trafficking. Country groupings were based on a) natural or geopolitical constructs (i.e. "regions" and "continents"), b) our knowledge international drug trafficking, and c) how cryptomarket use is distributed among countries as discussed in the existing literature (Van Buskirk et al., 2016; Dolliver, Ericson & Love, 2016; Dolliver & Kuhns, 2016).

For the Americas, we use the category *Central and South America Including Mexico* because of the role these countries have as producers and exporters of illicit substances to the rest of North America, Oceania and Europe (Boivin, 2011; EMCDDA, 2016a; UNODC, 2011). Within and around Europe we observed a trend in which the revenue generated by cryptomarket vendors per country was lower in eastern and southern countries closer to Africa and Russia (e.g. Belarus, Ukraine, Spain, Greece), while higher in countries towards the west and north (e.g. United Kingdom, Germany, The Netherlands). The lack of vendor activity on cryptomarkets in Russia and nearby countries may in part be ascribed to the existence of the Russian Anonymous Marketplace (RAMP)¹. This is a forum-based market for illicit substances that conforms to Martin's (2014a) definition of cryptomarkets. We therefore separated this broader geographical area into the two regions "Russia, Belarus and Ukraine" and "Most of Europe". Analytically, the determination of which side of this coding scheme Eastern European countries are placed, is of less relevance as cryptomarket activity generally declines the further we move east (as shown in our findings). The countries included in the remaining regions – Oceania, Asia, the Middle East and Africa – were grouped based on standard geo-political groupings.

By coding the regions to the locations to which a vendor states a product can be shipped, we can further characterize each transaction as *domestic*, *potentially regional* and *potentially international*. Additional precision is achieved using a regular expression search which marks a transaction as *domestic* if the text of the feedback review contains the text strings *next day delivery* (We note that RAMP was shut down by law enforcement after this study was conducted (DeepDotWeb, 2017), *NDD* (Next Day Delivery) or *domestic*. A transaction is therefore coded as domestic if the review text matches the regular expression or the product could only be shipped domestically. It is defined as potentially regional, if it can be shipped within the region of the country (e.g. North America, Europe), and it is defined as potentially international if it can ship outside its region of origin. The latter two, potentially regional and international, are upper-bound estimates as it is highly likely that some users will simply purchase product domestically from a vendor who ships internationally.

In summary, our methodology builds upon previous approaches that used data from cryptomarkets collected using web crawling. We developed the method using dynamic information to identify transaction properties (prices and shipping information) and accessing additional free-text shipping information to provide more precise categorizations of transactions as domestic, potentially regional and potentially international.

Data Quality

Cryptomarket researchers have recently expressed concerns (see Aldridge & Décary-Héту, 2015; Buskirk, Roxburgh, Naicker & Burns, 2015; Dolliver, 2015a, 2015b; Munksgaard, Demant & Branwen, 2016, ,) in connection to the validity and reliability of findings generated in connection to data collection from cryptomarkets using webcrawling. It is therefore essential to establish the completeness of data collected and associated validity and reliability of analyses and results by exposing potential shortcomings. We do so by detailing our crawling methodology, and by comparing our results to findings from previous research.

The first potential shortcoming of the data collection method we used is connected to insufficiently frequent crawls (Munksgaard et al., 2016). Because crawls are static images of

1

markets, there is an inherent risk of "losing data" if too much time passes between crawls. If data (e.g. a review or product) is only available for a brief time, and the crawler is not operational during that time, the observation will not be included in the dataset. Given that many items listed for sale on cryptomarkets are available for less than three weeks (Christin, 2013), more frequent crawls, and more complete crawls, mitigate this risk. Munksgaard et al. (2016) provides a strategy for estimating coverage by comparing the number of downloaded pages in a crawl to the observed internal hyperlinks observed in the crawls, yielding an estimate of crawl coverage. Unfortunately, we were unable to adopt this strategy as the DATACRYPTO software is not configured to store the HTML pages it collects after each crawl. Alternatively, DATACRYPTO produces metrics after each crawl, specifically the number of listings, vendors and feedbacks. We have been able to compare these numbers to past scrapes for consistency. This allowed the research team to continuously evaluate the performance of the tool.

[FIGURE 1 ABOUT HERE]

Figure 1 plots the daily number of observations from DATACRYPTO for the two datasets of observations we use, product history and user reviews. As is observed, crawls are increasing in coverage after 2015 being both more frequent and more extensive, with a break in this period wherein no data were collected. The absolute number of observations per crawl are relative to a) market activity, and b) market size, making strict comparisons unfit (i.e. that we should observe as many items in 2016 as in 2014). Supply and demand fluctuates, meaning that so do the number of observed items and sales. However, Soska & Christin (2015) observe that cryptomarket supply and demand has grown continually over this period. This result is echoed in our observations, wherein more reviews and products are observed per crawl over time. Reviewing the representation of crawler activity we see no grounds for concern, but note the less frequent data collection in 2014 and 2015 in comparison to 2016, and the periods with no data collection in 2013 and 2015. The less frequent data collection in these periods will result in less reliable coverage during these periods.

[TABLE 3 ABOUT HERE]

Minor differences (e.g. the time of day a website was crawled) render studies of cryptomarkets incomparable with respect to small-scale details, such as the exact number of reviews or available items (Munksgaard et al., 2016). However, we expect that results from our dataset should nevertheless show substantial continuity when compared to previous research (Aldridge & Décary-Héty, 2015). Table 3 presents general indicators, market share, mean and median transaction value, for two key substances (cannabis and ecstasy), which make up almost half of the cryptomarket sales. Comparisons to Demant et al. (2016) and Kruithof et al. (2016) show continuity in these indicators: cannabis constitutes the largest category for in terms of sales, followed by ecstasy and MDMA. Neither of these studies is perfectly comparable to ours: Demant et al. (2016) use data from 2014 and 2015 collected with a custom crawler and from an open archive (Branwen et al., 2015) and do not apply holding prices; and Kruithof et al. (2016) use data collected with DATACRYPTO only in 2016. As collection periods differ, this is likely to be the cause for the close but not similar mean and median transaction values, as well as the market share of each substance.

[FIGURE 2 ABOUT HERE]

Figure 2 plots the sum of daily transactions across both drug and non-drug items from 2014 with LOESS trendline to aid readability. The figure shows broad trends similar to those identified by Soska and Christin (2015); our data therefore exhibits the kind of continuity that researchers like Aldridge & Décary-Hétu (2015) identify as a critical indicator of data integrity. In sum, our dataset has good coverage in spite of less frequent data collection in mid-2015. Reviewing some general indicators, the prices and market shares of MDMA and cannabis, and the revenues generated in 2014 we also show continuity between previous findings and our dataset.

Findings

In the following sections, we present our findings. Focusing on three popular substances with well-established trafficking routes – cannabis resin, cocaine, and MDMA, we first present findings on how the cryptomarket distribution of these substances compares to the production, export and transit countries for these substances. We then examine the extent of domestic, regional and international distribution on cryptomarkets. This provides an insight into whether, and how, cryptomarkets “disrupt” or replicate existing trafficking and distribution modes of illicit substances.

Cocaine

About two-thirds of the world's cocaine production comes from Colombia with the rest coming from Peru and Bolivia (Boivin, 2011). Over half of their combined production is shipped to the USA, by far the country with the largest demand for cocaine in the world, with the remainder shipped to Europe and to a lesser extent, Africa and Australia (EMCDDA, 2016a). *En route* to its consumption countries, cocaine may pass through Central and South America, the Caribbean and West Africa (UNODC, 2011). In Europe, cocaine will typically enter through the ports in the Netherlands and Belgium or through Spain and Portugal (EMCDDA, 2016a). If the cryptomarkets actualize their disruptive potential, we would expect to see cocaine vendors located along these routes where cocaine will be both cheaper and have lower levels of adulteration.

[TABLE 4 ABOUT HERE]

We find a total of 273.075 cocaine transactions on cryptomarkets for which we can identify a country from which vendors shipped the drug. Table 4 shows the distribution of these transactions including only countries which are the origin of 1.000 or more transactions. Transactions originating from Mexico, the Caribbean and Central and South America are all combined in this analysis. Although all cocaine is produced in these areas, and most will transit through the regions (UNODC, 2011, 2016), we only observe sales of about \$508.000 (less than 1% of all cocaine revenues) from this region. In Europe, the Netherlands, an entry point for many shipments of cocaine, accounts for 11.3% of the global cocaine supply. Spain, another entry point (Calderoni, Berlusconi, Garofalo, Giommoni, L., & Sarno, 2016, p. 12 Chandra, Barkell, & Steffen, 2011), is only responsible for 1.3% of the revenue generated on cryptomarkets. Countries in Africa, through which cocaine increasingly transits (EMCDDA & Europol, 2013, EMCDDA, 2016a, p. 44), account for about \$1.000 of cocaine sales (less than 0.01%; not shown in table). Thus, much of the cryptomarket revenues generated by cocaine occur for vendors located outside of production, distribution and import countries. Indeed, the

Netherlands distribute less cocaine in terms of value than the UK and Ireland (28.7%), neither of which are transit countries for cocaine flowing into Europe. The same conclusion can be drawn about the USA; vendors there generated one quarter (25.5%) of all revenues, even though the USA is neither a transit nor producer country for cocaine. Thus, our findings suggest that the cryptomarket cocaine trade is not dominated by vendors located in Central and South American production countries, and only minimally generated by vendors in European transit countries. Instead, the largest share of the cryptomarket trade in cocaine is found among vendors located in the high consumption countries of the UK and USA for this drug.

Cannabis Resin

The production of cannabis resin, in contrast to its herbal form (skunk, pot), is limited to few countries and the supply chain from production to consumption includes more actors. Morocco, Afghanistan and Lebanon are the three leading production countries (UNODC, 2016). The resin consumed in Europe generally originates in Morocco and North Africa from where it enters Europe through Spain and Portugal with the Netherlands and Belgium serving as a secondary distribution and transit countries (EMCDDA and Europol, 2016; EMCDDA & Europol, 2013, p. 62, p. 61). Afghanistan and Lebanon supply their neighboring countries (respectively Pakistan or Iran and Near East countries). Cannabis resin therefore serves as an ideal case to examine the transformative potential of cryptomarkets, given the clearly defined trafficking routes not found for herbal cannabis, which is generally produced widely for consumption within the production country or neighboring countries (EMCDDA & Europol, 2016; Potter, Bouchard, & Decorte, 2013, p. 43, p. 57; UNODC, 2016).

[TABLE 5 ABOUT HERE]

Table 5 presents cryptomarket distribution of cannabis resin across countries. Due to the small number of sales from some individual countries, we merge all African, Asian and Middle Eastern countries into regions. Consequently, it becomes evident that the role of these regions, where resin is produced, are of negligible importance in the cryptomarket economy. Rather, we see that the UK and Ireland are responsible for nearly half (46.5%) of all cannabis resin transactions, and one third (33.3%) of the revenue generated in the category. Some cannabis resin sold on cryptomarkets does originate from Africa-based vendors, however the amount constitutes less than 1% of cannabis resin revenues. As with cocaine, the Netherlands is again prominent: the country is the third largest cryptomarket distributor of cannabis resin in Europe and our findings show that Dutch vendors are responsible for 14% of revenue generated by cannabis resin. Of Spain and Portugal, which are import countries in Europe, only Spanish vendors generate substantial revenue (4.6% of all revenue for this drug). Thus, the findings for cannabis resin suggests a pattern which is close to inverse of what we would expect considering that price increases and quality decreases as product travels from its source: we observe minimal sales in production countries, little more in import countries and almost half of all transactions in a consumption region (UK and Ireland).

MDMA and Ecstasy

MDMA and ecstasy pills, in contrast to both cannabis resin and cocaine, is primarily manufactured in Western industrialized countries. Though the substance can be produced anywhere with access to precursors (UNODC, 2016), the European supply is mainly produced in the Netherlands and surrounding countries (EMCDDA, 2016b), while some of the North American supply is produced in Canada (US Department of Justice Drug Enforcement Administration, 2015).

[TABLE 6 ABOUT HERE]

Table 6 presents our findings for MDMA and ecstasy pills including every country which is the origin of 1,000 or more transactions. Contrary to what was the case for cocaine and cannabis resin, almost a quarter of both revenue and transactions originates in a production country; the Netherlands. The Netherlands and neighboring Germany and Belgium, are responsible for about 41% of the global cryptomarket transactions of MDMA. Our results show that the UK and the USA, both consumer countries, represent about 40% of the revenues generated by the sale of MDMA. The distribution of MDMA on cryptomarkets therefore contrasts to that of cannabis resin and cocaine, with a substantial proportion of the supply originating from vendors based in well-known production countries.

Sourcing Globally Through Cryptomarkets

The first series of analyses suggest that cryptomarkets have not significantly transformed or disrupted the traditional structure of drug trafficking for neither cannabis resin or cocaine, which on cryptomarkets generally are sold from consumption countries. The case is different for MDMA, for which we find that production countries make up a sizeable proportion of the sales on cryptomarkets.

An alternate perspective on the actualization of the suggested transformative potential of cryptomarkets, is whether transactions are local, global or regional. Using customer feedbacks, we can estimate the lower bound number of transactions that are domestic by combining shipping information with indicators present in the review comments. Figure 3 shows the daily proportion of transactions per potential destinations for each of the substances after January 1st 2014 with a linear trendline.

[FIGURE 3 ABOUT HERE]

In 2014, for all three drugs, domestic transactions appear to represent *at least* 25% of all transactions. The actual proportion of domestic transactions is likely to be higher however as potentially regional or international transactions also include domestic transactions. The general trend across all the three substances is a stable increase in transactions destined for either domestic or regional customers, and a decrease in (potential) international transactions which eventually represent at most 50% of all transactions. Thus, across the three substances with clearly specified trafficking routes that might enable the transformative potential of cryptomarkets, we nevertheless see indications that selling is increasingly domestic or intra-regional over time.

Discussion

Our results suggest that cryptomarkets can complement traditional drug trafficking at the international level. Indeed, the flows of certain drugs on cryptomarkets follow different routes than those used to transport illicit substances from producing countries to consuming countries. Most sales of cocaine and cannabis resin are made in countries that are further away from the production, transit and import countries. In contrast, the distribution of ecstasy and MDMA can be linked to a production country, the Netherlands, which is its largest distributor. Taking a more longitudinal look at the evolution of drug shipments by cryptomarkets, we observe a shift towards increasingly catering to domestic or regional markets with a decrease in sales that might reach an international audience. This holds for all three substances included in our analyses.

These findings do not suggest that cryptomarkets are circumventing the actors and networks involved in drug trafficking regardless of substance. Rather, it suggests a more complicated picture: cryptomarkets can shorten supply chains, and this appears to be the case for MDMA, but not for cannabis resin or cocaine. We first discuss the implications of our findings for the role of organized crime groups in international drug smuggling and then move on to discuss why cryptomarkets have not realized the transformative or disruptive potential some have posited (e.g. Griffiths & Mounteney, 2017).

Most illicit drug smuggling operations are built around fluid networks of individuals rather than bureaucratic and static structures (Benson & Decker, 2010; Calderoni, 2012; Desroches, 2007; Morselli, 2001). International smugglers sometimes use brokers to negotiate with drug producers and national importers (Calderoni, 2012; Morselli, 2001). These importers in turn sell to regional wholesalers who distribute drugs in smaller amounts to local wholesalers (Adler, 1993). This chain ends with local drug dealers or drug users acting as social suppliers (Coomber and Moyle, 2014). The smuggling of each drug is structured around a varying number of layers between drug producers and users; this number may also change for a single type of drug over time. Our results for cocaine and cannabis resin suggest that cryptomarkets have not circumvented organized crime groups involved in their trafficking. For MDMA, the labelling of cryptomarkets as a game changing innovation (EMCDDA, 2016b) for organized crime groups may be true. Indeed, cryptomarkets facilitate the purchase of MDMA from the Netherlands and the platforms are therefore competing with, or being used by, traditional traffickers and smugglers. This is not the case for cannabis resin and cocaine, which are sold in countries that are not hubs of the traditional smuggling routes, leaving intact the traditional roles of trafficker, smuggler, and other middle-level suppliers.

We suggest that the explanations for this partly unfulfilled transformative potential are to be found on a micro and macro scale. On a micro scale, the preferences of buyers and vendors, and the risks they take, are likely to impact the choice of sourcing from online or offline suppliers. On a macro scale, the availability of technology and digital divide also has explanatory power. Barratt et al. (2016) suggest that cryptomarkets are first and foremost used to reduce risks in the riskiest parts of the drug supply. From a buyer's perspective, sourcing domestically or regionally (e.g. inside the EU) is therefore preferable as international shipping entails possible customs interference (seen as risk). Additionally, it increases waiting time and possibly includes language barriers (Décary-Hétu et al., 2016). This suggests that even if we were to observe vendors from production or transit countries, these would not likely have appeal as

buyers' value safety and convenience. This argument, however, stands in contrast to the dominance of the Netherlands in the cryptomarket economy. This is a well-known production, transit, import and consumption country in the traditional drug economy, also publicly known for its significant role in the cryptomarket economy. This means that parcels shipping from the Netherlands may be flagged by borders officials for inspection (Kruithof et al., 2016). In the case of the Netherlands, buyers knowingly purchase from a high-risk country. Ascribing the non-existent supply from source countries of cocaine and cannabis resin to their status as production countries neglects that the Netherlands despite such status continues to dominate the cryptomarket MDMA supply. Further stands the question of whether it is even possible to ship product out of production countries, as parcels are likely to be heavily scrutinized. It is not possible to conclude on this from this analysis, but the apparent success of the vendors in Netherlands shows that being a known production country does not hinder playing a significant role in cryptomarket distribution.

The decreasing prevalence of international transactions on cryptomarkets may at first appear puzzling because buyers and vendors have access to a global marketplace. As Barratt et al. (2016) suggest, cryptomarkets are used to minimize risk and so the decreasing prevalence of international purchases could simply reflect that domestic and regional drug selections are now broad enough to support most users. In other words, the cryptomarkets are increasingly capable of satisfying local demand and buyers are increasingly able to source their product locally. On the supply-side, volume and risk may explain the absence of supply from production countries for resin and cocaine. Producers and associates typically deal in large quantities (Calderoni, 2012) and would need to lower the average quantity of drugs they sell in each transaction. Restructuring and organizing their business to do so may increase costs and the number of people involved in transactions. A higher level of interactions could lead to increased risks of detection and arrest (Hofmann & Gallupe, 2015). Thus, for producers cryptomarkets may simply be riskier and less profitable.

While internet access and digital literacy on a societal scale may hinder adaptation of cryptomarkets (Martin, 2014b, p. 364), the availability of bitcoin is also a hindrance because it likely necessitates a broader social use (e.g. peers to buy bitcoin from anonymously). Buying products on cryptomarkets requires bitcoin, preferably bought using an anonymizing medium such as LocalBitcoins (Bancroft & Reid, 2016), and selling on cryptomarkets requires the laundering of those earnings into usable currency. The availability and access to internet and communications technology, in particular bitcoin, may explain the dispersed nature of cryptomarket demand and supply, and we therefore suggest that further research consider the dispersion of cryptomarket activity within the discussion of a "digital divide" (see for example Buchi, Just & Latzer, 2015, Min, 2010, Warschauer, 2004).

Limitations and Further Research

Though cryptomarkets offer unprecedented access to high quality data on a genre of drug markets (Barratt & Aldridge, 2016) there are still limitations to the data. For one, vendors may be lying about where their product ships from and may use drop-shipping² (Aldridge & Askew, 2017). Social regulation, both formal and informal, minimize the odds that fraudulent practices

² 'Drop-shipping' is the practice of selling drugs as an intermediary without handling the product.

take place however. Buyers would undoubtedly complain publicly if their package was sent from a different country than the one they expected it to.

Other substances that have a shorter path from producers to consumers (e.g. herbal cannabis) may circumvent organized crime groups, though these will be involved in the distribution rather than the trafficking. Findings on NPS presented by Dolliver and Kuhns (2016) shows that available sources are increasingly dispersed, which suggests increased domestic availability of these substances. We suggested that domestic and regional availability may influence who buyers purchase drugs from. It is possible that an increased domestic and regional availability simply satisfies a demand which previously had to rely on international sources. We therefore suggest that further research consider and explore this relation between geographic availability and purchasing patterns.

Finally, we also suggest exploring the relation between the actual purchase and its destination. As Van Buskirk et al. (2016) suggests, it is likely that some cryptomarket buyers purchase drugs internationally and then resell domestically through cryptomarkets. Such a practice would circumvent the organized crime groups involved in drug trafficking, and further research could use product weight and prices to explore whether production and origin countries tend to sell larger quantities, and if vendors in consumption countries then resell product domestically.

Conclusion

Cryptomarkets are organized global marketplaces. Because of the economic realities of drug trafficking, the potency of drugs is generally higher and their price lower the closer they are to their source. This would suggest that cryptomarkets should supply illicit substances from sources that are closer to the countries where they are produced (i.e. production, transit and import countries). Our findings, using product reviews as a proxy for how much an individual country supplies, show that the reality is more complex. For cannabis resin and cocaine, the relation is the opposite, as we see consumption countries being responsible for a larger share of the supply. The USA, the U.K. and Ireland are responsible for more than 50% of both transactions and revenue generated in the category cocaine, while the primary origin regions, Central and South America and the Caribbean, are of marginal importance responsible for less than 1% of the total revenue generated. For cannabis resin, the entire continent of Africa, in which Morocco is a key producer, is responsible for 0.2% of the revenue generated. In fact, more than 50% of the revenue being generated in Germany, the U.K. and Ireland, again suggesting an inverse pattern in which the primary suppliers of product on cryptomarkets are not production, import or transit countries. The cryptomarket supply of MDMA exhibits a pattern different from cocaine and cannabis resin with the Netherlands being responsible for 25% of the revenue generated and is the largest distributor. Martin (2014a) and the EMCDDA (2016b) suggest that cryptomarkets may be a game changer for organized crime groups involved in the trafficking of illicit substances as they become superfluous. This may be the case for MDMA, but not cocaine and cannabis resin which are not sold from production, transit or import countries to the same extent as consumption countries, which implies that the product has been trafficked to these. We also find that cryptomarket transactions are increasingly either domestic or regional. This suggests that the actualization of the supposed transformative potential of cryptomarkets is not an inevitable outcome.

7. References

- Adler, P. (1993). *Wheeling and dealing: An ethnography of an upper-level drug dealing and smuggling community*. Columbia University Press, USA, New York.
- Aldridge, J. and Askew, R. (2017). Delivery dilemmas: How drug cryptomarket users identify and seek to reduce their risk of detection by law enforcement. *International Journal of Drug Policy*.
- Aldridge, J. and Décary-Hétu, D. (2014). Not an 'Ebay for Drugs': The Cryptomarket 'Silk Road' as a Paradigm Shifting Criminal Innovation. Available at SSRN 2436643.
- Aldridge, J. and Décary-Hétu, D. (2015). A response to Dolliver's "Evaluating drug trafficking on the Tor Network: Silk Road 2, the sequel".
- Aldridge, J. and Décary-Hétu, D. (2016). Hidden Wholesale: The drug diffusing capacity of online drug cryptomarkets. *International Journal of Drug Policy*, 35:7-15.
- Bancroft, A. and Reid, P. (2016). Challenging the techno-politics of anonymity: the case of cryptomarket users. *Information, Communication & Society*, 20(4):497-512.
- Barratt, M. J. (2012). Silk Road: eBay for drugs. *Addiction*, 107(3):683.
- Barratt, M. J. and Aldridge, J. (2016). Everything you always wanted to know about drug cryptomarkets* (*but were afraid to ask). *International Journal of Drug Policy*, 35:1-6.
- Barratt, M. J., Ferris, J. A., and Winstock, A. R. (2016). Safer scoring? Cryptomarkets, social supply and drug market violence. *International Journal of Drug Policy*, 35:24-31.
- Benson, J. S. and Decker, S. H. (2010). The organizational structure of international drug smuggling. *Journal of Criminal Justice*, 38(2):130-138.
- Böhme, R., Christin, N., Edelman, B., and Moore, T. (2015). Bitcoin: Economics, Technology, and Governance. *Journal of Economic Perspectives*, 29(2):213-238.
- Boivin, R. (2011). *Le monde à l'envers: Analyse de la structure du trafic transnational de drogues illicites*. PhD thesis, School of Criminology, University of Montreal.
- Boivin, R. (2014). Risks, prices, and positions: A social network analysis of illegal drug trafficking in the world-economy. *International Journal of Drug Policy*, 25(2):235-243.
- Branwen, G., Christin, N., Décary-Hétu, D., Andersen, R. M., StExo, Presidente, E., Anonymous, Lau, D., Sohlhlz, Kratunov, D., Cakic, V., Buskirk, V., and Whom (2015). *Dark Net Market archives, 2011-2015*.
- Broséus, J., Gentile, N., and Esseiva, P. (2016a). The cutting of cocaine and heroin: A critical review. *Forensic Science International*, 292: 73-83.
- Broséus, J., Rhumorbarbe, D., Mireault, C., Ouellette, V., Crispino, F., and Décary-Hétu, D. (2016b). Studying illicit drug trafficking on Darknet markets: structure and organisation from a Canadian perspective. *Forensic science international*, 264:7-14.

- Buchi, M., Just, N., and Latzer, M. (2015). Modeling the second-level digital divide: A five-country study of social differences in Internet use. *New Media & Society*, 18(11):2703-2722.
- Buskirk, J. V., Roxburgh, A., Naicker, S., and Burns, L. (2015). A response to Dolliver's 'Evaluating drug trafficking on the Tor Network: Silk Road 2, the sequel'. *International Journal of Drug Policy*, 26(11):1124-1125.
- Calderoni, F. (2012). The structure of drug trafficking mafias: The 'Ndrangheta and cocaine. *Crime, Law and Social Change*, 58(3):321-349.
- Calderoni, F., Berlusconi, G., Garofalo, L., Giommoni, L., and Sarno, F. (2016). The Italian mafias in the world: A systematic assessment of the mobility of criminal groups. *European Journal of Criminology*, 13(4):413-433.
- Caulkins, J. P., Disley, E., Tzvetkova, M., Pardal, M., Shah, H., and Zhang, X. (2016). Modeling the Structure and Operation of Drug Supply Chains: The Case of Cocaine and Heroin in Italy and Slovenia. *International Journal of Drug Policy*, 31:64-73.
- Caulkins, J. P. and Reuter, P. (2006). Illicit drug markets and economic irregularities. *Socio-Economic Planning Sciences*, 40(1):1-14.
- Chandra, S., Barkell, M., and Steffen, K. (2011). Inferring Cocaine Flows from Price Data: Evidence from the World Drug Report. *Journal of Drug Policy Analysis*, 4(1).
- Christin, N. (2013). Traveling the Silk Road: A Measurement Analysis of a Large Anonymous Online Marketplace. *Proceedings of the 22nd international conference on World Wide Web*, pages 213-224.
- Coomber, R. and Moyle, L. (2014). Beyond drug dealing: Developing and extending the concept of 'social supply' of illicit drugs to 'minimally commercial supply'. *Drugs: Education, Prevention and Policy*, 21(2):157-164.
- Décary-Hétu, D. and Aldridge, J. (2015). Sifting through the net: Monitoring of online offenders by researchers. *European Review of Organised Crime*, 2(2):122-141.
- Décary-Hétu, D., Paquet-Clouston, M. and Aldridge, J. (2016). Going international? Risk taking by cryptomarket drug vendors. *International Journal of Drug Policy*, 35:69-76.
- Demant, J., Houborg, E., and Munksgaard, R. (2016). Personal use, social supply or redistribution? Cryptomarket demand on Silk Road 2 and Agora. *Trends in Organized Crime*, pages 1-20.
- DeepDotWeb (2017, September 21). Russian Authorities Busted RAMP, the Oldest Darknet Market. *DeepDotWeb*. Retrieved from <https://www.deepdotweb.com/2017/09/21/russian-authorities-busted-ramp-oldest-darknet-market/>
- Desroches, F. (2007). Research on upper level drug trafficking: a review. *Journal of Drug Issues*, 37(4):827-844.
- Dolliver, D. S. (2015a). A rejoinder to authors: Data collection on Tor. *International Journal of Drug Policy*, 26(11):1128-1129.

- Dolliver, D. S. (2015b). Evaluating drug trafficking on the Tor Network: Silk Road 2, the sequel. *International Journal of Drug Policy*, 26(11):1113-1123.
- Dolliver, D. S., Ericson, S. P., and Love, K. L. (2016). A geographic analysis of drug trafficking patterns on the tor network. *Geographical Review*.
- Dolliver, D. S. and Kuhns, J. B. (2016). The Presence of New Psychoactive Substances in a Tor Network Marketplace Environment. *Journal of Psychoactive Drugs*, pages 1-9.
- EMCDDA (2016a). Perspectives on drugs: Cocaine trafficking to Europe. Luxembourg: European Monitoring Center for Drugs and Drug Addiction.
- EMCDDA (2016b). Recent changes in Europe's MDMA/ecstasy market. Luxembourg: European Monitoring Centre for Drugs and Drug Addiction.
- EMCDDA and Europol (2016). EU drug markets report. In-depth analysis. Luxembourg: European Monitoring Centre for Drugs and Drug Addiction.
- EMCDDA & Europol (2013). EU Drug Markets Report - A Strategic Analysis. Luxembourg: EMCDDA & Europol.
- Europol (2016). IOCTA – Internet Organized Crime Threat Assessment. Hague, Netherlands: Europol.
- Goldsmith, J. (2000). Unilateral regulation of the Internet: A modest defence. *European Journal of International Law*, 11(1):135-148.
- Griffiths, P. and Mounteney, J. (2017). Disruptive Potential of the Internet to Transform Illicit Drug Markets and Impact on Future Patterns of Drug Consumption. *Clinical Pharmacology & Therapeutics*, 101(2):176-178.
- Hofmann, D. C. and Gallupe, O. (2015). Leadership protection in drug trafficking networks. *Global Crime*, 16(2):123-138.
- Holt, T. J., Smirnova, O., and Chua, Y. T. (2016a). Exploring and Estimating the Revenues and Profits of Participants in Stolen Data Markets. *Deviant Behavior*, 37(4):353-367.
- Holt, T. J., Smirnova, O., and Hutchings, A. (2016b). Examining signals of trust in criminal markets online. *Journal of Cybersecurity*.
- Hutchings, A. and Holt, T. J. (2016). The online stolen data market: disruption and intervention approaches. *Global Crime*, 18(1):11-30.
- Kerr, T., Small, W., and Wood, E. (2005). The public health and social impacts of drug market enforcement: A review of the evidence. *International journal of drug policy*, 16(4):210-220.
- Kruithof, K., Aldridge, J., Décary-Hétu, D., Sim, M., Dujso, E., and Hoorens, S. (2016). Internet-facilitated drugs trade: An analysis of the size, scope and the role of the Netherlands. Santa Monica, CA: RAND Corporation.
- Martin, J. (2014a). *Drugs on the dark net: how cryptomarkets are transforming the global trade in illicit drugs* [Kindle edition]. New York: Palgrave Macmillan.

- Martin, J. (2014b). Lost on the Silk Road: Online drug distribution and the 'cryptomarket'. *Criminology and Criminal Justice*, 14(3):351-367.
- May, T. and Hough, M. (2004). Drug markets and distribution systems. *Addiction Research & Theory*, 12(6):549-563.
- Min, S. (2010). From the Digital Divide to the Democratic Divide: Internet Skills, Political Interest, and the Second-Level Digital Divide in Political Internet Use. *Journal of Information Technology & Politics*, 7(1):22-35.
- Moeller, K., Munksgaard, R., Demant, J. (2017) Flow My FE the Vendor Said: Exploring Violent and Fraudulent Resource Exchanges on Cryptomarkets for Illicit Drugs. *American Behavioral Scientist*, 61(11):1427-1450.
- Morselli, C. (2001). Structuring Mr. Nice: Entrepreneurial opportunities and brokerage positioning in the cannabis trade. *Crime, Law and Social Change*, 35(3).
- Munksgaard, R., Demant, J., and Branwen, G. (2016). A replication and methodological critique of the study 'Evaluating drug trafficking on the Tor Network'. *International Journal of Drug Policy*, 35.
- Nakamoto, S. (2008). Bitcoin: A peer-to-peer electronic cash system. Retrieved from: <https://bitco.in/pdf/bitcoin.pdf>
- Potter, G., Bouchard, M., and Decorte, T. (2013). *World Wide Weed: Global Trends in Cannabis Cultivation and its Control*. Surrey, England: Ashgate Publishing, Ltd.
- Reuter, P. and Caulkins, J. (1998). What Price Data Tells Us About Drug Markets. *Journal of Drug Issues*, 28(3):593-513.
- Reuter, P. & Kleiman, M. (1986) Risks and Prices: An Economic Analysis of Drug Enforcement. *Crime and Justice* 7: 289-340
- Soska, K. and Christin, N. (2015). Measuring the Longitudinal Evolution of the Online Anonymous Marketplace Ecosystem. 24th USENIX Security Symposium (USENIX Security 15), pages 33-48.
- UNODC (2005). *World Drug Report, Volume 1: Analysis*. New York, NY: United Nations Office on Drugs and Crime.
- UNODC (2011). *The Transatlantic Cocaine Market*. New York, NY: United Nations Office on Drugs and Crime.
- UNODC (2016). *World Drug Report*. New York, NY: United Nations Office on Drugs and Crime.
- US Department of Justice Drug Enforcement Administration (2015). 2015 National Drug Threat Assessment Summary. Report, United States Department of Justice - National Drug Intelligence Center. Retrieved from: <https://www.dea.gov/docs/2015%20NDTA%20Report.pdf>.
- Van Buskirk, J., Naicker, S., Roxburgh, A., Bruno, R., and Burns, L. (2016). Who Sells What? Country Specific Differences in Substance Availability on the Agora Cryptomarket. *International Journal of Drug Policy*, 35:16-23.

- Van Hout, M. C., & Bingham, T. (2014). Responsible vendors, intelligent consumers: Silk Road, the online revolution in drug trading. *International Journal of Drug Policy*, 25(2), 183-189.
- Warschauer, M. (2004). *Technology and social inclusion: Rethinking the digital divide*. Cambridge, MA: MIT press.

Market	Reviews	Reviews with dates	Revenue generated	Active sellers	Active items	Date of first review	Date of last review
Abraxas	202,565	202,479	26,974,298	1,243	12,847	2014-12-29	2015-10-31
Agora	599,583	468,668	105,793,160	2,546	38,729	2013-12-30	2015-09-04
Alphabay	576,035	575,945	79,722,541	3,145	37,893	2015-03-19	2016-07-17
Cryptomarket	45,712	45,550	3,218,741	460	2,383	2014-11-12	2016-04-29
Dream Market	492,876	490,037	76,882,978	2,078	30,073	2013-12-27	2016-07-12
East India Company	3,410	3,408	469,901	185	820	2015-05-16	2015-12-15
Evolution Marketplace	248,008	248,007	30,712,198	1,962	18,039	2014-01-13	2015-03-14
Hansa Market	11,928	11,928	1,016,771	389	2,689	2015-09-02	2016-07-07
Middle Earth Marketplace	19,868	19,868	2,813,064	437	3,592	2014-08-09	2015-11-01
Nucleus Marketplace	288,877	288,877	46,440,126	1,672	23,027	2014-12-02	2016-04-10
Pandora Marketplace	3,384	3,384	513,770	101	246	2013-12-07	2014-08-27
Silk Road	86,122	86,122	13,878,842	925	5,894	2011-03-30	2013-09-14
Silk Road 2.0	405,910	399,951	128,310,036	985	16,495	2013-11-27	2014-09-29
Silkkitie	13,266	NA	1,277,089	234	1,558	NA	NA
Valhalla	12,744	NA	1,136,277	440	3,405	NA	NA
Total	3,010,288	2,844,224	519,159,792	16,802	197,690	30-03-2011	2016-07-17

Table 1: Cryptomarkets included in this study

Table 2: Coding of countries and regions

Africa	Asia	Central and South America including Mexico	Russia, Belarus and Ukraine	Most of Europe	Middle East	Canada and USA	Oceania
Angola, Cameroon, Ethiopia, Ghana, Kenya, Morocco, Namibia, Seychelles, South Africa, Sri Lanka, Togo	Afghanistan, Bangladesh, Cambodia, China, India, Japan, Malaysia, Dem. People's Rep. of Korea, Pakistan, Phillipines, Thailand, Viet Nam	Argentina, Barbados, Bolivia, Brazil, Colombia, Costa Rica, Dominican Republic, Ecuador, Guatemala, Jamaica, Mexico, Peru, Philippines, Venezuela	Belarus, Russian Federation, Ukraine	Albania, Andorra, Austria, Belarus, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Kosovo, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom and Ireland	Israel, Lebanon, Qatar, Saudi Arabia, United Arab Emirates, Yemen	Canada, United States of America	Australia, Fiji, New Zealand

Figure 1: Number of daily observations made by DATACRYPTO ($n = 14,109,935$)

Table 3: Economic indicators and previous research

Substance	Indicator	2014-2015: Demant et al. (2016)	2016: Kruithof et al. (2016)	2013-2016: This study
Cannabis	% of total revenue	29	31	26
	Mean price	\$153	NA	\$163
	Median price	\$64	NA	\$66
Ecstasy	% of total revenue	\$20	16	19
	Mean price	\$227	NA	\$254
	Median price	\$86	NA	\$81

Figure 2: Daily revenue on included markets from 2014 ($n = 3,389,398$)

Table 4: Distribution of cocaine transactions across countries (n = 273,075)

Country	Active listings	Transactions	Revenue (\$)	% of global revenue	% of global transactions
United Kingdom and Ireland	3,137	93,779	17,645,278	28.70	34.30
United States of America	3,131	63,740	15,678,405	25.50	23.30
Netherlands	2,256	42,964	6,929,654	11.30	15.70
Germany	1,776	29,219	5,867,297	9.50	10.70
Australia	1,195	14,961	7,309,055	11.90	5.50
Canada	625	8,099	2,562,920	4.20	3.00
France	359	5,683	773,530	1.30	2.10
Spain	95	4,220	806,664	1.30	1.50
Belgium	184	3,907	813,457	1.30	1.40
Central and South America	182	1,778	508,677	0.80	0.70
Switzerland	100	1,741	656,357	1.10	0.60

Table 5: Cannabis resin ($n = 151,165$)

Country	Active listings	Transactions	Revenue	% of global revenue	% of global transactions
United Kingdom and Ireland	4,200	70,291	5,237,633	33.30	46.50
Germany	2,398	26,979	2,900,832	18.50	17.80
Netherlands	1,122	12,819	2,193,413	14.00	8.50
France	650	9,926	793,009	5.00	6.60
United States of America	747	9,348	1,507,263	9.60	6.20
Spain	412	6,710	729,907	4.60	4.40
Denmark	161	2,360	182,675	1.20	1.60
Sweden	209	2,220	303,040	1.90	1.50
Italy	282	1,931	321,932	2.00	1.30
Canada	271	1,713	249,680	1.60	1.10
Australia	180	1,600	195,876	1.20	1.10
Norway	229	1,319	227,561	1.40	0.90
Asia	133	1,194	406,121	2.60	0.80
Belgium	123	929	303,122	1.90	0.60
Switzerland	94	479	44,769	0.30	0.30
Africa	48	418	29,227	0.20	0.30
Czech Republic	27	260	12,144	0.10	0.20
Finland	38	201	15,572	0.10	0.10
Austria	29	165	17,192	0.10	0.10
Portugal	31	143	9,594	0.10	0.10
New Zealand	3	66	572	0.00	0.00
Poland	15	55	2,401	0.00	0.00
Slovakia	1	15	1,537	0.00	0.00
Croatia	1	10	35961.6	0.20	0.00
Middle East	3	10	412.13	0.00	0.00

Table 6: MDMA and Ecstasy (n = 382,277)

Country	Active listings	Transactions	Revenue	% of global revenue	% of global transactions
Netherlands	8,104	88,033	24,849,558	25.10	23.00
United Kingdom and Ireland	4,349	78,139	10,627,826	10.70	20.40
United States of America	5,248	74,028	12,657,970	12.80	19.40
Germany	5,583	60,012	14,169,353	14.30	15.70
Australia	3,139	32,027	11,986,447	12.10	8.40
Canada	1,386	19,812	6,713,703	6.80	5.20
Belgium	631	10,281	7,643,343	7.70	2.70
China	813	6,075	8,336,988	8.40	1.60
France	369	2,958	286,805	0.30	0.80
Finland	198	2,605	349,890	0.40	0.70
Czech Republic	107	2,121	187,635	0.20	0.60
Sweden	220	1,525	190,976	0.20	0.40

Figure 3: Proportion of transactions by destination for cocaine ($n = 256,797$), cannabis resin ($n = 138,798$) and ecstasy and MDMA ($n = 349,531$).