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ACCEPTED MANUSCRIPT

Title: An island apart? Risks and prices in the Australian cryptomarket drug trade

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DOI: <http://dx.doi.org/10.1016/j.drugpo.2017.09.005>

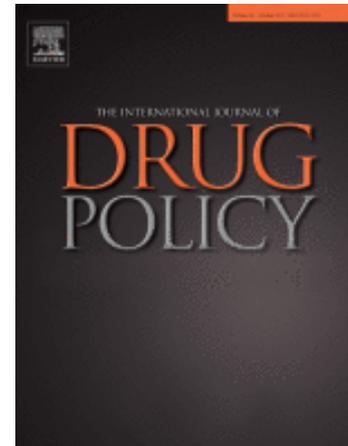
Reference: DRUPOL_2079

To appear in: *International Journal of Drug Policy*
December 2017 Volume 50, Pages 64–73

Accepted: September 11, 2017

Revised: July 2, 2017

Received: January 16, 2017



Please cite this article as:

Cunliffe, J., Martin, J., Décary-Hétu, D., Aldridge, J. (2017) An island apart? Risks and prices in the Australian cryptomarket drug trade in *International Journal of Drug Policy* 50:64-73

An Island Apart? Risks and Prices in the Australian Cryptomarket Drug Trade

Abstract

Background

Australia has a reputation as an anomaly with regard to cryptomarket drug trading, with seemingly disproportionately high levels of activity given its relatively small size, high prices and anecdotal accounts of it being a destination where many foreign-based vendors will not sell. This paper aims to investigate these claims from a risk and prices perspective.

Methods

By analysing data for over 60,000 drug products available for purchase from eight cryptomarkets in January 2016 this work builds a descriptive picture of the Australian online market in comparison to the rest of the world, before moving onto analyse the prices of drugs available to Australian consumers, both online and through conventional drug supply routes.

Results

Results show that the Australian online illicit drugs market is of considerable size, internally isolated and with methamphetamine sales being particularly large by comparison to other countries. Australian cryptomarket vendors sell drugs at significantly higher prices than those listed by their foreign counterparts. Online prices are however broadly comparable to street prices, with the exception of methamphetamine where prices appear to be much lower online.

Conclusions

These findings indicate that the perceived stringency of Australian border protection inadvertently increases the competitiveness and local market share of domestic cryptomarket vendors via a consumer side 'risk tariff', challenging the traditionally vendor-oriented drugs risk and prices framework.

cryptomarkets | Australia | illicit drugs | risks and prices

Introduction

Since the formation of the infamous and now defunct *Silk Road* in 2011, the use of cryptomarkets to trade illicit drugs has greatly expanded. By 2015, revenues from drug sales were thought to be in excess of \$100 million USD worth of illicit drugs per annum (Soska & Christin 2015:40) and estimated to be around about \$170 million USD by 2016 (Kruithof et al. 2016). Research has suggested that the design and regulatory mechanisms of these marketplaces may make drug selling less risky than conventional methods by connecting buyers and sellers via digital systems (principally Tor and Bitcoin) and postal networks (Martin, 2014a; 2014b; Van Hout & Bingham, 2013a), rather than through conventional interpersonal networks that are often complex, lengthy and highly stratified (see, for example, Malm & Bichler 2011). Similarly, the risk from law enforcement may be reduced as traditional anti-drug policing operations, such as buy-bust undercover operations and raids on drug retailing hotspots have less success (Martin, 2014b; Décary-Héту & Giommoni, 2016) and more resource-intensive and unfamiliar modes of investigation such as cyber-investigations that seek to exploit information leakage in Tor connections (Huber et al., 2010; Geddes et al., 2013), bitcoin transactions (Reynolds & Irwin, 2017) or wider disruption of both the actors and the markets (cf. Hutching & Holt, 2016, and disruptions to the trade in stolen data) are still in their infancy. Online anonymity and physical separation of participants may also reduce violent interactions, thereby substantially reducing another important source of risk affecting street dealers as they do business. Barratt et al.'s (2016) analysis of cryptomarket users in the Global Drug Survey found that these buyers reported fewer threats and less violence than reported in connection to traditional offline markets, including through strangers, known dealers and even friends. The study also found that other comparative risks were lower in connection to cryptomarket buying, including the risks of arrest and rip-off, although "exit-scams" are a real concern and have considerable impact on cryptomarket usage (Soska and Christin, 2015).

With their 'risks and prices' framework (RPF), Reuter and Kleiman (1986) argue that the price of illegal drugs is determined not only in connection to the material costs associated with production, distribution and selling, but also the non-material costs associated with the illegal status of the goods and services. Critical here are the costs connected to risks taken by drug suppliers in their activities. Décary-Héту et al (2016) have identified the risks that drug dealers face in a range of domains, including the risk of violence, risk to profit and reputation, and the risk of arrest. According to Reuter and Kleiman (1986), these risks will be assessed by sellers in the drug supply chain on the basis of their perceived likelihood and severity, and then 'monetised' in the form of price increases that are passed on to consumers as financial compensation. Empirical research provides support for the RPF (see Grossman et al 2002; Levitt & Venkatesh 2000; Weatherburn et al 1995). Caulkins and Reuter (2010), for example, estimate that in the United States approximately one quarter of the retail price of cocaine is due to distributors increasing prices in order to compensate them for the risk of incarceration, while up to one third of the price is due to compensation for risks of interpersonal violence.

However, applying the RPF to drug markets is fraught with methodological and empirical complexities. Drug markets are notoriously heterogeneous, comprising both 'open' and 'closed' varieties. They vary significantly in size and value, as well as in the overall length and stratification of supply chains. Illicit drug markets have widely varying levels of risk, competition and profitability (Coomber 2010; 2006; Pearson et al 2001), and the role that an apparent increase in risk plays may be counterintuitive (Bright & Ritter 2010; Caulkins & Reuter, 2006; Poret 2003; Skott & Gepsen 2002; Pollack & Reuter, 2014). Complex interactions between innumerable, unanticipated and sometimes unquantifiable 'real world' variables challenge the predictive capacities of the RFP – a problem regularly encountered when neat economic modelling runs up against the intricate and messy reality of a real world marketplace (Bouchaud, 2008). Critiques have also been made regarding the assumption inherent to the RPF that drug dealers are rational actors who set prices on the basis of accurately perceived risk (see, for example, Caulkins & MacCoun 2003). Indeed, it has been argued that cryptomarkets may function as illicit knowledge sharing communities enabling drug sellers to access more and improved information to inform risk assessments (Aldridge & Askew 2017). While it is nevertheless prudent to remain mindful of the constraints on rationality (see Jacobs & Wright, 2010), the RPF remains a widely employed conceptual framework whereby pricing data may be used to estimate and measure the risks associated with participation in illicit drug markets.

Do cryptomarket buyers and sellers transact in an environment with reduced risk of conflict and violence? Do they face lower risk of apprehension and arrest when accessing illegal drugs in this way? Is the risks of rip-offs and other loss such as parcel interceptions by postal and borders officials lower? Ascertaining these relative risks in cryptomarket drug trading may be addressed at least in part by establishing the effect of these marketplaces on the pricing of substances made available for sale. If cryptomarkets function to reduce the various risks involved in the illegal drug trade, as Aldridge, Stevens and Barratt (2017) argue is indeed the case, the RPF would predict that drug prices should be lower than those found in offline markets.

Australia represents an ideal case study for an analysis of the RPF on cryptomarket drug prices for a number of reasons. Van Buskirk et al (2016a) demonstrated that cryptomarkets enjoy unusual popularity in Australia, with the highest number of unique sellers per capita on the now-defunct Agora marketplace and research by Kruithof et al. (2016) found that transactions per-vendor generated by Australian sellers was exceeded only by vendors based in the UK and Germany. Australia's geographical isolation as an island continent, alongside its distance from global drug trafficking routes, may on the one hand account for the popularity of cryptomarket trade in the country, providing Australians with a new point of access to previously unavailable or prohibitively expensive drugs. On the other hand, relative isolation from global trading routes may also have allowed Australian law enforcement efforts to centre largely on its domestic drug markets (Ritter et al, 2011), creating additional layers of effort and risk for those trafficking illegal drugs into Australia, and thereby translating into retail drug prices at the top of international league tables (Global Drugs Survey, 2015). In 2014 the Australian government announced an \$88 million

increase in funding for screening its borders, with the number of mail items required for screening to increase by 10 million to 50 million items and seizures at Australia's borders for a wide range of illegal substances have risen sharply in recent years, both in overall quantities seized and in numbers of seizures (Australian National Audit Office, 2015).

Two research designs have been deployed by researchers to examine price differentials between cryptomarket versus offline purchased substances. In the first, data were obtained in connection to drug samples submitted by users to the Dutch Drug Information Monitoring System. Service users were able to self-report where the drug had been purchased (online or offline), and the price paid for the drug. Researchers found that prices were mostly higher online, ranging from 10-23% higher although with marginally high purities (Van der Gouwe et al. 2017). The second methodology employed by researchers is the use of crawler-based methods in which data are downloaded directly from cryptomarkets, the so-called 'digital trace' method (Décary-Héту & Aldridge, 2015). First employed by Christin (2013) to study the now defunct Silk Road, digital trace methods are particularly valuable because they generate large datasets comprising near-complete populations in comparison to the often partial and so less representative samples obtained through self-report methods or in connection to law enforcement activities (Barratt & Aldridge, 2016). First employed by Christin (2013) crawler-based research has revealed many aspects of cryptomarkets, including: their overall size, composition and regional concentration (Munksgaard et al 2016; Dolliver 2015; Dolliver & Kuhns 2016; Soska & Christin 2015; Christin 2013); the characteristics of online drug vendors, including variations between actors located across different cryptomarkets (Dolliver & Kenney 2016) and their propensity to sell drugs internationally (Décary-Héту et al 2015); the extent to which cryptomarkets involve large quantity selling indicative of a wholesale supply function (Demant, Munksgaard & Houborg 2016; Aldridge & Décary-Héту 2016); as well as region-specific analysis of Canadian cryptomarket activity (Broséus et al 2016), a focus on Dutch cryptomarket activity (Kruithof et al 2016) and broader country specific differences in substance availability (Van Buskirk et al, 2016a).

Where product listing prices from digital trace methodologies have been used in previous cryptomarket research, it has predominantly been to attempt to get a measure of the revenues made by markets or vendors (Christin, 2013; Soska & Christin, 2015; Aldridge & Décary-Héту, 2016) and in connection to the prices paid by customers. To date, just one paper has deployed digital trace methods to compare cryptomarket drug prices. Van Buskirk et al (2013) calculated and compared median prices for drug listings from Australian based vendors and compared these to vendors outside Australia and listing international shipping. For all of the drugs considered by the researchers, the prices set by Australian vendors were substantially higher – between 3 and 6 times the median price of international vendors for the same drug. For most drugs, Australian vendor prices were comparable to domestic prices found for these substances with one exception: offline domestic prices for methamphetamine were substantially higher than the prices charged by Australian cryptomarket vendors selling domestically. The authors offer no explanation for this particular finding.

Our analysis thus follows a similar approach to that employed by Van Buskirk et al (2013), but with some methodological improvements. Van Buskirk and colleagues relied only on all drugs listed for sale by vendors, rather than on listings having generated sales. This strategy can paint a misleading picture. Kruithof et al. (2016) found that only a minority of cryptomarket listings in 2016 generated any sales (28%), and listings that did generate sales tended to be lower-priced. Price comparisons that include listings that do not generate sales will therefore over-estimate cryptomarket prices and provide misleading comparisons to prices found in offline drug markets. Our analysis employs transaction (actual sales) data to filter out the majority of listings that do not generate actual sales. Moreover, our paper also offers a cross-market analysis enabled by a multi-market dataset and presents a distributional analysis of prices, rather than rely solely on the median value. Finally, by limiting the analysis of internationally sourced drugs to just those products available for shipping to Australia a closer comparator from the perspective of the buyer is made available. Digital trace methods have therefore yet to be exploited fully to examine price differentials between cryptomarket and offline purchased drugs, and represent an untapped and potentially valuable method in this area of research.

Research Aims

Our analyses employ quantitative data scraped from eight of the largest marketplaces in January 2016 to provide the first Australian-specific analysis of cryptomarket-facilitated drug trading. This study has three aims: the first is to characterise and understand the levels of drug-related cryptomarket activity in Australia in comparison to the rest of the world. The second goal is to compare prices between Australian based cryptomarket vendors and those located outside of Australia. The final aim is to contrast Australian online prices with typical street prices for comparable products.

According to the RPF, if risks associated with selling drugs via cryptomarkets are indeed lower than those involved with selling drugs via conventional means, this lower risk should be passed on to consumers in the form of lower prices. Therefore, our overarching hypothesis is that drugs sold by Australian cryptomarket vendors should be priced higher than those sold by international competitors on these marketplaces, but lower than found in the offline domestic Australian drug market. We also hypothesise that differences in prices should be most pronounced where significant risks exist for street dealers generated by intra-market violence and law enforcement intervention.

Method

The data used as a basis for this study were obtained using the DATACRYPTO software developed by Décary-Héту & Aldridge (2013). DATACRYPTO is a web-crawler that systematically downloads all HTML pages contained on the marketplaces, with a subsequent partly automated and partly manual process of data cleaning. Eight

marketplaces of varying sizes were crawled in January 2016. These were Alphabay, Crypto Market, Darknet Heroes League, Dream Market, French Dark Net, Hansa Market, Nucleus and Python Market. Data were extracted in connection to product listed for sale, including drug type, quantity and customer feedback associated to their purchases. Vendor-level variables include the country which the vendor ships from and the possible destination countries.

Drugs were grouped into 8 drug types and an 'other' category (as outlined in appendix A), splitting out methamphetamine throughout the analysis to highlight the specific interest in this drug in the Australian context (Hamilton & Dunlop 2016; Scott et al 2015). For reasons of focus the majority of this paper will focus on the drug types of cannabis, ecstasy-type, cocaine and methamphetamines. These drug types are the most relevant to the Australian context and are the main drugs of concern in the Sindicich et al. (2016) Australian drug trend series *Findings from the Ecstasy and Related Drugs Reporting System (EDRS)*.

Vendors often list across multiple cryptomarkets, or with multiple accounts in one cryptomarket (or both). Vendors were classified as the same if either the PGP key used to encrypt their messages matched. PGP keys are by definition unique and other researchers (e.g. Broséus et al., 2016; Soska & Christin 2015) have used PGP key to identify multiple vendor account held by the same vendor. Vendors' profiles were also matched where vendor descriptions across marketplaces where typically lengthy vendor generated text were duplicated exactly. All vendors who had listings on the markets at the time of data collection were included in the analysis.

The number of instances of customer feedback for each listing over the previous 30-day period was taken to represent the level of activity for a product. For listings that appeared on the websites for less than 30 days the overall level of feedback was extrapolated by generating a number of transactions per day and then multiplying that number by 30. For example, if a product had only been listed for 10 days and had received 2 instances of feedback, it would be assigned 6 instances of feedback for the 30-day period in our analyses. This exact method was used by Kruithof et al. (2016). Following on from this, transactions were proxied by the number of instances of feedback that a product received, and as such this is likely an underestimate of the total number of transactions for any one product or seller. This established method of measuring activity (Christin, 2013 Aldridge and Décarry-Héту, 2014) works under the assumption that feedback is a regular given on these markets and therefore their number can be taken to represent overall activity. In total there were 106,348 products or services present in the dataset, of which 60,223 (56.6%) were drugs. Of the 60,223 products available to this analysis, only 16,771 (27.9% of the total) had generated sales (i.e. those which have received at least one instance of customer feedback in the preceding 30 days) and these analyses focus only these 'active' products.

The countries that the product was defined as shipping from and to were cleaned manually from the product level information. The country of origin was grouped into 5 categories: *Australia, Europe, North America, Asia* and *Other*. Of those listed as originating in *Europe*, 40.1% were from the UK, 20.9% from Germany and 19.3% from the Netherlands; they

represent the main contributors of active products. For *North America*, 85.7% of active products were listed as being from the USA. *Other* included products that listed multiple countries (88.2% of active products in this grouping) or where the country of origin was unknown (7.5% of active products). This latter category also holds all African, Caribbean, Central and South American countries, but only list 36 active products. For the purposes of this paper, this fine level distinction is left alone to allow focus on the Australian specifics, with the *Other* category left as is to capture those products of rare and dubious data quality.

An extra level of data cleaning was added to the 'shipping to' field to account for any specific mentions of Australia in either the product *or* seller description. This took the form of searching for any instances of the word "aus" within both the seller and product description text fields. These were then further inspected manually and any mention of Australia was classified with table 1 presenting the results.

[Insert Table 1 about here]

Prices were listed in bitcoins and converted to price in US dollars at the time of collection. Vendors are known to occasionally list products at artificially high prices to retain instances of product feedback whilst discouraging buyers when they are out of stock. The median price across every historical instance of each product was therefore used to account for this variability (an average of 4.4 historical prices per product; Min = 1.0; Max = 14.0; S.D. 3.4). A similar method has previously been used by Soska & Christin (2015).

The analysis of prices follows two methodologies. The first is a comparison between online products bought from Australia and those from an international seller but available to an Australia-based buyer. It is important, therefore, to limit this part of the analysis to just those products that would be *available* to the Australian buyer. Of the 1,136 products as listed as originating in Australia, 1,132 were available for purchase in Australia (and 1,028 available *only* to Australia). 4,957 of the 8,150 European origin active products (60.8%), 142 products out of 148 from Asia (96.0%) and 1,266 out of 5,836 (21.7%) of active products from North America were available to an Australia-based buyer. Finally, 1,246 of the 1,440 (86.5%) products from the 'other' country division were available to Australians, reflecting the international nature of this grouping. Once restricted to this subset of products, prices were compared using a log linear regression of price on the country of origin for the overall price of drugs listed and within each drug category separately. In each regression, controls were added for the individual, lowest level drugs types as listed in the appendix A along with the number and weight of products associated with each listing as well as their square (to account for non-linear changes in the pricing as quantities get higher). The analysis was implemented using a Poisson regression model with robust standard errors (Silva and Tenreiro, 2006).

The second method of price comparisons presents a distributional analysis of the prices of specific products within specific weight and package size bands in comparison to the 'street' price, split between those bought from Australia and those bought from an international vendor and available to an Australia-based buyer and compared to the price of 'offline'

purchased substances detailed in Sindicich et al. (2016) *Findings from the Ecstasy and Related Drugs Reporting System (EDRS)*. The results from the EDRS report are converted to US dollars (USD) using the conversion rate at the midpoint of the data collection time frame on the 01/07/2015 of 1 AUD = 0.766 USD. It is something of a balancing act to make an accurate comparison between the listings on the online cryptomarkets and those reported by EDRS. On the one hand the EDRS presents a point estimate of the price of a (usually) single unit of a drug (or in the case of herbal cannabis, a quarter ounce) from interviews with a sample of user. The data provided by DATACRYPTO, on the other hand, holds information on a range of product listings which are listed with a different number of products in a batch, different weights and different (purported) purities (Caudevilla et al, 2016). Appendix B holds a detailed discussion of the steps taken to allow these comparisons.

It should be stressed that choosing the range of weights/number of products/purities retrieved from the DATACRYPTO tool to be used as a comparator for the EDRS point estimates is a parsimonious and subjective selection to make, balancing the need for adequate sample size for international vendors willing to ship products to Australia and Australian based vendors who sell each product against precision and specificity. The decisions used in this work have been arrived at after careful consideration of meaning and sample size, but that does not mean that they present the definitive pricing of online drugs. Not only is the data a snapshot from January 2016, but there are a myriad of other ways in which the data could have been grouped and cut. These results should therefore only be used in the context applied in this work, namely to allow a rough comparison between imported and domestic products and to give a hint at the disparities/similarities between those prices and the typical 'street' price.

Results

Australian market activity

Table 2 presents descriptive analysis of the number of products, vendors and transactions by country of origin when limiting the dataset to look only at those products that are classified as 'active' (i.e. had received at least one instance of feedback in the previous 30 days). Australia is well represented on cryptomarkets, with the number of products, vendors and transactions associated with Australia as a country of origin taking approximately 7% share on each measure while representing only 0.3% of the world population.

[Insert Table 2 about here]

There is, however, variation across drug categorisations. Cannabis and cocaine seem comparatively under-represented with just 4.1% and 4.6% of products in those categories, respectively originating from Australia. This is similarly reflected in Australian vendors making up around 5% of the total of each drug and accounting for 4.9% (cannabis) and 4.2% (cocaines) of all transactions. For ecstasy-type products, however, Australia seems to be over-represented compared to the overall product share, with 9.3% of the worldwide

products. In terms of number of vendors for ecstasy-type products Australians are again over represented with 9.5% of vendors (though this relates to just 42 unique accounts).

Perhaps the most significant finding concerns methamphetamine, a relatively widespread and popular illicit drug in Australia (Degenhardt et al 2016). Of the 483 different active methamphetamine listings in the dataset, 24.8% (120) are listed as originating from Australia, and these 120 products are offered by 24 different vendor accounts, almost as many vendors as the entirety of Europe (27) and four-tenths as many as North America (58), despite the vastly different population sizes. Between them, these 24 vendors are responsible for 27.1% of total transactions recorded worldwide in the dataset for this drug.

Price analysis: Australia vs international

Turning now to analysis of the list price of the products, and limiting analysis just to products that the vendor is willing to ship to Australia, Table 3 presents regression coefficients from the log linear regression of price on the country of origin with Australia-based products as the reference and as such the presented coefficients show the percentage change in the expected price by region of origin, controlling for listing weight, number of products and the lowest granulation of drug groups.

[Insert Table 3 about here]

What is immediately clear from Table 3 is how much more expensive illicit drugs are if they originate in Australia, with products from North America typically costing 75% the price of their Australian equivalent, European products costing 52% and those from 'other' places of origin costing 61%. Asian products were not significantly different in price but with their low sample size this is not unexpected. As with the analysis of products, vendors and transactions however, the overall figure belies a more complex picture within different drug types. Cannabis is the only category that does not vary in price between the countries, whereas Ecstasy type products are typically less than one third of the price if they are purchased from a country other than Australia. Cocaine products and methamphetamines are almost similarly cheaper, being at least 40% the price if bought from a vendor located outside Australia and shipped into the country.

Price analysis: online vs offline

Figure 1 presents a results from a further subset of drugs within each of the larger drug categories discussed above to allow suitable comparisons to the price of 'offline' purchased substances detailed in EDRS report (Sindicich et al., 2016). In this display, the black bar represents the interquartile range of the online prices with the median as a cross, whilst the black triangle represents the EDRS 'street' price.

[Insert Figure 1 about here]

In some way the results from Figure 1 reiterate the findings presented from the regression in Table 3, in others they go beyond what was seen there. The reiterations are mainly found by looking at the prices available to Australian customers from non-Australian based sellers

and comparing to those online vendors based in Australia. In short, and with the exception of herbal cannabis, the Australian based products are *much* more expensive.

The most important finding from figure 1 is, however, in the comparison with the street price as reported by the Sindicich et al. (2016) EDRS report. Although these results need to be treated with caution (due to the comparability issues discussed previously) the results are somewhat against initial expectations, though broadly in line with Van Buskirk et al. (2013). Cocaine, for instance, had a street price of around US\$230, broadly comparable to the median online price of US\$240 per gram. Accounting for the spread of the Australian based products, it is possible to buy cheaper cocaine online, but it is equally possible to buy a gram for more money. For ecstasy pills, the online price from an Australian buyer seems to be in general in excess of the street price, with only 30% of online products available at a cheaper price. For methamphetamine, however, the differential is severe, with the street price at both the median *and* the 75th percentile of the online Australian based product's price being over US\$80 more expensive. So, notwithstanding the warnings of the subjective nature of the cuts in the data, it may be asserted with a high degree of confidence that street methamphetamine is significantly more costly than the online equivalent.

Discussion and implications

In line with the previous work of Van Buskirk (2013; 2016a; 2016b) and Kruithof et al. (2016) this analysis paints a picture of a busy and geographically isolated Australian-based online marketplace. This analysis goes beyond previous work, however, in the identification that the vast majority of Australian listings are available *only* to Australian customers, whereas products from elsewhere (particularly European but also over a fifth from North America) are far more likely to be offered by the vendor to an international buyer. Looking deep still at the prevalence of different drug sales attributed to Australia-based vendors, it can be seen that Ecstasy-type drugs and, particularly, methamphetamine, are over-represented by Australian based products, vendors and the number of transactions that these products receive. It is worth restating that over a quarter of the total sales across all of the markets for methamphetamine seem to be generated by products of Australian origin, sold within that customs jurisdiction and attributable to just 24 unique vendors.

These results also demonstrate that whilst there are a non-negligible number of products/vendors stating that they will not ship to Australia, this is far outweighed by the number that specifically state that they will ship to that destination or make no mention of the country as a specific case for concern. This is true when looking at all products or just active products. This despite the perception amongst national European and international law enforcement agency representatives that the Australian Border Force (ABF) is especially vigilant (Kruithof et al., 2016) and their increasing level of funding (Australian National Audit Office, 2015).

Perhaps the most significant finding associated with this research confirms those first highlighted by Van Buskirk (2013) but left without explanation: the price difference between

illicit drugs sold by Australian cryptomarket vendors and street dealers. Herbal cannabis, MDMA and cocaine are all priced at a seemingly comparable level to those prices reported as the 'street' price in the Sindicich et al. (2016) EDRS report. This work, however, reports the significant variation in the prices available online, and in all cases there are *some* products available from an Australian vendor at comparable costs or below the 'street' price. This provides limited support for our initial hypotheses that cryptomarket drug trading is typically less costly in material and/or non-material terms than conventional dealing. This may be a symptom of increased online purity, package weights more closely aligned to the purported deal size in an online environment, maximisation of profit with vendors deliberately listing their product at levels comparable to the street price, or (most likely) a combination of all three. Aldridge, Stevens and Barratt (2017) stress that in order to make properly matched comparisons on price between cryptomarket versus offline purchased drugs, price needs to be purity adjusted to take into account the higher purity levels found for cryptomarket sourced substances (Caudevilla et al. 2016; Van der Gouwe et al. 2017) and quantity received similarly needs accounting for due to the greater likelihood of under-weight deals sold offline compared to a cryptomarket context. Without the ability to include these factors in our analysis this study may have under-identified actually-lower prices obtained on cryptomarkets, suggesting a potentially fruitful avenue for future research.

From a RPF perspective it is also possible that in the Australian context, the high levels of risk in sourcing products for sale in a street *or* online environment overshadows the levels of risk involved in the final transaction to the eventual user. There may also be a consumer side perception of risk driving these similarities in prices, with purchasers willing to accept an added price differential to avoid the interaction with a potentially hazardous personal exchange. This point shall be returned to in the next section.

For methamphetamine, however, the online/street price difference was significant, with street prices well above the range of online prices and, coupled with the high Australian market share high market share, this requires further discussion. According to the RPF, this difference indicates that in Australia the relative costs and risks associated with selling methamphetamine may be significantly higher on the street compared to via a cryptomarket. Accounting for this difference is difficult, but there are at least three empirically grounded explanations that are consistent with the RPF and could explain the relatively higher street prices specifically for methamphetamine: levels of violence, policing and supply side structural differences.

The Australian methamphetamine market is well known to represent an unusually dangerous trading environment for street dealers, with the Australian Criminal Intelligence Commission (ACIC) identifying the methamphetamine market as the 'highest risk' illicit drug market in the country (ACC 2015:35). This is due in part to the disproportionate involvement of a range of well-organised criminal groups including outlaw motorcycle gangs (OMCGs) in the trade of methamphetamine to the Australian market. OMCGs have an unusually heavy presence in Australia and these groups have a well-established reputation for using violence to dominate the local methamphetamine trade (ACC 2015;

McKetin et al 2005). This contrasts significantly with, for example, the Sydney heroin market, in which Coomber and Maher (2006) observe that violence amongst dealers is rare, despite their trading a similarly highly priced illicit drug. Disproportionate levels of violence in the methamphetamine trade may also be partly attributable to the psychoactive effects of the drug itself, the so-called 'psychopharmacological' explanation of the drugs-violence link (Goldstein, 1985). McKetin et al (2005) note that regular methamphetamine use is common amongst user-dealers of the drug as well as customer-users, and interaction with those who may be suffering from the effects of psychosis may add a significant risk, and therefore price increases.

Another explanation for the higher risks and higher prices associated with street methamphetamine is its status as a priority target for local law enforcement. Methamphetamine is considered a particularly problematic drug in Australia and widespread public concern has prompted a significant policing crackdown (NIT 2015). In 2015, the Australian federal government established the National Ice Taskforce (NIT) to help coordinate state and federal law enforcement investigations into the supply of methamphetamine and, at present, more than 80% of the ACIC's organised crime 'National Targets' are involved with the domestic methamphetamine trade (ACC 2015). These and other law enforcement initiatives focused on disrupting the supply of methamphetamine have precipitated an 88% increase in arrests related to amphetamine-type substances (amongst which methamphetamine is predominant) between 2009-10 and 2013-14 (NIT 2015:58). The effect of this police activity is likely to be felt most acutely by street dealers given that they occupy the most visible and therefore the riskiest stage of the supply chain (Bouchard & Ouellet, 2011).

Lastly, relatively higher street prices for methamphetamine may also be due to the structural characteristics of the drug supply chain. A trend observed across illicit drug markets is the tendency for participants to insulate themselves from the riskiest section of the supply chain – the retail stage – through the inclusion of intermediaries (Martin 2014b). McKetin et al (2005:47) confirm this practice in the Sydney methamphetamine market, highlighting the use of 'gophers' to carry out high risk activities such as drug transportation. The inclusion of intermediaries has important implications for drug pricing as each additional participant in the supply chain imposes a financial impost that results in higher retail prices. One intriguing possibility consistent with this hypothesis suggested by Buskirk et al (2016a), is that Australian cryptomarket vendors may be sourcing their drugs not from local suppliers, but from other cryptomarket vendors located overseas. The existence of large price differences between foreign and locally sourced methamphetamine means that local vendors who procure methamphetamine directly from a foreign vendor (and thereby assume the risk of interception at the border) can subsequently impose significant price increases, doubling or even tripling the original price, and still sell their drugs at a profit and a price lower than that offered by the average local cryptomarket vendor. Further research will be required to confirm this hypothesis.

A further significant finding associated with this research is the price difference between illicit drugs offered by international vendors prepared to ship to Australia and domestic cryptomarket vendors. With the exception of cannabis, which is also priced relatively modestly on the street in Australia, average prices for all drugs were *significantly* higher when purchased from an Australia-based as opposed to a foreign cryptomarket vendor. In an apparently globally integrated online drug market, prices would be expected to naturally converge as customers 'vote with their feet' and spend their currency on more affordable, better value for money products. However, this research clearly indicates that Australian-based vendors are selling their products in significant numbers and, for methamphetamine, opioids and ecstasy, these sales account for a disproportionately high number of transactions recorded worldwide. These price disparities therefore raise a pertinent question for which the RPF, in its current form, does not adequately account: why would drug buyers located in Australia prefer more expensive, domestically-sourced products when there are cheaper, foreign alternatives readily available, literally, at the click of a button?

When considered from the perspective of such an Australian buyer, the calculation of risk appears significantly different when considering purchasing from a domestic vendor. By choosing a local vendor, an Australian buyer may be more confident that any drugs will be delivered without first coming to the attention of law enforcement (assuming the risk of being 'ripped off' or the possibility of an 'exit scam' is roughly equal independent of the physical location of the vendor). Locally-sourced drugs also come with the additional benefit of being delivered more quickly than those sourced from overseas vendors, by a factor of up to three weeks due to standard international delivery times for packages sent from distant locations such as Europe or the US. The alternative, an increased uncertainty regarding whether or not posted drugs will be intercepted crossing the border and the associated possibility of identification by law enforcement, particularly when considered in the context of longer waiting times due to delays in international shipping, represent, in combination, significant disincentives that many local buyers appear willing to pay a substantial premium to avoid.

The large price disparities between Australian and foreign cryptomarket vendors thus indicate a significant market distortion, one that, we argue, must at least be partially explained by the perceived effectiveness of Australian border protection agencies in detecting drugs trafficked through the international postal system. However, rather than this intervention resulting in increased prices for imported drugs – as one would typically expect according to the RPF – it appears as though the presence of Australian border protection influences drug prices differently by creating additional risk and uncertainty for local *buyers*. Previous research indicates that many risks, including those posed by law enforcement, are in fact lower for people who purchase drugs via cryptomarkets rather than from a conventional dealer (Barratt et al 2016; Martin 2014b; van Hout & Bingham 2013). None of these studies, however, specifically examined the perceptions of risk amongst buyers who purchase drugs from a foreign cryptomarket vendor either from Australia or any other country perceived to have a heavily policed border.

We term this premium – the difference in prices between Australian and foreign cryptomarket vendors – a ‘risk tariff’ as it effectively functions as a tax or duty on imported drugs. The notion that interventions by law enforcement constitute a form of indirect ‘taxation’ is consistent with the RPF, but with one significant distinction: previous iterations of the framework emphasised the role of drug *distributors* in adjusting their prices in response to the various risks posed by law enforcement (Caulkins & Kleiman 2011; Caulkins & Reuter 1998; Reuter & Kleiman 1986). Consumer demand was considered relevant, but primarily in terms of its elasticity (how sensitive consumer demand is to fluctuations in retail prices). This research indicates a more complex reality: the presence of a substantial domestic cryptomarket trade indicates that some buyers are highly sensitive to risks associated with law enforcement, and border protection in particular, and this carries significant implications for the pricing of illicit drugs.

The policy implications associated with this finding are somewhat contradictory. On the one hand, Australian border protection appears to be deterring at least some local buyers from sourcing illicit drugs from overseas. This assists in maintaining the relatively high price of illicit drugs in Australia, and is therefore consistent with the federal government’s demand reduction law enforcement strategy. On the other hand, however, the supply of illicit drugs is, according to the ACIC, the most significant source of income for organised crime groups operating in the country, and is associated with a range of serious crimes, including homicide, assault, firearms trafficking and money laundering (ACC 2015). By imposing a risk tariff on foreign drugs available on cryptomarkets, Australian border protection agencies are effectively insulating local organised crime groups from overseas competition. This means that Australian cryptomarket vendors, street dealers and the local organised crime groups who supply them, are able to operate with less foreign competition than would otherwise be possible without the inadvertent protectionism afforded by the Australian authorities.

By applying a theoretical framework, namely the RPF, to the unique characteristics of Australian cryptomarket activity and considering the price available to consumers, this work carries significant implications for our understanding of the broader online illicit drugs trade. Rather than cryptomarkets facilitating a globally unrestricted trade in illicit drugs, this research confirms and extends previous findings of Australia as a relatively isolated ‘island’, with many Australian drug buyers favouring local vendors despite the high price differentials, and relatively few of those vendors send drugs out of the country. The isolation that is characteristic of Australian cryptomarket trading suggests that cryptomarkets have not facilitated the development of a globally integrated online illicit drugs market, but rather one where trading is concentrated within regional clusters based upon shared customs jurisdictions and shaped, at least in part, by buyer perceptions of risk – found, in this work, to be particularly pertinent in the ‘high-risk’ case of the Australian methamphetamine market. This raises the question for future work of whether it would be possible to be more prospective with this type of analysis: whether a high risk street dealing environment is characterised by large online/offline price differentials, and whether high-

risk environments can be identified via this type of price analysis rather than the other way round. Further research is required to validate and test this hypothesis in other settings.

Acknowledgements

Thanks to David Bright for his insights into the Australian methamphetamine market. This research was funded by a Macquarie University Research Development Grant [9201401496].

Appendix A

Drug categorisations

Drug Category	Drug types included in the category (in decreasing order of frequency within group)
Cannabis	Hash, herbal cannabis, extracts (these cover 85.6% of the group), seeds, synthetic cannabinoid, edibles and drinkable, cannabis products NEC
Ecstasy-type	MDMA (ecstasy) pills, MDMA powder, Mephedrone powder, MDMA capsules, MDA powder (covering 93.3% of group), other ecstasy type drugs
Cocaines	Cocaine (covering 94.3%), crack cocaine, cocaine/coca seeds, coca leaf, cocaine paste
Amphetamines	Amphetamine Sulphate, amphetamine pills
Methamphetamines	Methamphetamine (not tablet)
Psychedelics	LSD blotter, ketamine, mushrooms – dried, DMT, 2c-b pill, change, AMT (freebase), 2c-b powder, GHB, mushrooms – powdered, mescaline (78.6% of group), other psychedelics
Opioids	Heroin (covering 88.5% of the grouping), opium, other opioids
Prescription	Xanax, Alprazolam, Diazepam, Adderall, Fentanyl, Viagra, Oxycodone, Ambien, Clonazepam, Valium, Tramadol, Etizolam, Cialis, Codeine, Ativan, Modafinil, Ritalin, Hydrocodone, Methylphenidate, Testosterone, Phentermine, Morphine, Oxycontin, Rivotril, Kamagra, Zopiclone, Bromazepam, Methadone, Clenbuterol (covering 70.0%) other prescription drugs
Other drugs	Multi-drug listing, combination drugs (67.8% of group) alcohol and tobacco listings

Appendix B

The following decisions were made to facilitate the comparison between the DATACRYPTO products and the Sindicich et al. (2016) *Findings from the Ecstasy and Related Drugs Reporting System (EDRS)* equivalents:

1. Vendor-reported drug purity levels was ignored, despite the perceived increase in purity being cited as a main attraction to online purchasing (Van Hout & Bingham, 2013b) on the understanding that it could not be quantified with any accuracy for either online or street sources, and that when a purchase is made in either a 'street' or online environment it is predominantly a 'blind' transaction and hinges on a number of essentially qualitative and user specific judgements not necessarily related solely to purity (Bancroft and Reid, 2016).
2. As the EDRS presents prices for small quantities, the prices for comparison from DATACRYPTO were restricted to those for similarly small amounts of the specific drugs types whilst maintaining adequate numbers of observations, as follows:
 - a. The price of herbal cannabis was taken as 1/4oz (7g) from the EDRS. From the online dataset there appeared to be a steady drop in the median price as the weight of the listing increased. Nevertheless there were some discontinuities: between 1 and 3 grams the median price was between \$15 and \$16 per gram; falling to \$9 and \$11 per gram for packages between 7 and 28 grams (1 ounce); with a further fall beyond that weight to around \$5 per gram. The comparison was therefore chosen to be products listed as between 7 and 28grams (between a quarter ounce and an ounce)
 - b. From the DATACRYPTO information available on the strength of ecstasy tablets was typically the weight of active product in one pill, though this information was missing for approximately 10% of listings. Pill strength was not included in calculating the price of ecstasy pills purchased on cryptomarkets; only the number of pills per listing. As with cannabis pricing there price discounts available for purchasing larger numbers of pills: the median price varied from \$5 and \$7 per pill for listings of 10 pills or less; and \$3 to \$4 per pill for purchases of 10 or more pills. The comparator was chosen to be listing with 10 pills or less, providing adequate sample size for accurate distributional analysis (this represents 53.4% of active listings).
 - c. Although there was variation in the reported purity of cocaine available online, this information was missing for 67.0% of the listings. Every listing was for 'one' product. The median price dropped as batches got larger, typically \$80 per gram to 10 gram packages, whereupon the median dropped by around \$20 per gram to about \$60 per gram. The EDRS report distinguishes price for between a 'cap' (a small amount typically used for a single injection) and a gram and therefore the

comparator to the EDRS report was chosen to be listing of 1g or more and less than or equal to 10 grams , representing 68.1% of active listings. This upper limit may appear high but was necessary to give a robust distribution of prices as it left only 37 Australian based products as a comparator, and with the aforementioned drop in price occurring after 10grams, is suitable.

- d. 77.4% of active methamphetamine listings were for 5 grams or under and the price stayed relatively flat up to this point at between \$55 and \$65 per gram. The EDRS report makes the distinction between a 'point' (0.1 grams) and a gram as a purchase quantity and therefore listings of between 1g and 5g is chosen as the comparator to the EDRS estimate, representing 55.9% of active listings (purity was generally missing and the number of products in 99.8% of cases was listed as 1).

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Table 1 Classification of mentions of Australia in either the product or vendor descriptions

	Any Product		Active Products			
	All products	Internat'l products	All products	Internat'l products		
No products	60,223	32,834	16,771	7,284		
Mentions of Australia in product description	1,792	3.0%	5.5%	34	0.2%	0.5%
...and wont ship to Australia	727	1.2%	2.2%	18	0.1%	0.2%
...and will ship to Australia	1,065	1.8%	3.2%	16	0.1%	0.2%
Mentions of Australia in vendor description	14,087	23.4%	42.9%	3,556	21.2%	48.8%
...and wont ship to Australia	4,181	6.9%	12.7%	1,161	6.9%	15.9%
...and will ship to Australia	9,906	16.4%	30.2%	2,395	14.3%	32.9%

Table 2 Number and percentage of products, vendors and transactions by country of origin and selected drug types, active products only.

		Overall		Cannabis		Ecstasy-type		Cocaines		Methamphetamines	
		N	% of total	N	% of total	N	% of total	N	% of total	N	% of total
Products	Australia	1,136	6.8%	223	4.1%	219	9.3%	65	4.6%	120	24.8%
	Europe	8,150	48.6%	2,578	47.3%	1,420	60.0%	868	61.6%	93	19.3%
	North America	5,836	34.8%	2,282	41.9%	411	17.4%	355	25.2%	231	47.8%
	Asia	148	0.9%	4	0.1%	12	0.5%	1	0.1%	3	0.6%
	Other	1,501	8.9%	365	6.7%	303	12.8%	121	8.6%	36	7.5%
Vendors	Australia	152	7.4%	40	5.3%	42	9.5%	17	5.4%	24	18.6%
	Europe	783	38.1%	331	43.8%	214	48.3%	170	53.8%	27	20.9%
	North America	731	35.5%	255	33.8%	110	24.8%	75	23.7%	58	45.0%
	Asia	31	1.5%	4	0.5%	7	1.6%	1	0.3%	1	0.8%
	Other	360	17.5%	125	16.6%	70	15.8%	53	16.8%	19	14.7%
Transactions	Australia	6,258	6.7%	1,517	4.9%	958	8.6%	415	4.2%	767	27.1%
	Europe	47,329	50.7%	15,805	50.8%	6,785	61.0%	6,439	64.6%	545	19.3%
	North America	32,155	34.5%	11,727	37.7%	2,176	19.6%	2,379	23.8%	1,393	49.2%
	Asia	516	0.6%	10	0.0%	25	0.2%	1	0.0%	11	0.4%
	Other	7,065	7.6%	2,070	6.6%	1,177	10.6%	741	7.4%	115	4.1%

Table 3 Percentage change for expect price of drugs available to Australia-based customers by region of origin, controlling for price, weight and drug type, active products only

	Overall		Cannabis		Ecstasy-type		Cocaines		Meth-amph'mine	
	Exp (β)	p	Exp (β)	p	Exp (β)	p	Exp (β)	p	Exp (β)	p
Australia (reference)										
Europe	0.52	***	0.93	0.15	0.23	***	0.36	***	0.38	***
North American	0.75	***	1.11	0.07	0.35	***	0.40	***	0.38	***
Asia	1.10	0.48	1.69	0.12	0.30	***	n/a	***	0.28	***
Other	0.61	***	0.99	0.83	0.29	***	0.33	***	0.24	***

* = significant at the 95% level, ** = significant at the 99%, *** significant at the 99.9% level.

Figure 1 Price distributions available to Australian buyers of specified drug, active products

