



# Adapting to Local Conditions: Similarities and Differences in Anonymous Online Market Between Chinese and English Speaking Communities

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**Abstract.** In this paper, we have conducted a comparative analysis of anonymous online market between Chinese and English speaking communities. First, we collect public data of multiple Chinese and English anonymous online markets. Then, we conduct a comparative analysis of the Chinese and English anonymous online markets from three aspects: market operation mechanism, market security mechanism, and goods sales situation. We find that Chinese and English anonymous online markets are both affected by factors such as market demand and relevant laws and regulations, and there are differences in the goods sales situation. In contrast, English anonymous online markets are relatively mature in market operation mechanism and market security mechanism, while Chinese anonymous online markets are still on their developing stage. We finally discuss the impact of law enforcement agencies' crackdown on Chinese and English anonymous online markets, as well as the focus and methods of Chinese and English anonymous online market governance.

**Keywords:** Anonymous online market · Comparative analysis · Market governance

## 1 Introduction

Anonymous online markets are online shopping platforms that run in a special network environment such as Tor [14], and they allow both buyers and vendors to hide their identities, making it difficult for others to identify their real identities or trace them. As a result, many illegal goods, such as drugs, leaked information data, and hacking services, have become the popular goods in anonymous online markets.

Since the emergence of “Silk Road”, the first large-scale anonymous online market in 2011 [4], the scale and the number of anonymous online markets worldwide have increased. Like other Internet applications, the anonymous online market is developing in multiple languages, with different participants and different goods sold. Those differences usually depend on the specific needs of market audiences, which may help researchers understand the development trends and relevance of cybercrime in different language communities. In recent years, with the increasing influence of the anonymous online market in Chinese speaking community, the number of Chinese anonymous online markets is also increasing, and a market system that can meet the needs of Chinese users has been formed. In this paper, we first collect public data of multiple anonymous online markets, then conduct a research on the anonymous online market in Chinese. We combine with previous work on anonymous online markets in English, extract the similarities and differences between anonymous online markets in Chinese and English speaking communities. In short, we make the following contributions:

1. We have collected public data on multiple anonymous online markets in Chinese and English, and combine with previous research on the English anonymous online market. We have analyzed and summarized the characteristic of Chinese and English anonymous online markets.
2. We have studied into Chinese and English anonymous online markets from three aspects: market operation mechanism, market security mechanism and goods sales situation. We have revealed the similarities and differences between Chinese and English anonymous online markets.
3. We have analyzed and explained the reasons for the similarities and differences between the Chinese and English anonymous online markets.

The rest of the paper is organized as follows. We give an anonymous online market overview and describe the methods for collecting public data in Sect. 2. Then we compare and analyze Chinese and English anonymous online markets from the three aspects as market operation mechanism, market security mechanism and goods sales situation in Sect. 3, and point out the similarities and differences between these two. We discuss our research results in Sect. 4, including ethical considerations, the crackdowns of law enforcement in Chinese and English speaking communities against the anonymous online market, and the focus and methods of law enforcement in these two communities. We outline related work in Sect. 5 and we give our conclusion and future research directions in Sect. 6.

## 2 Anonymous Online Market Overview and Data Collection

In this section, we will first give a overview of anonymous online market. Then we introduce our methods of collecting anonymous online market public data.

## 2.1 Anonymous Online Market Overview

As the name implies, anonymous online market is an online market that operates in an anonymous network. Anonymous online market is built by combining onion service and web server software together. Common web server software is used to build anonymous online market, such as Apache, Nginx and Windows IIS Server. In fact, the anonymous online market itself does not sell goods. Its role is to provide a risk manageable platform for participants in transaction, such as vendors and buyers. In general, anonymous online markets usually have the following characteristics:

1. The anonymous network market operates in an anonymous network, which makes the communication between participants (buyers and vendors) highly anonymously, so that participants can be protected from the interference by law enforcement to some extent.
2. The anonymous online market provides better security mechanism in protecting users' accounts. Users need to enter account password and CAPTCHA when logging in to the account, or log in to the account through two-factor authentication (2FA) based on PGP [1].
3. Anonymous online markets build their payment system with cryptocurrencies (such as Bitcoin [19]), which can effectively avoid the trace ability of assets that exist when using traditional electronic payment system (such as wire transfers or credit card payments).
4. Anonymous online markets usually use advanced settlement methods such as escrow to reduce transaction risks. When the buyer has purchased goods in the market, the payment will not be directly transferred to the vendor's account, but be managed by the market first. After the buyer confirms the receipt of the goods, the market will transfer the payment to vendor. Similar settlement methods are commonly used in anonymous online markets such as finalized early (FE) and multisig.

## 2.2 Data Collection

We have collected the public data of multiple anonymous online markets. Table 1 lists the markets we crawled, the time the measurements spanned, and the number of snapshots that were taken.

**Table 1.** Anonymous online markets crawled. (\* denote the English market, and - denote the Chinese market.)

Market	Measurement dates	# snap.
Chinese trading market <sup>-</sup>	07/02/2019–10/27/2019	115
Tea-Horse Road <sup>-</sup>	10/15/2019–11/11/2019	28
Darknet China <sup>-</sup>	12/16/2019–03/14/2020	79
Empire Market <sup>*</sup>	01/15/2020–03/12/2020	46

We design and use the Python crawler framework based on Selenium [3] and Requests-HTML [2] library to collect the public data in Chinese anonymous online market. The crawler framework uses the Selenium library to and corresponding Firefox drivers to simulate real user's behavior of logging in to the market, so that the crawler framework can run normally in a complex login environment. After logging in to the market, the crawler framework obtains cookies from the browser and updates the cookies to the HTMLSession object of the Requests-HTML library. In order to improve the efficiency of the crawler framework, the data collection after login will be continued by the HTMLSession object in Requests-HTML.

Kanich et al. [16] emphasized that the measurement should not be detected by the targets in measurement, otherwise they could change their behaviors, which would taint the measurements. So, hiding trace is important during crawling. In order to enhance the hidden effect, for each page request, the crawler replaces the circuit once. We implement this functionality by using stem [5]. We start our crawling thread at random time every day. For example, in the adjacent two days, we start to crawl at 5am and 2pm respectively.

### 3 Comparative Analysis of Anonymous Online Market in Chinese and English

In this section, we analyze and compare the Chinese and English anonymous online markets from three aspects: market operation mechanism, market security mechanism and goods sales situation. Then we extract the similarities and differences between the Chinese and English anonymous online markets.

#### 3.1 Market Operation Mechanism

Similar to the online market running on the surface network, anonymous online markets are also built on common web server software, including Apache, Nginx and Windows IIS Server. Among them, most anonymous online markets prefer to use Nginx. We have tested 8 Chinese and English anonymous online markets and found 6 of them are built using Nginx. Only 1 anonymous online market is built by Apache and the other 1 by Windows IIS Server. We show the result in Table 2. Compared with the English anonymous online market, Chinese anonymous online market are more likely to use the Nginx server. For example, the 3 Chinese anonymous online markets we collect in Table 2 are all built on Nginx.

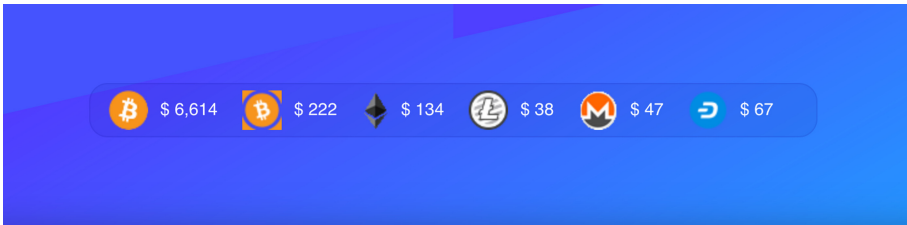
For the anonymous online market with a large number of users, Nginx server has shown great advantages in reverse proxy, anti-concurrency and anti-DDoS attacks. Those advantages can help the owner of anonymous online market to operate stably when accessed by multiple users. On the other hand, it also enables the anonymous online market to better respond to DDoS threats.

Anonymous online markets use crypto-currencies for transactions. Common crypto-currencies in anonymous online markets include Bitcoin (BTC), Litecoin

**Table 2.** Web server software used by anonymous online market.

Market	Web server software
Chinese Trading Market	Nginx
Tea-Horse Road	Nginx
Darknet China	Nginx
Empire Market	Apache
Square Market	Windows IIS Server
Yellow Brick	Nginx
Bitbaz Market	Nginx
Pax Romana	Nginx

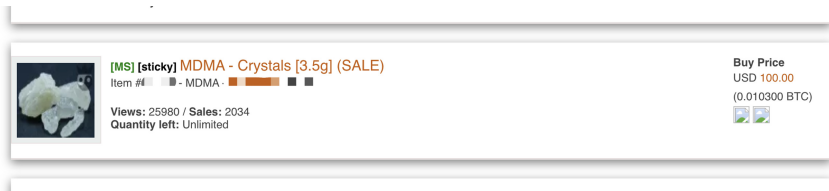
(LTC) and Monero (XMR). Since the price of crypto-currencies fluctuates frequently, the anonymous online market usually displays the real-time price of crypto-currencies against conventional currencies in the homepage. As shown in Fig. 1, users can evaluate the prices of goods in the market more intuitively.

**Fig. 1.** Anonymous online market crypto-currency to real currency price display.

English anonymous online markets usually support multiple crypto-currencies, and the crypto-currencies supported in different markets are also different. As shown in Fig. 1, this market supports Bitcoin, Bitcoin Cash(BCH), Ethereum, Monero, Litecoin and Dash at the same time. For comparison, “Empire Market” supports three crypto-currencies, Bitcoin, Litecoin and Monero while “Dream Market” only supports Bitcoin and Bitcoin Cash [28]. Although different markets support different types of crypto-currencies, all markets support Bitcoin. Unlike English anonymous online markets, Chinese anonymous online markets usually only support Bitcoin. For example, the three Chinese anonymous online markets listed in Table 1 are all only support Bitcoin. It can be found that in terms of support for crypto-currency, the Chinese anonymous online market is relatively simple.

Escrow is currently the most popular transaction settlement method used in the anonymous online market, and is also the transaction settlement method commonly used in the Chinese anonymous online market. In addition to escrow,

many English anonymous online markets also support FE and multisig. FE allows the transaction to be settled immediately after the buyer pays for the goods, without waiting for the buyer to confirm the receipt. But this method has a fraud risk and only a few vendors can use it with the permission of the market administrator. Multisig is a new type of transaction settlement method, which allows transaction settlement under the approval of two-thirds of the transaction parties (any two parties in the market, buyers and vendors). Figure 2 shows a commodity that supports multisig. Multisig can effectively prevent the loss of transaction money when the market is suddenly offline or closed.



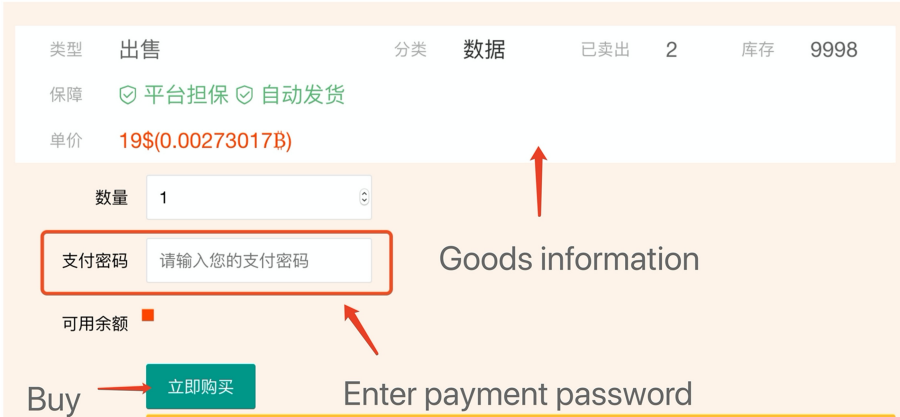
**Fig. 2.** A commodity that support multisig. (“[MS]” tag is in the front of the commodity title.)

### 3.2 Market Security Mechanism

**Account Security.** When the user registers an account in the market, the username and login password need to be set. In addition, English anonymous online markets usually require users to set a 6-digit personal identification number (PIN) when registering an account. The PIN can improve the security of the user’s account, and is usually used when the user trades with others or resets account, which can better protect the account from the threat of password leak. Similar to the PIN, the Chinese anonymous online market usually supports payment password. As shown in Fig. 3, payment password is used to protect the user’s property and is usually used when the user pays for the goods. In addition to the above mechanisms for the security of user’s accounts, anonymous online market users also need to enter a CAPTCHA when logging into their accounts. Before the end of 2019, the most of Chinese anonymous online markets have not set up CAPTCHA in their login pages and registration pages. From the end of 2019 to the beginning of 2020, many Chinese anonymous online markets have improved the platform, and set up CAPTCHA on their login pages and registration pages.

In order to improve the security of user accounts, English anonymous online markets recommend that users should set up PGP public key after registering accounts. The account that sets the PGP public key can login through 2FA. As shown in Fig. 4, 2FA requires users to use the corresponding PGP private key to decrypt the message displayed in the login page, and enter the content (such as security code) required on the page. Therefore, only the user with the correct

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**Fig. 3.** Payment password in Chinese anonymous online market transactions.

PGP private key can login through 2FA. The PGP can also be used for communication between buyer and vendor, thereby protecting the communication between the two parties from the impact of middleman attacks.

The Chinese anonymous online markets have not yet deployed the PGP to ensure the security of user accounts and transactions. However, Chinese anonymous online markets pay more attention on the privacy of vendors. Many Chinese anonymous online markets have specially processed personal information such as vendor ID. For example, in “Chinese Trading Market”, only the vendor number is used to distinguish vendors; “Darknet China” hides the middle part of the vendor ID and only shows the first and last characters (for example “A\*\*\*e”). Although the above two methods can protect the vendor’s information to a certain extent, making it more difficult for law enforcement to identify the vendor, it also increases the difficulty of identifying the buyer. In the anonymous online market, reputation is the most critical factor in determining the success of a vendor. Usually, buyers identify their trusted vendors by vendor ID. For “Chinese Trading Market”, buyers can use the vendor number to distinguish vendors. But for “Darknet China”, because the buyer can only observe the first and last characters of the vendor ID, the scammers in the market can use the vendor ID with the same first and last characters as the high-reputation vendor ID to sell the goods to defraud the buyer’s money, which is often difficult for buyers to discern.

**Website Security.** In recent years, with the increasing number of anonymous online markets, there have been more and more attacks on anonymous online market. For example, “Dream Market” had suffered serious cyber-attack from unidentified attackers. Regarding the source of this attack, there are conjectures in the relevant forums of the anonymous network showing that the attack

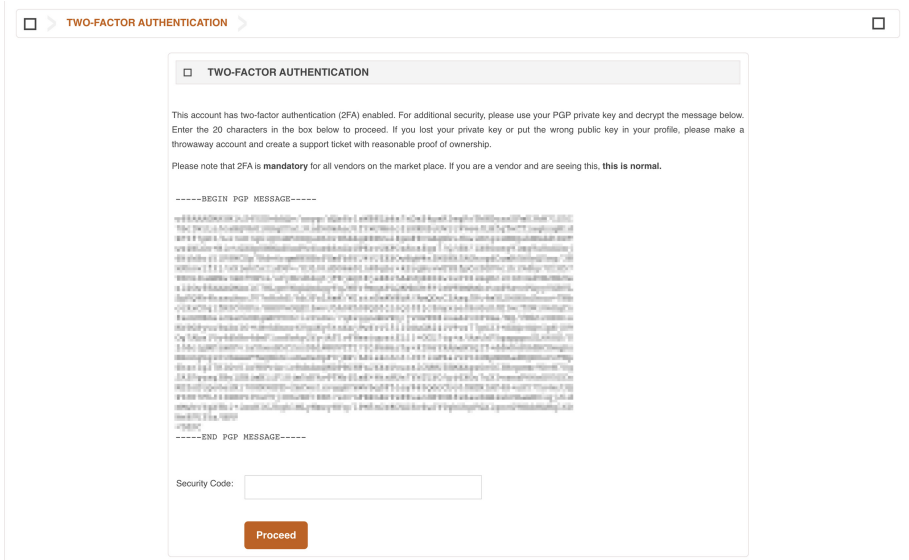


Fig. 4. Anonymous online market with 2FA login.

is coming from competitors of “Dream Market”, and there are other conjectures saying that the attack is coming from the law enforcement [28]. Similar to “Dream Market”, “Chinese Trading Market” and “Tea-Horse Road” also suffered cyber-attacks from unidentified attackers during 2019. In response to this, “Chinese Trading Market” published a message on its web homepage showing that the attack came from the law enforcement. On the other hand, “Tea-Horse Road” administrator made an announcement in its market forum stated that the cyber attack suffered by “Tea-Horse Road” came from a competitor, and pointed out that this competitor had recruited hackers publicly through Telegram. From these attacks we can be seen that the anonymous online markets are constantly facing cyber threats from law enforcement and competitors with similar businesses.

Many anonymous online markets have adopted relevant security measures to deal with cyber-attacks. The most typical countermeasure is the multi-domain strategy, which uses multiple domain names for mapping to the same market. Because “.onion” domain is generated by the Tor software running on the onion server, the anonymous online market administrator can generate multiple “.onion” domains for his market. The list of domains is called mirrors list. When a certain domain name of the market cannot be accessed, users can access through other domain names in the mirror list. Currently, most English anonymous online markets and some Chinese anonymous online markets use this strategy. However, with the increment in the number of domain names in the same market, and the difficulty for “.onion” domains to remember, many malicious users take advantage of it for phishing.

### 3.3 Goods Sales Situation

According to the previous research [7, 12, 23, 26], the goods sold in English anonymous online market are mainly drugs, chemicals and digital goods. For example, the left side of Fig. 5 shows the main types of goods in “Dream Market” [28], including drugs, digital goods, drugs paraphernalia, services and others. Among them, drugs and digital goods account for about 50% and 40% of the total “Dream Market” goods, respectively.

We have also carried out statistics on the classification of goods in “Empire Market”. The classification of goods in “Empire Market” is shown on the right of Fig. 5. During our measurement, we find goods in “Empire Market” are similar to “Dream Market”: drugs and chemicals are also the most important goods in “Empire Market”, accounting for about 68% of the total market goods. At the same time, digital products, guides and tutorials, and digital goods such as software and malware account for about 25% of the total merchandise in the “Empire Market”.

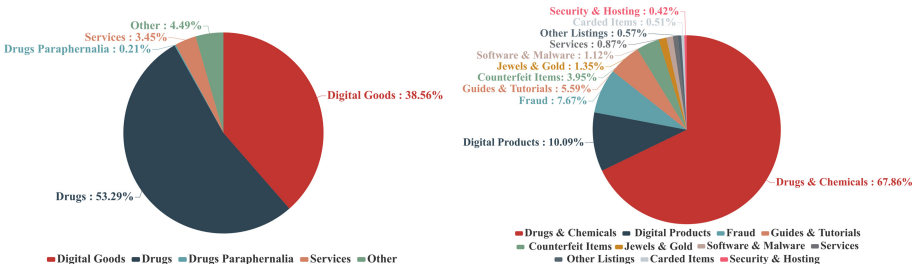
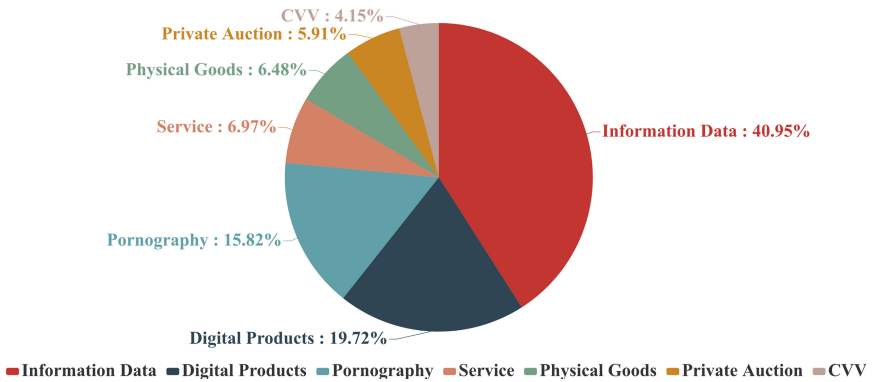


Fig. 5. “Dream Market” (left) and “Empire Market” (right) main categories.

For Chinese anonymous online market, each market in Chinese anonymous online markets has its own classification criteria. Therefore, we have developed a classification standard and trained a classifier to reclassify all products in the market.

To build and confirm the classifier, we select 4,331 pieces of goods information of the determined classification to form a data set, divide them into training set, test set and verification set, and use the “goods title” and “goods description” fields in the goods information as the classification characteristics. The input of the classifier is processed by the Convolutional Neural Network (CNN) algorithm with high accuracy. Then we feed to the model to train the classifier. The accuracy of the final classifier on the test set can reach 80%.

The goods in all markets are finally divided into seven categories: “Information Data”, “Physical Goods”, “Pornography”, “Services”, “Digital Products”, “CVV” and “Private Auction”. Figure 6 shows the goods classification of the Chinese anonymous online markets after reclassification, in which information data, digital products and pornography are the most important goods in the



**Fig. 6.** Main categories of Chinese anonymous online markets.

Chinese anonymous online markets, accounting for almost 40%, 20% and 16% respectively.

The goods sold in English anonymous online markets are usually dominated by drugs, chemicals and digital goods. Goods in Chinese anonymous online market are mainly information data and other digital goods, and information data dominate the market. Therefore, there are certain differences between the English anonymous online markets and the Chinese anonymous online markets.

Next, we will analyze the reasons for the differences in the anonymous online markets between Chinese and English, and make a comparative analysis of the most important online goods in Chinese and English anonymous online markets, including information data, pornographic films and hacking technologies.

**Important Goods in English Anonymous Online Market.** As we known, the drug trade has high profits. The most important goods in the “Silk Road”, the first large-scale integrated anonymous online market, was drugs. As shown in Fig. 7, Christin listed the 20 types of goods with the largest number of goods in “Silk Road” [12]. Among them, 16 types are related to drugs. At the same time, the number of soft drugs such as weed, cannabis and hash in “Silk Road” is greater than hard drugs such as opiates. And we also observed similar phenomena in “Empire Market”.

The sale of goods in the “Silk Road” reflects the huge demand for soft drugs. Since the rise of the anonymous online market, this demand has never changed. British journalist Wensley Clarkson mentioned in his book “Hash: The Secret and Chilling Story Behind the Drug’s Deadly Underworld” [13] says: “As a lucrative cash crop, the global gross output value of cannabis exceeds the sum of corn and wheat. Hash is a concentrated product of hemp, and is a recreational drug considered to be the most acceptable to society. It is estimated that the largest source of economic income for organized criminal groups worldwide is Hash.” Meanwhile, Cannabis such as Hash are not included in the scope of control or have a low degree of control in some countries and regions. Therefore,

Category	#. items	Pct.
Weed	3338	13.7%
Drugs	2194	9.0%
Prescription	1784	7.3%
Benzos	1193	4.9%
Books	955	3.9%
Cannabis	877	3.6%
Hash	820	3.4%
Cocaine	630	2.6%
Pills	473	1.9%
Blotter (LSD)	440	1.8%
Money	405	1.7%
MDMA (ecstasy)	393	1.6%
Erotica	385	1.6%
Steroids, PEDs	376	1.5%
Seeds	374	1.5%
Heroin	370	1.5%
DMT	343	1.4%
Opioids	342	1.4%
Stimulants	291	1.2%
Digital goods	260	1.1%

**Fig. 7.** Top 20 product categories by number of “Silk Road”.

cannabis have lower trade risks than other drugs. Additionally, the anonymous online market has provided a safer sale method for vendors of this high-profit industry, allowing both parties in the transaction to hide their identity, Cross-border transactions can be conducted without contacting the other party.

**Important Goods in Chinese Anonymous Online Market.** With the continuous advancement of China’s online real-name system process, users’ online virtual identities are matched with real identity information. More and more personal information is used in various web applications, which provides convenience for the management of Internet governors in China. However, due to the lack of data security management in many Internet applications, lack of legal awareness for network administrators and lack of relevant regulations, there is a great information leakage risk of personal information data stored in these Internet applications, even causing large-scale leakage of personal information data. Personal information data can be used by fraud gangs to implement precise fraud. According to relevant reports, Chinese police have cracked 200,000 online telecommunications fraud cases and captured 163,000 suspects in 2019, up 52.7% and 123.3% year-on-year respectively. This shows that China’s fraud

cases are on the rise, and precise fraud can greatly increase the success rate, thereby bringing greater benefits to criminals. The popularity of the Chinese anonymous online market provides a safer trading platform for black industry practitioners and precise fraud groups engaged in the sale of personal information data. Driven by profits and criminal needs, information data have gradually become the most important goods in Chinese anonymous online markets.

**Information Data.** The information data sold in Chinese and English anonymous online markets are very similar. The information data in the Chinese anonymous online market mainly include personal real-name, asset, network accounts, bank accounts and passwords in many industries such as finance, e-commerce platforms, transportation and education. Information data in English anonymous online markets mainly include Social Security Number (SSN), birthday, bank card account and password, and “Fullz”<sup>1</sup>.

Although the information data sold in Chinese and English anonymous online markets have certain similarities, due to the difference in social environment, buyers of information data may be used for different purposes. Data buyers in Chinese anonymous online market will usually use these data for precise marketing and precise fraud; while data buyers in English anonymous online market usually use information data for identity theft or tax fraud. For example, a purchaser of information data in the United States can use the SSN of the minor he purchased to carry out tax fraud [6], that is, use the child tax credit when submitting a tax return. Due to that parents usually pay little attention to the credit status of their children, purchasers of information data can also use a synthetic identity with a minor social security code to apply for a credit card, which will cause the victim a double loss of credit and money.

The proportion of information data in English anonymous online markets is relatively small. For example, the volume of information data in “Empire Market” only accounts for 4.9% of the total market goods, which is far lower than 40.95% in Chinese anonymous online markets. Although the proportion of information data in “Empire Market” is relatively small, the actual number of information data in the two markets is not different, since the total number of market goods in “Empire Market” is about 7 times that of “Chinese Trading Market”, and the number of information data in “Chinese Trading Market” is slightly higher than “Empire Market”. On the other hand, we have studied the cumulative trading of information data in “Empire Market” and “Chinese Trading Market” from February 2018 to mid-March 2020. During this period, the average cumulative information data of “Empire Market” goods transactions were approximately 69,725; the average cumulative information data transactions of “Chinese Trading Market” were approximately 56,146. This shows that the overall situation of the information data in “Empire Market” and “Chinese Trading Market” is similar. In terms of goods number, “Chinese Trading Mar-

<sup>1</sup> Fullz is a slang term used by credit card hackers and data resellers which means full packages of individuals’ identity information. “Fullz” usually contains an individual’s name, Social Security number, birth date, account numbers and other data.

ket” is slightly higher than “Empire Market”; but in terms of actual trading, “Empire Market” is slightly higher than “Chinese Trading Market”.

**Pornography.** Another important online goods in anonymous online markets is pornography. Among them, pornography in Chinese anonymous online market accounts for about 15.82% of the total market goods; while in English anonymous online market, pornography accounts for about 4%. But on the other hand, users in Chinese anonymous online market usually do not show a strong willingness to pay for pornography. We use the buyer’s purchase probability to measure the buyer’s willingness to purchase a certain type of goods. The buyer’s purchase probability is defined as in Eq. 1. Let the total sales of a certain category of goods be  $S$  and the total number of user’s browsing of goods be  $V$ , the purchase probability  $P$  of the buyer of the goods is:

$$P = \frac{S}{V} \quad (1)$$

In this subsection, the pornography purchase probability in “Chinese Trading Market” and “Empire Market” are calculated respectively. The pornography purchase probability in “Empire Market” reached 5.96%, which is about 46 times that of the “Chinese Trading Market”. It can be seen from the above that for pornography, although the Chinese anonymous online market has a larger market share, English anonymous online market users have shown a stronger purchase intention than Chinese anonymous online market users.

**Hacking Technology.** In recent years, the rapid development of the anonymous online market not only provides a safer and more convenient trading platform for leaked information data and pornography, but also enables hacker technology transactions to be conducted in a more covert way. Hacking technology in the anonymous online market can usually be divided into two types: actual hacking resources and teaching resources. The actual combat resources mainly include malware, exploit kit, hacking tools, and cyber-attack services. The teaching resources usually include text and video, which are mainly used to provide technical guidance for technical enthusiasts.

We further divide hacking technology products into 4 categories: malware, tools, tutorials, and services. Table 3 shows the basic situation of the 4 categories of hacking technology goods in Chinese and English anonymous online markets. The hacking technology goods sold in Chinese and English anonymous online markets are very similar, but there are certain differences due to different audiences.

It can be seen from Table 3 that, in addition to some common hacking tools and malicious programs, malware and tools in Chinese anonymous online market are more focused on private information theft; while similar goods in English anonymous online markets are more focused on phishing, social network account theft and property theft. In terms of tutorial, English anonymous online market is still more focused on phishing, account theft and property theft, but Chinese

anonymous online market is more focused on low-cost sales of Kali Linux, penetration testing and well-known online security training platforms for fee-based teaching videos. In terms of service, most vendors in Chinese anonymous online markets have limited the scope of their services. They usually only target illegal or overseas websites involving black and gray products, and usually do not accept the target of attacks on websites of sensitive businesses such as government and education. However, there are a few vendors in Chinese anonymous online markets that have not restricted their service scope. In the English anonymous online market, most vendors that provide service do not restrict the scope of service demand.

**Table 3.** Hacking technology goods in anonymous online markets

Category	Chinese anonymous online market	English anonymous online market
Malware	Include monitoring software, CVE vulnerability exploit kits, various viruses and Trojan	Include 0-day exploit, ransomware and Trojan
Tools	Include website penetration, Wifi attack, password cracking, Android remote control, camera attack, and SQL injection	Include phishing site deployment, SQL injection, Wifi attack, Android remote control, Bitcoin theft, and social network account theft
Tutorials	Involves Kali Linux, penetration test, DDoS attacks, paid tutorials on security training platforms, and hacking technology books	Involves basic hacking tutorials, phishing site construction, social network account theft, and payment service theft
Services	Involves DDoS attacks, website penetration, Domain Name System (DNS) hijacking, and SMS bombing	Involves DDoS attacks, botnets, website attacks, SMS bombing and email bombing

## 4 Discussion

In this section, we give our discussions on Chinese and English anonymous online markets. First, we discuss ethical considerations. Then we discuss the impact of external attacks on anonymous online market and the focus and methods of Chinese and English anonymous online market governance.

### 4.1 Ethical Considerations

For ethical considerations, first of all, the data we collected is public. Anyone can observe these data by browsing the market pages, so there is no risk of exposing

the users' privacy. In addition, we adopt a relatively conservative data crawling method, and limits the frequency of crawler to a certain extent, so as not to cause cyber-attack on any market.

## 4.2 Law Enforcement Intervention and Anonymous Online Market Governance

At present, many researchers such as [11,23] have shown that English anonymous online markets usually have a certain "resilient" for the crackdown by law enforcement agencies. The crackdown by law enforcement agencies cannot completely prevent the trading behavior of market users, but only force them to move to other markets. For example, the closure of "AlphaBay" and "Hansa" in 2017 caused a large number of anonymous online market users to move to "Dream Market" [27]. The Chinese anonymous online market usually does not completely disappear after being subjected to a malicious network attack, but will continue to operate after a short repair. It can be seen that Chinese anonymous online market has shown a certain degree of stability.

Therefore, regardless of English anonymous online market or the Chinese anonymous online market, the strategy of forcibly closing the market or attacking the market through cyber-attacks cannot deter anonymous online markets. Since the anonymous online market is dominated by profits and demand, reducing people's demand for illegal goods will play a decisive role in the governance of the anonymous online markets. However, the reduction in demand will be a protracted process, and the illegal transactions in anonymous online market threaten the security of cyberspace is imminent. Law enforcement agencies need to formulate more targeted market interventions. For example, for the transactions of physical goods, law enforcement agencies can strengthen the control of logistics, thereby blocking the illegal transactions at the transport phase.

However, the main goods sold in Chinese anonymous online market are information data, and logistics control has no effect on these virtual goods. Therefore, when governing the anonymous online market, Chinese government should strengthen its network supervision and the protection of various information and data, together with network security companies. At the same time, increase the level of attention to precise marketing and crack down on precise fraud, increasing the criminal costs of criminals.

## 4.3 Market Demand and Vendor Behavior

Considering the differences between Chinese and English anonymous online market goods, we found that the types of goods sold in the market mainly depend on the specific needs of members of the language community to which the market belongs. At the same time, the language community to which the market belongs may not be directly related to the language community to which the vendor belongs. For example, a study by Scourfield et al. [22] shows that many vendors from China sell goods in English markets, and the goods they sell occupy

a larger market share. Vendors usually decide in which (language community) market they will sell their goods based on the potential consumers of their goods.

Therefore, researchers can focus more on the consumption habits of consumers in the language communities where the market belongs, and then discover potential cybercriminal goods and behaviors, take measures before they appear in the anonymous online market.

## 5 Related Work

In most anonymous online markets, drugs are the most important goods, which has made the research in recent years mostly focus on drug market transactions such as [8, 10, 17, 18, 21], transaction participants [24, 25] and the geographical characteristics of transaction trafficking in [9, 15, 20]. In this work, besides drugs, we also pay attention on other types of goods such as digital goods.

In 2015, Christin et al. [23] measured and analyzed the anonymous online market ecosystem, and similar studies include [12, 26, 28]. However, their research target is the anonymous online market in English, which usually does not include anonymous online markets in other languages. And we have conducted a research on the Chinese anonymous online market and the first (to our knowledge) comparative analysis of the Chinese and English anonymous online markets.

## 6 Conclusion

In this work, we first collect the public data about Chinese and English anonymous online markets. Then we combine with previous research results and conduct a study on the characteristics of Chinese and English anonymous online markets.

We finish a comparative analysis of Chinese and English anonymous online markets from three aspects: market operation mechanism, market security mechanism and goods sales situation. The analysis results that the English anonymous online market is relatively mature in terms of market operation mechanism and market security mechanism, while the Chinese anonymous online markets are still on their developing stage. In addition, due to the influence of market demand and relevant laws and regulations, there are certain differences in the goods sales situation between anonymous online markets in Chinese and English. Finally, we discuss the impact of law enforcement crackdowns on Chinese and English anonymous online markets, as well as the focus and methods of Chinese and English anonymous online market governance.

The same vendor may sell goods in the markets of different language communities, so they may be a true international vendors proficient in multiple languages. Although our paper does not discuss this type of vendor, we can use our research as a basis and combine with more types of data for in-depth research in the future.

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## References

1. Pretty Good Privacy. [https://en.wikipedia.org/wiki/Pretty\\_Good\\_Privacy](https://en.wikipedia.org/wiki/Pretty_Good_Privacy). Accessed 29 Apr 2020
2. Requests-HTML: HTML Parsing for Humans (writing Python 3)! <http://requests-html.kennethreitz.org/>. Accessed 29 Apr 2020
3. SeleniumHQ Browser Automation. <https://www.selenium.dev/>. Accessed 29 Apr 2020
4. Silk Road (marketplace). [https://en.wikipedia.org/wiki/SilkRoad\(marketplace\)](https://en.wikipedia.org/wiki/SilkRoad(marketplace)). Accessed 29 Apr 2020
5. Welcome to Stem! Stem 1.8.0 Documentation. <https://stem.torproject.org/>. Accessed 29 Apr 2020
6. Why does my 3-year-old son have a bad credit history? Dark web world surge. <http://tech.sina.com.cn/cs/2019-02-27/doc-ihrfqzka9518025.shtml>. Accessed 11 Apr 2020
7. Aldridge, J., Décarry-Héту, D.: Not an ‘Ebay for Drugs’: the cryptomarket ‘Silk Road’ as a paradigm shifting criminal innovation. Available at SSRN 2436643 (2014)
8. Bancroft, A., Reid, P.S.: Concepts of illicit drug quality among darknet market users: purity, embodied experience, craft and chemical knowledge. *Int. J. Drug Policy* **35**, 42–49 (2016)
9. Broséus, J., Rhumorbarbe, D., Morelato, M., Staehli, L., Rossy, Q.: A geographical analysis of trafficking on a popular darknet market. *Forensic Sci. Int.* **277**, 88–102 (2017)
10. Buxton, J., Bingham, T.: The rise and challenge of dark net drug markets. *Policy Brief* **7**, 1–24 (2015)
11. Calis, T.: Multi-homing sellers and loyal buyers on darknet markets (2018)
12. Christin, N.: Traveling the silk road: a measurement analysis of a large anonymous online marketplace. In: Proceedings of the 22nd International Conference on World Wide Web, pp. 213–224 (2013)
13. Clarkson, W.: Hash: The Secret and Chilling Story Behind the Drug’s Deadly Underworld. Not Avail (2013)
14. Dingedine, R., Mathewson, N., Syverson, P.: Tor: the second-generation onion router. Technical report, Naval Research Lab Washington DC (2004)
15. Dittus, M., Wright, J., Graham, M.: Platform criminalism: the ‘last-mile’ geography of the darknet market supply chain. In: Proceedings of the 2018 World Wide Web Conference, pp. 277–286 (2018)
16. Enright, C.K.K.L.B., Savage, G.M.V.S.: The Heisenbot uncertainty problem: challenges in separating bots from chaff (2008)
17. Leontiadis, N., Moore, T., Christin, N.: Measuring and analyzing search-redirection attacks in the illicit online prescription drug trade. In: USENIX Security Symposium, vol. 11 (2011)
18. Martin, J.: *Drugs on the Dark Net: How Cryptomarkets are Transforming the Global Trade in Illicit Drugs*. Springer, London (2014). <https://doi.org/10.1057/9781137399052>

19. Nakamoto, S.: Bitcoin: a peer-to-peer electronic cash system. Technical report, Manubot (2019)
20. Norbutas, L.: Offline constraints in online drug marketplaces: an exploratory analysis of a cryptomarket trade network. *Int. J. Drug Policy* **56**, 92–100 (2018)
21. Rhumorbarbe, D., Staehli, L., Broséus, J., Rossy, Q., Esseiva, P.: Buying drugs on a darknet market: a better deal? Studying the online illicit drug market through the analysis of digital, physical and chemical data. *Forensic Sci. Int.* **267**, 173–182 (2016)
22. Scourfield, A., et al.: Synthetic cannabinoid availability on darknet drug markets—changes during 2016–2017. *Toxicol. Commun.* **3**(1), 7–15 (2019)
23. Soska, K., Christin, N.: Measuring the longitudinal evolution of the online anonymous marketplace ecosystem. In: 24th {USENIX} Security Symposium, {USENIX} Security 2015, pp. 33–48 (2015)
24. Van Hout, M.C., Bingham, T.: ‘Surfing the silk road’: a study of users’ experiences. *Int. J. Drug Policy* **24**(6), 524–529 (2013)
25. Van Hout, M.C., Bingham, T.: Responsible vendors, intelligent consumers: silk road, the online revolution in drug trading. *Int. J. Drug Policy* **25**(2), 183–189 (2014)
26. Van Wegberg, R., et al.: Plug and prey? Measuring the commoditization of cybercrime via online anonymous markets. In: 27th {USENIX} Security Symposium, {USENIX} Security 2018, pp. 1009–1026 (2018)
27. van Wegberg, R., Verburgh, T.: Lost in the dream? Measuring the effects of operation Bayonet on vendors migrating to dream market. In: Proceedings of the Evolution of the Darknet Workshop, pp. 1–5 (2018)
28. Zhou, G., Zhuge, J., Fan, Y., Du, K., Lu, S.: A market in dream: the rapid development of anonymous cybercrime. *Mobile Netw. Appl.* **25**(1), 259–270 (2020). <https://doi.org/10.1007/s11036-019-01440-2>