

have any legal remedies and countermeasures available, except for a negative reputation rating. We thus hypothesise (H_5) that the carding forums to be analysed have working reputation systems that are at least as sophisticated as those of legal marketplaces, for instance eBay. This expectation applies only to open forums where everybody can participate.

As discussed, the efforts needed for gaining trust are extensive. A consequence might be that sellers concentrate on establishing reputation on one specific forum instead of several forums. It is therefore not expected that sellers are present on multiple forums. By assuming this, we support Motoyama's et al. [7] expectation of non-existing multiple accounts. In contrast, we disagree with Ablon et al. [6] who argue without providing any reasons that sellers would advertise on multiple marketplaces. We hypothesise (H_6), therefore, that the vast majority of actors are not operating on more than one forum.

III. METHODOLOGY

In this section, we describe our data collection approach. We collected names of underground forums from various sources, and selected 5 forums that matched our selection criteria for examination. Data spanning a period of three months was collected from the forums, and we tested our hypotheses on the data.

A. Forum search

The first step of the examination is the forum search. We took the following steps to find carding forums: First, we collected names of forums that were mentioned by research literature. Second, we carried out searches via Google. Third, we used other search engines and information pages, runstitch.citysearch.vip, webstatsdomain.org and "The Hidden Wiki." Finally, we searched forums that we already found for references to other forums. In the latter case, we adopted the method of snowball sampling [24]. The only selection criterion at this point was that, due to the authors' language abilities, the forums had to be at least partly in English or in German.

By this means, we found 25 forums, 15 of them via Google. The 25 forums are listed in Table I. The forum names mentioned in existing literature research were of little use since all the mentioned forums had already been shut down. We found five forums through other forums, and five from listings and other search pages. Although numerous forums were listed, most of them did not exist anymore. Two of the forums discovered during the first search in February 2015 were shut down at the beginning of the analysis in June 2015. Notwithstanding, the carding underworld seems to be dynamic. We found one active forum containing posts dating back to 2008.

Besides forums, we discovered more than two dozen stores (e.g. *Globalcards* and *Dexter*, offering mainly credit card numbers). We did not include these single-vendor marketplaces in our analysis since they differ significantly from forums. They do not gather multiple sellers, they have no reputation systems, and users normally do not communicate with each other. Hence, they do not meet our interest in interactions between forum members.

Forum name	Forum address (http://...)
Agoraforum	labcxobeprrsrfx.onion/
Altenen	www.altenen.com
Crdpro	crdpro.su
Crimenetwork	crimenc5wxi63f4r.onion
Cardingforum	www.cardingforum.org
Hackingforum	hackingforum.ru
Unixorder	www.unixorder.com
Crdclub	crdclub.ws
Carderscave	www.carderscave.ru
Infraud	infraud.cc
Lampeduza	lampeduza.so
Blackstuff	www.blackstuff.net/forum.php
Bus1Nezz	bus1nezz.biz
Cardingmafia	www.cardingmafia.ws
Bpcsquad	www.bpcsquad.com
Procarder	www.procarder.ru
Cardersforum	www.cardersforum.se/
Crimes	crimes.ws/
Carderbase	carderbase.su
Carder	carder.me
Darkstuff	www.darkstuff.net
Coinodeal	coinodeal.com
Tuxedocrew	www.tuxedocrew.biz
Privatemarket	privatemarket.us
Omerta	omerta.cm

TABLE I: Names and web addresses of discovered forums. The ones we focused on are highlighted in boldface text.

To narrow down the analyses, we chose five out of the 25 forums (see Table II for detailed examination: *Altenen*, *Crdpro*, *Crimenetwork*, *Bpcsquad*, and *Tuxedocrew*). The first three are the largest forums we found (as measured by number of posts) and should thus be the most fruitful ones. We excluded *Agoraforum* despite possessing the greatest number of posts, because 99% of its posts are requests for referral links for registration on Agora Marketplace. *Tuxedocrew* is included as it is one of the smallest forums and has existed for around two years. Thus, it is not entirely new and it might provide interesting insights when its content is compared to that of larger forums. Finally, we chose *Bpcsquad* since it is a medium-sized forum. It is remarkable to note that it is the largest one of the very new forums. To sum up, our selection criteria are forum size, founding date, and, to a lesser degree, content. These criteria should ensure a good mix. *Altenen*, *Bpcsquad* and *Tuxedocrew* are mainly or exclusively in English, *Crimenetwork* in German and *Crdpro* half in English, half in Russian.

B. Temporal sampling

In order to have a comparable time-coverage of all five forums, we monitored activity on them over a period of three months, specifically from April to June 2015. This means that a snapshot was made by the end of June and data of the previous three months was collected. This three-month period was determined by the largest forum, *Altenen*.

This limitation to three months meant that no full activity-record could be recorded. Furthermore, it introduced the risk of catching three "special" months instead of a whole year's coverage. However, we argue that the current situation is of interest and not the past, and that three months are still more advantageous than shorter periods. Moreover, the collected data showed that a substantial volume of posts can be captured in three months, especially from the larger forums. Admittedly,