# Economics of Cyber Security
## Individual Paper

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## Abstract

Over the years many dark net markets have risen in popularity or have disappeared because of them being hacked or because of the operators being arrested. In this paper a research on the relation between the availability of guns, stolen credit cards and the respective lifespan of a dark net market will be conducted. By analyzing the dark net markets that have appeared and disappeared we can conclude that dark net markets where guns are available generally have a 13% to 18% percent longer lifespan, depending on whether we include scam markets into our calculations, when comparing to dark net markets that do not sell guns. The availability of stolen credit cards however decreases the average lifespan of a dark net market by 3% to 8% percent.

# Introduction

Illegal markets such as The Farmers Market already moved to the TOR network back in 2010 [1] and with the rise of Silkroad which was founded 2011, more dark net markets started to appear. The first dark net markets such as The Farmers Market mainly sold drugs and even though drugs is still one of the major product categories found on dark net markets, other product categories such as weapons, credit cards batches, services and cyber assets also started to appear. Law enforcement agencies including police departments have a hard time to maintain law and order because of the anonymity of buyers and sellers inside the TOR network. If dark net markets grow even more then they might become an increasingly larger problem for law enforcement agencies but also for companies and individuals who might suffer from the consequences of dark net markets. Possible consequences could be a larger number of deaths or terrorist attacks because of the weapons being sold, or an increase in the number of drug addicts. In this paper the effects of the availability of guns and credit cards on the lifespan of a dark net market is researched. The availability of guns could make the market into a bigger target for governmental agencies or they might generally be more secure because of them being a bigger target.

# Literature Review

Since the rise of dark net markets, a lot of research has been done in this field, evolving it to a completely new field. This however that not a lot of literature has already been written on this. And most literature can only touch the surface because only data from the user perspective can be obtained.

One of the more recent papers from Swansea University by Julie Buxton and Tim Bingham [3] explain the dramatic growth of illegal substances. It does not only pose a major challenge for law enforcement agencies but also for the UN International drug control system and related legal structures in which these agencies operate. The paper also identifies the rise of hidden markets which do not have publicly available onion addresses. Possible counter measurements that have been used in the past often only close down a particular site, but come with the cost of proliferating hidden drug markets. The papers also argues that the international cooperation and enforcement between countries can still be improved a lot.

The paper "Use of Silk Road, the online drug marketplace, in the United Kingdom, Australia and the United States" by the National Drug Institute researched the motivations of people using drugs on Silkroad online [2]. To be aware of the reasons why people might use online markets for certain product categories gives insight into reasons why a platform might invest more in security or not. For example, all users value security, but some might value it more than others. Someone being caught while buying a gun, might suffer larger sentences in some countries then they would for being caught with drugs for example.

In "From Dealer to Doorstep – How Drugs Are Sold on the Dark Net" [4] published by the Swansea University insight is provided on how dark nets deliver the goods to their customer. The method that they choose indirectly effects the life span of the dark market, because some ways might be less secure than others. For example, a lot of buyers let their products be delivered to a mailbox at train stations to avoid having their identity being revealed by the destination of the product they bought.

Another paper: "The Dark Net: Self-Regulation Dynamics of Illegal Online Markets for Identities and Related Services" [5] investigates the functioning of illegal market places and how market operators try their best to gain the trust of customers. As will be seen in this paper, a lot of dark net markets appeared to be scam which indirectly affects the life span of the dark net markets. It is therefore important to see how markets try to gain trust of customers that are wary of scam markets.

In "Constructive activism in the dark web: cryptomarkets and illicit drugs in the digital 'demimonde'" [6] it is explained how crypto market such as Silk Road 1, became popular and self-governing society. Most users viewed the market not only as a simply market but also as a society or a philosophical framework that they lived in. Stronger online societies often have longer life spans then those that do not.

# Research Question, Objective and Hypothesis

**Research Question**
The main research question of this paper is "How does the availability of guns and credit cards effect the lifespan of dark net markets grow or shrink over time?" Where most dark net market mainly sell drugs several dark net markets also started to include guns, cyber weapons or other services.

**Objective**
Because data about dark net markets can generally only be obtained by observation (market operators do not make data available) it is often hard to find definitive conclusions. The objective of this paper however is to see whenever there is a difference in life span on markets that sell guns compared to those that do not sell guns. The reason why this is the case will be stated as a hypothesis but should be studied more to draw based conclusions.

**Hypothesis about the availability of guns on a dark net market effecting their lifespan**
My prediction is that the availability of guns on a dark net market does have an effect on the lifespan on a dark net market. Markets selling guns are more likely to become targets of police force units or international organizations such as Interpol. Since the availability of guns is a more direct threat to society then, for example drugs is, stakeholders that want to maintain law and order are likely to prioritize those markets.

**Hypothesis about the availability of stolen credit cards on a dark net market effecting their lifespan**
I think it's most likely that the availability of credit cards on a market will affect the lifespan of a market in a negative way. I, however, do not expect it to have a big impact, since I believe the availability of drugs (which is sold on virtually every dark net market) is of rather the same scale. Where guns can directly harm people, resulting in deaths or threatening situations, stolen credit cards are used to steal part of the money that an owner owns. Even though this might be about large amounts, it is often that case that only small amounts of money are available on those cards which makes it less interesting for police forces then, for example, a terrorist trying to buy a gun on a dark net market. In addition to the difference impact on society when compared to guns, it is also still possible for the police to track down individuals who try to cash out the credit cards at ATM machines, while preventing someone to shoot someone is harder since it is often unknown where an attacker might appear and take action.

# Methodology

To perform an analysis it is necessary to find appropriate data on which the analysis can be performed. Because the original received data about multiple markets was mainly raw unparsed HTML and contained records of only a week, it was necessary to search for another data source that could be analyzed in order to answer the research question. Because dark net markets operators do generally not make statistics publicly available we can only reach data which can be viewed from the user's perspective on dark net markets. Gwern Branwen provides an excellent overview of all notable dark net markets that have appeared and disappeared over time and tracked metadata such as their first appearance and the reason they were closed. The data can be found at [7] and is still updated regularly. The data also contained whenever guns and credit cards were available on historic and current dark net markets and could therefore be used as a source to answer the research question. The methodology will mainly consist of a quantitative approach.

**Cleaning up the data**

Because the data was only available on his HTML webpage, I firstly converted it to Excel such that analysis could be done more easily. I also removed unnecessary columns that was irrelevant to the research question being stated in this paper.

**Comparing the overall lifespan distributions graphs**

By comparing lifespan distribution graphs it is possible to analyze where the differences lie between markets that do sell guns or credit cards and those that do not.

**Calculating the average lifespan of markets that sell guns / credit cards and those that do not**

In order to do this four groups calculations were done on markets that: Sell guns, do not sell guns, sell stolen credit cards, and do not sell stolen credit cards. Because a high percentage of scam markets exist within the dark net market world, I also included calculations that excluded those scam markets to see if that makes a difference. By analyzing the amount of scam markets in relation to the availability of guns indirect effects on the average lifespan of dark net markets might also be inferred. The average life span that flow from these calculations can be compared to each other to support or disprove the hypotheses stated in the previous section.

# Results

In this section the methods described in the previous section have been applied and generated a result that will be discussed. First the lifespan distribution graphs are analyzed and compared to each other. Afterwards the average

Before we compare the lifespan distribution graphs of all markets that sell guns compared to those that do not, we also created the lifespan distribution graph of all markets together. Note that not all the names of the dark markets we covered could be displayed, since otherwise the graph would become too large.
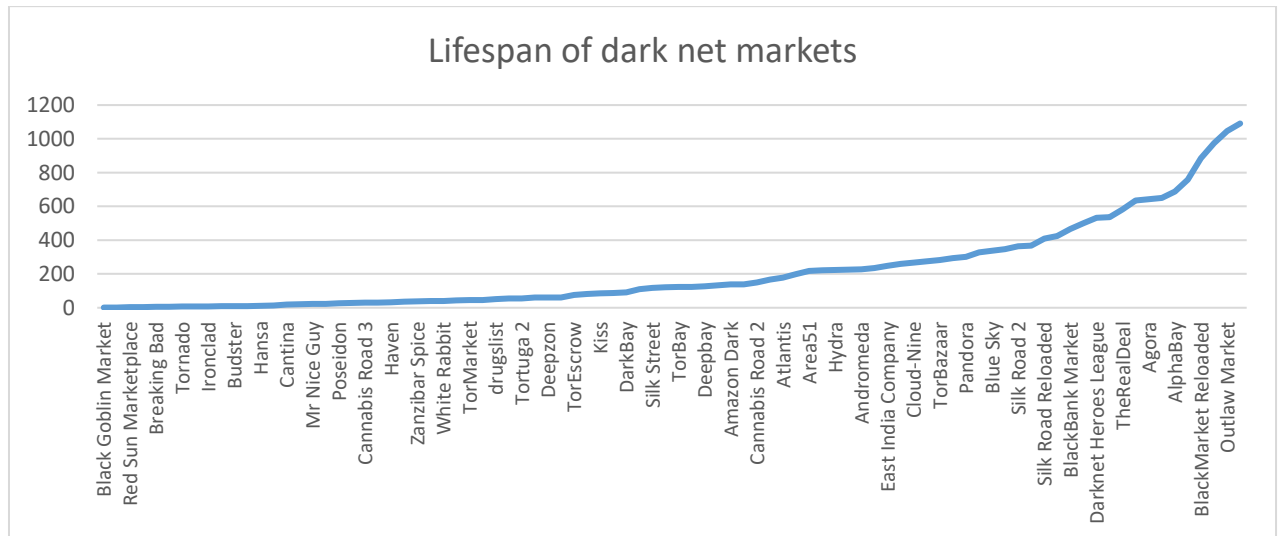


**Figure 1:** The lifespan of all tracked dark net markets.

**Comparing Lifespan Distribution Graphs of markets in relation to the availability of guns.**

As can be seen in Figure 1, the lifespan of dark net markets generally follows an exponential trend. Most dark net markets tend to disappear after around 100 days either because they are being hacked because of them using insecure platforms whereas on other market appeared to be scam or had their operators arrested by the government. In Figure 2 and 3 the lifespan distribution graphs of the markets selling guns and markets that do not sell guns are shown.
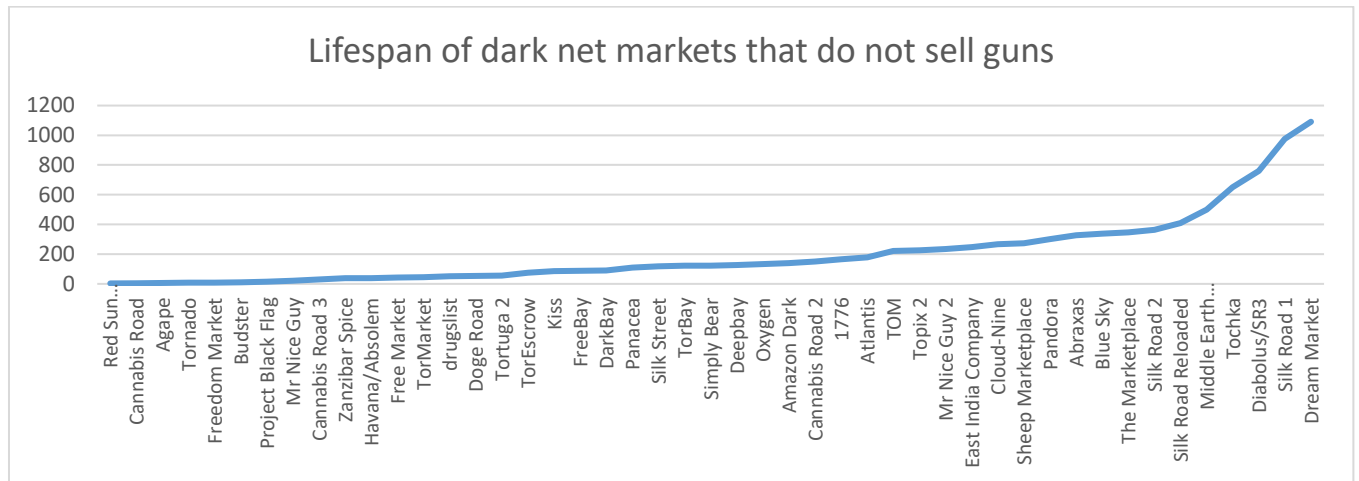


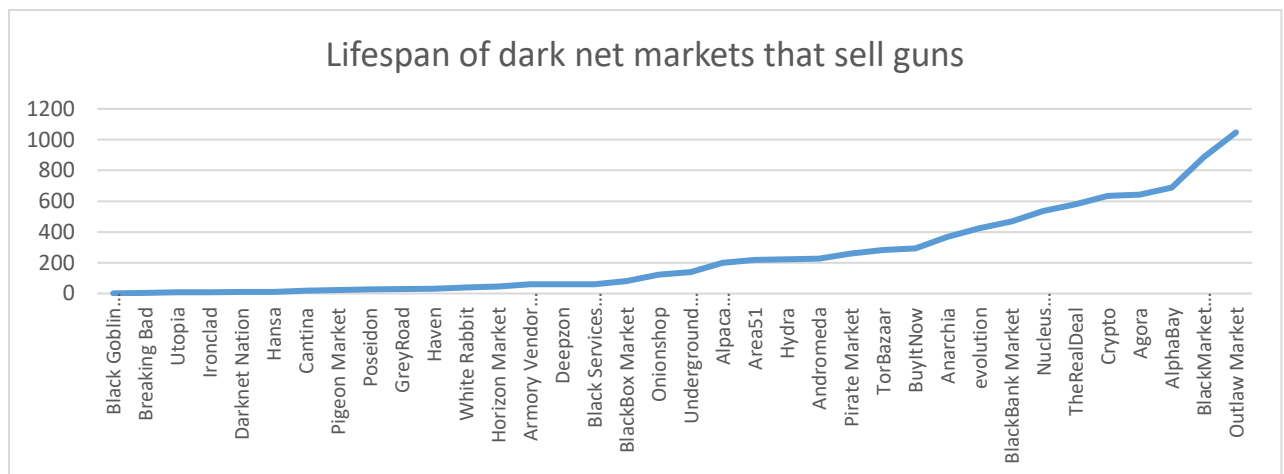**Figure 2:** The lifespan of all dark net markets that do not sell guns



**Figure 3:** The lifespan of all dark net markets that do sell guns

As can be seen from Figure 1, 2 and 3, is that the main difference between markets that sell guns and those that do not is that the markets that do sell guns generally have a higher percentage of markets that live longer than 400 days and have a high percentage of markets that live only a few days, whereas for markets that do sell guns these percentages are smaller. That means that markets that sell guns generally have a larger time span that those that do not.

**Comparing Lifespan Distribution Graphs of markets in relation to the availability of credit cards.**

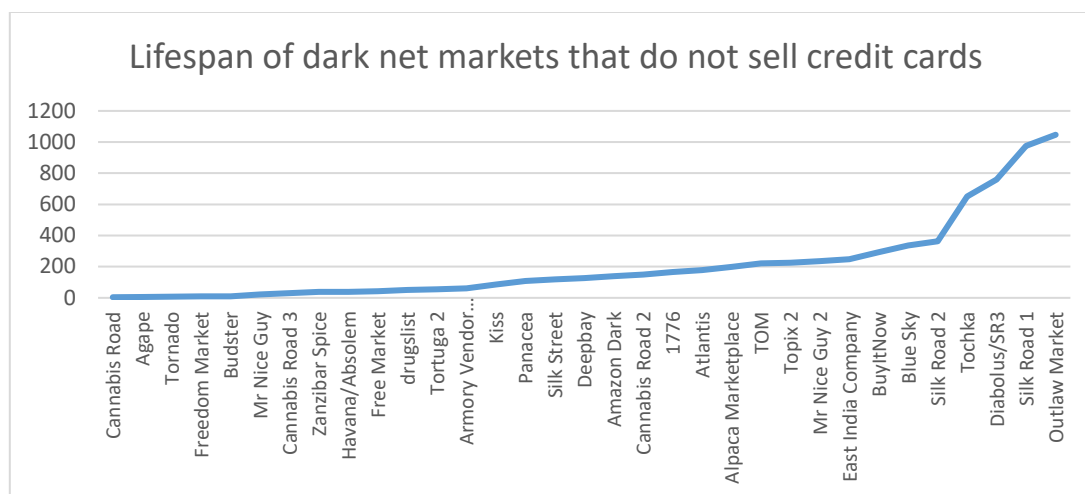Like we compared the lifespan distribution graphs of guns, we will also do so for credit cards.



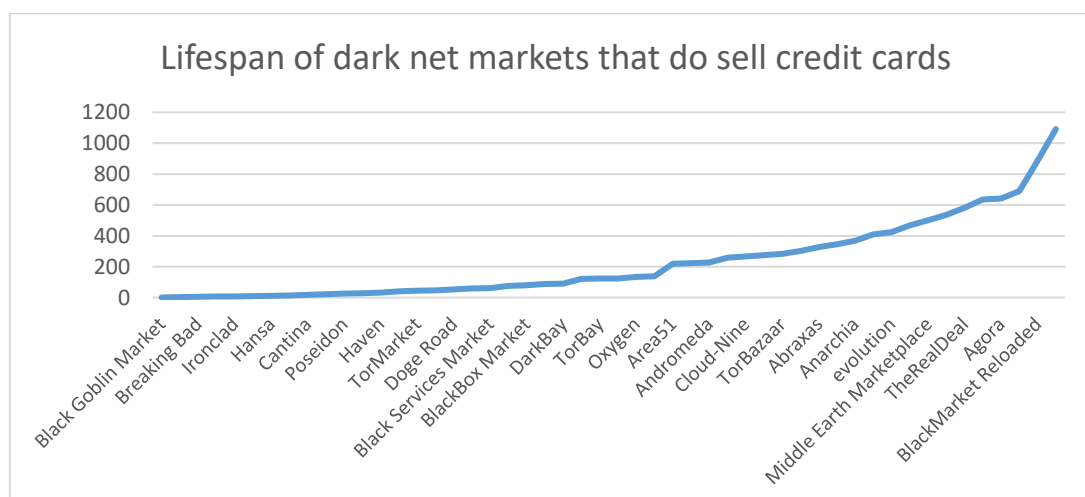**Figure 4:** The lifespan of all dark net markets that do not sell credit cards



**Figure 5:** The lifespan of all dark net markets that sell credit cards.

As can be seen from Figure 4 and 5 that the markets that do not sell credit cards more or less grow linearly in size till about the life span of 400 days and grow exponentially from that point on. Thus when a market reaches 400 days, the likelihood of its length in days increasing a lot more is larger than for markets that do not sell credit cards and did not reach the 400 days mark. For markets that do sell credit cards this curve is more exponential and more distributed over the entire graph, meaning that the older those markets get, the more likely it is that they will survive longer. This is partly due the amount of scam markets that are being discovered within the first year, thus increasing the amount of disappearing markets within the first 365 days.

**Effects of the availability of guns on the lifespan of a dark net market.**

To discover how the availability of guns on a market affects the lifespan of that market the average lifespan of markets selling guns and those of markets not selling guns was calculated. The statistics for markets selling guns are displayed in Table 1 and the statistics for markets not selling guns can be seen in Table 2. Markets that are currently being active are being taken into calculation with a lifespan of their first time of appearance to the current date.

| Dark net markets selling guns | |
|---|---|
| Average Lifespan (including scam markets) | 243 days |
| Amount of Markets (including scam markets) | 34 |
| Average Lifespan (excluding scam markets) | 279 days |
| Amount of Markets (excluding scam markets) | 20 |
| Percentage of scam markets selling guns | 41 % |

**Table 1:** Statistics on Dark net markets selling guns

| Dark net markets not selling guns | |
|---|---|
| Average Lifespan (including scam markets) | 205 days |
| Amount of Markets (including scam markets) | 47 |
| Average Lifespan (excluding scam markets) | 245 days |
| Amount of Markets (excluding scam markets) | 26 |
| Percentage of scam markets not selling guns | 45% |

**Table 2:** Statistics on Dark net markets not selling guns

As can be seen from the results in Table 1 and Table 2, Dark net markets selling guns have an average lifespan that is 18% percent higher if scam markets are taken into account and 13% higher if scam markets are excluded. This means that the hypothesis that dark net markets where guns are sold have a lower lifespan is false.

A possible explanation for this might be that the percentage of scam markets, which generally have a very short life span, is higher for markets that do not sell guns. This could be because market operators might perceive people that sell or buy guns as more dangerous and do not want to be pursued by them when they run away with the money. However this is just another hypothesis and solid research should be performed to confirm whenever this is one of the reasons that scam is less apparent on markets that sell guns. Another reason that dark net markets selling guns might have a longer life span because they are more secure then markets that do not sell guns. Sentences for operating an illegal market on which guns can be bought are likely to be higher than those that do not, and therefore there is a higher urgency

**Effects of the availability of fraudulent credit card on the lifespan of a dark net market.**
Aside the availability of guns, the availability of credit cards could also have a potential effect on the lifespan of a dark net market. Just as with guns described previously, the amount of scam markets are also taken into account for this. Table 3 describes the average lifespan of markets that allow selling fraudulent credit cards whereas Table 4 shows the average lifespan of markets that do not allow selling fraudulent credit cards.

| Dark net markets selling fraudulent credit cards | |
|---|---|
| Average Lifespan (including scam markets) | 212 days |
| Amount of Markets (including scam markets) | 50 |
| Average Lifespan (excluding scam markets) | 258 days |
| Amount of Markets (excluding scam markets) | 28 |
| Percentage of scam markets selling fraudulent credit cards | 44% |

**Table 3:** Statistics on dark net markets selling fraudulent credit cards

| Dark net markets not selling fraudulent credit cards | |
|---|---|
| Average Lifespan (including scam markets) | 228 days |
| Amount of Markets (including scam markets) | 33 |
| Average Lifespan (excluding scam markets) | 265 days |
| Amount of Markets (excluding scam markets) | 20 |
| Percentage of scam markets not selling fraudulent credit cards | 40% |

**Table 4:** Statistics on dark net markets not selling fraudulent credit cards

As can be seen from Table 3 and Table 4, the lifespan of markets selling fraudulent cards does not differentiate significantly from the markets that do not sell fraudulent cards. A reason for the might be because selling / using fraudulent credit cards is more common on dark net market just as drugs is quite common. Police forces are generally also more likely to focus on individuals stealing / obtaining those credit cards instead of preventing them from being sold, because preventing them to be sold is much harder when using the TOR network. The availability of credit cards on a market seems to decrease the lifespan for about 3% (when scam markets are not included) to 8% (when scam markets are included) when comparing to markets that do not sell credit cards.

This result is in correspondence with the hypothesis stated earlier. The effects of selling credit cards on the lifespan of a dark net market are rather insignificant when comparing to the effects of guns on the lifespan of a market. The reason behind this effect should be researched further but could be because of the low impact on society.

# Limitations

Data about dark net markets is very hard to obtain and often not very accurate. Because dark net market operators generally try to keep their platforms as secure as possible, the details of sales, amount of users or platform architecture is almost never made publicly available. This leaves us with the option of scraping websites and trying to derive those statistics or to simply observer the behavior and characteristics of a dark net market. The data source that I used contained information about many observed markets. However it was unavoidable to make some choices when the author collecting the data. For example, the author of the data source had to mark dark net markets as scam based on the forum reactions of sellers and buyers, but this of course does not guarantee that this is necessarily the case. After all markets could also have been hacked on which after the operators took a run to avoid any consequences. The educated guesses however stay a necessity in this area of research, and it is unlikely that accurate data of markets that are currently alive will ever become available.

**Future work**

The reason why markets that sell guns do have an increase in average lifespan should be researched more. What makes a market that sells guns or credit cards different from one that does not? Are those differences related to the availability of guns and credit cards? And how do these factors affect the lifespan of those market in the way that we have seen in this paper? Those are questions that should be researched in separate projects, but are generally hard to answer because of the lack of data.

More research could also be done in the area of tracking the lifespan of markets. Even though Gwern Branwen has done an excellent job on this, the reasons why some markets are closed are still unclear. Governments could give a disclosure this type of information after arrests have been made for example. This could help the research community in better understand the behavior of dark net markets.

## Conclusions

From the results displayed in this paper we can conclude that the availability of guns and credit cards does indeed have an effect on the lifespan of a dark net market. Guns however seem to have a positive effect on the lifespan of market which was rather unexpected since the availability of guns are a higher risk for society then a stolen credit card is. The assumption is that this is because the security of markets selling guns is generally higher because market operators generally suffer a higher penalty when they are arrested for operating a market that sells guns. However this should be verified in further researches. Credit card batches however seem to have the predicted small negative impact on the lifespan of a market. My prediction here is that credit card fraud has a smaller impact on society and is more common online. Because credit cards generally still need to be cashed out at ATM machines, the police forces still has traces it can follow to catch the people using the stolen credit cards. To verify these predictions, more research should be done, possibility with involving the governmental forces by asking for their motives behind targeting certain dark net markets.

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