Fraud Profiling

Contents

August 17, 2018

Overview

Fraud/Charge-off Definitions

- **NSF Behavior:** *Non-Sufficient Funds or overdrafts often related to debit pre-authorization or debit hold issues.*
- **Mobile Deposit Chargeback:** *Mobile deposit returned by issuing bank, often leading to overdrawn accounts when customers spend the provisional credits.*
- **External Transfer Chargeback** *Customers spending provisionally credited funds transferred into their account before the funds are returned to the sending bank.*
- **Opening Deposit Chargeback** *Deposit used to open account is returned to issuing bank.*
- **ATM Deposit Chargeback** *Spending provisionally credited funds from an ATM deposit prior to the funds being returned to the issuing bank.*

- **Bank by Mail/In OPerson** *Spending provisional funds from a bank or in person deposit before funds are returned to the issuing institution.*
- **Other** *All charge-off reasons that do not fit in the above categories.*

Note: For the purpose of this document, Opening Deposit Chargeback and Bank by Mail/In Person have been grouped in with Other in Other/Misc due to low cell counts.

Table 1: Overall count and cost of fraud (to date).

count	total_loss	hard_loss	fees
4222	$1,635,016.70	$1,365,837.78	$269,178.93

Table 2: Total counts by charge-off category

chargeoff_reason	count	rate
NSF Behavior	2494	59.07%
Mobile Dep Chargeback	413	9.78%
Ext Tran Chargeback	1207	28.59%
Other/Misc	19	0.45%
ATM Dep Chargeback	89	2.11%

The most common type of charge-off is NSF Behavior, which accounts for 59.07% of all charge-off types.

Fraud Volume

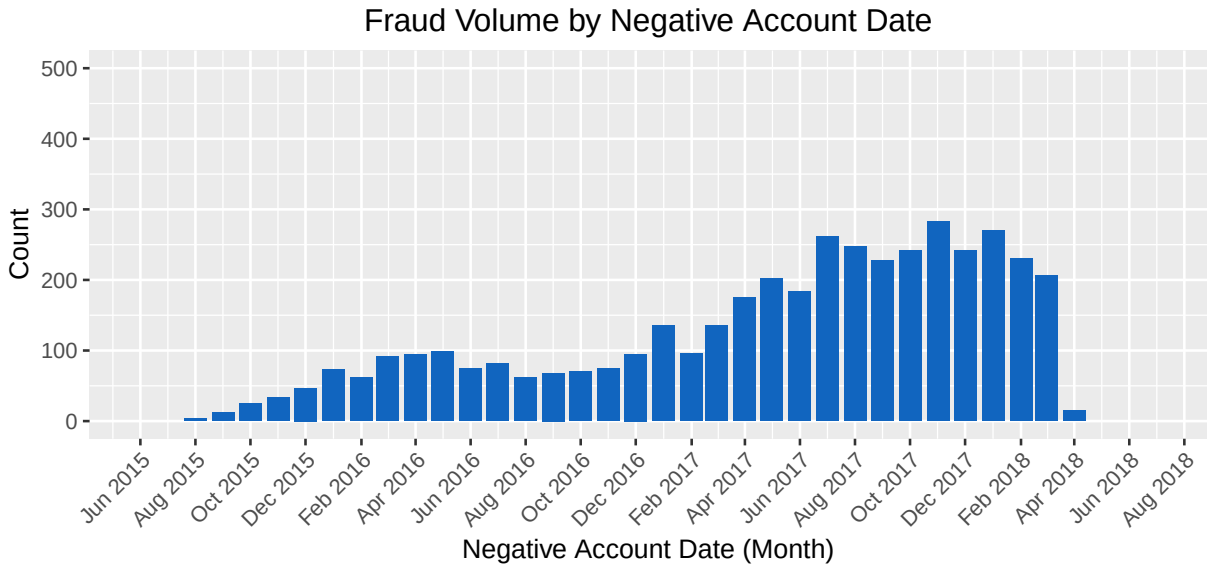
Four different methods of determining monthly fraud trends are presented below. They are calculated by the following:

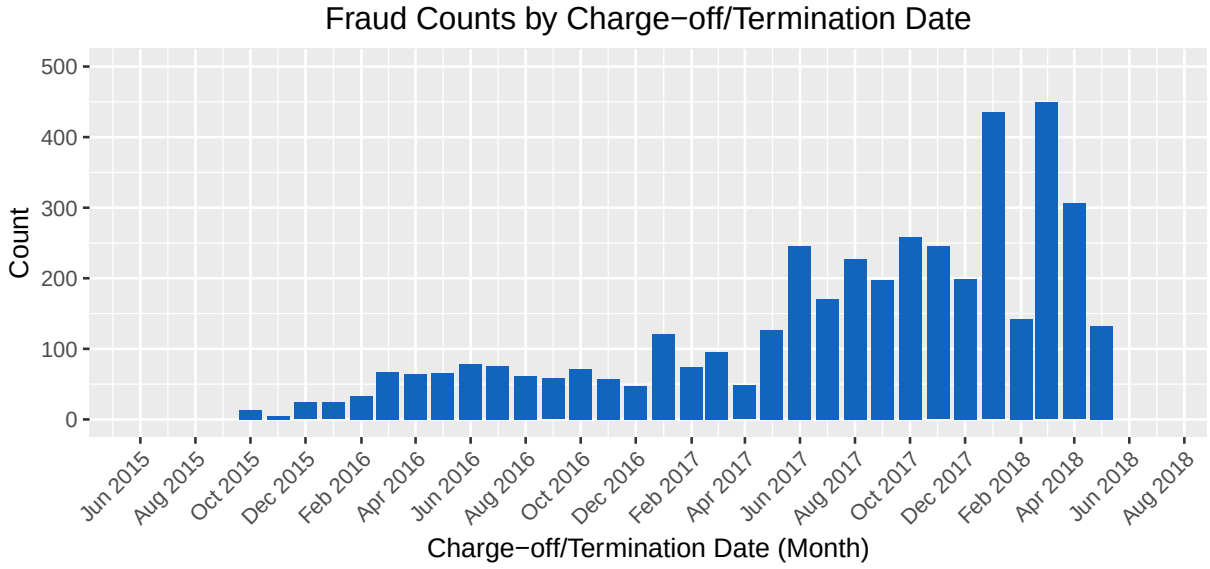
- **Negative Account Date:** The date at which an account becomes negative and stays negative for at least three consecutive days. This is in attempt to determine that date that the fraudulent activity occurred.
- **Charge-off/Termination Date:** The date that an account was charged-off, normally corresponding with an account termination.
- **Inception Date:** The date that the account was created.
- **Fraud Rate:** The proportion of fraudulent accounts over total accounts, calculated by any of the above date definitions.

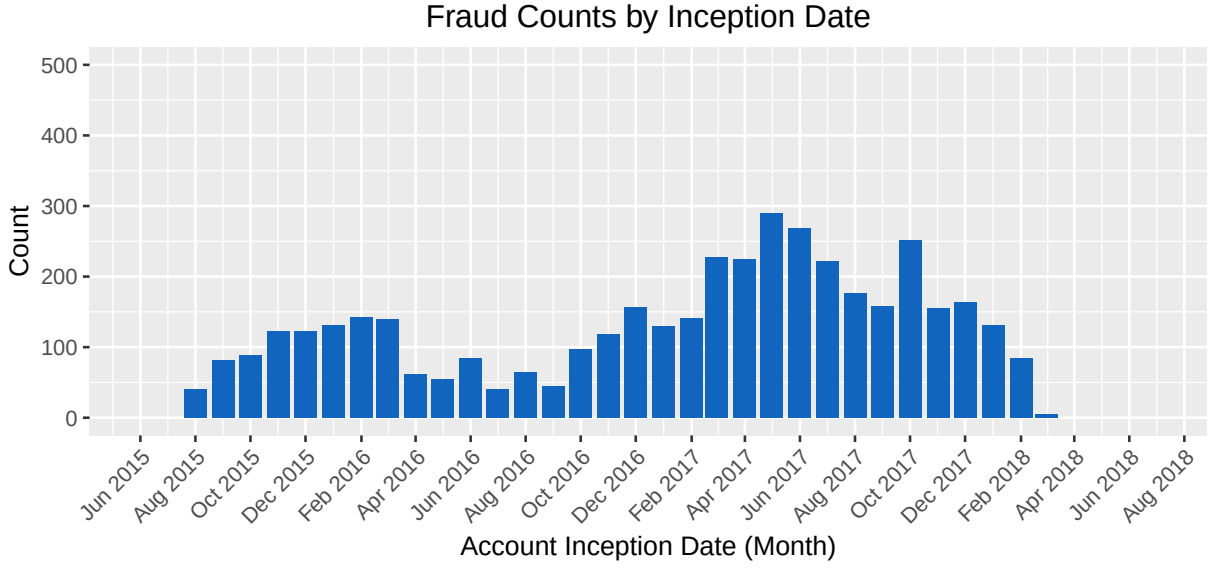
Monthly Counts

The below graphs shows the discrepancy between when an account commits the fraudulent activity versus when the account is actually closed and charged-off, especially noticed by the sporadic spikes in termination date versus negative account date. Previously, much of the account maintenance and fraud mitigation was performed by Radius.

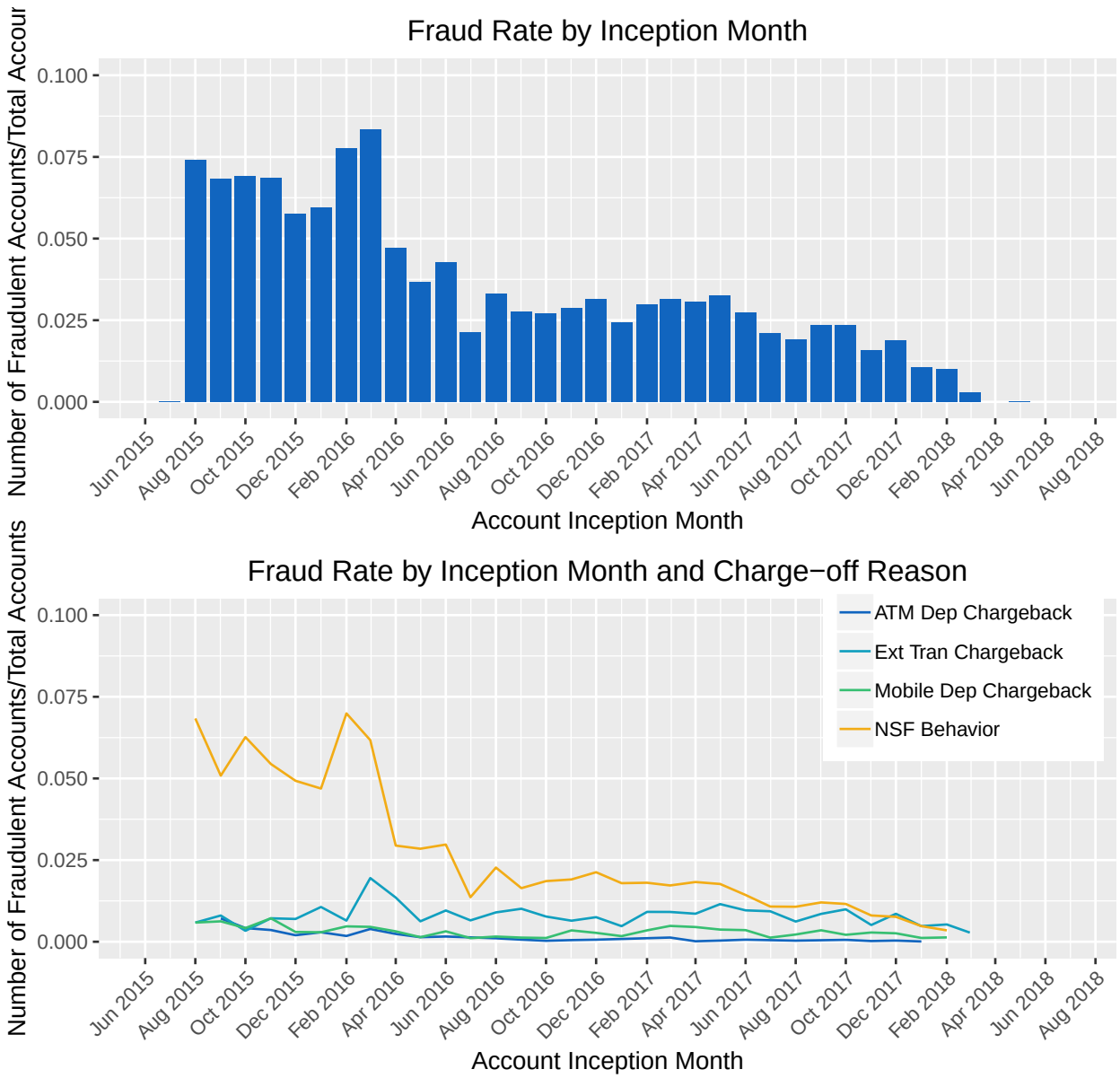
There is a noticeable dip in fraud based on account inception (origination). Further investigation into on-boarding and/or marketing trends may shed further light, however comparing the rate of fraudulent account origination verse total account origination (as in the following graph) indicates that there was actually a more steady decrease in the rate of fraudulent account origination than the previous graph suggests (see figure bellow).


Fraud Volume by Negative Account Date
Count
500
400
300
200
100
0
Jun 2015
Aug 2015
Oct 2015
Dec 2015
Feb 2016
Apr 2016
Jun 2016
Aug 2016
Oct 2016
Dec 2016
Feb 2017
Apr 2017
Jun 2017
Aug 2017
Oct 2017
Dec 2017
Feb 2018
Apr 2018
Jun 2018
Aug 2018
Negative Account Date (Month)


Fraud Counts by Charge−off/Termination Date
Count
500
400
300
200
100
0
Jun 2015
Aug 2015
Oct 2015
Dec 2015
Feb 2016
Apr 2016
Jun 2016
Aug 2016
Oct 2016
Dec 2016
Feb 2017
Apr 2017
Jun 2017
Aug 2017
Oct 2017
Dec 2017
Feb 2018
Apr 2018
Jun 2018
Aug 2018
Charge−off/Termination Date (Month)


Fraud Counts by Inception Date
Count
500
400
300
200
100
0
Jun 2015
Aug 2015
Oct 2015
Dec 2015
Feb 2016
Apr 2016
Jun 2016
Aug 2016
Oct 2016
Dec 2016
Feb 2017
Apr 2017
Jun 2017
Aug 2017
Oct 2017
Dec 2017
Feb 2018
Apr 2018
Jun 2018
Aug 2018
Account Inception Date (Month)

Monthly Fraud Rate



Aside from February and March of 2016, the rate of fraudulent accounts created has been going down when compared to total account origination. However, most (if not all) of the charge-off/fraud data labeling has been heavily relied on by Radius. Spot checking a number of account who went negative and never became positive has indicated that there may be upwards to an additional 30% of accounts that should have been charged-off or labeled as such, but currently have not been. This is likely due to the processes and procedures dictated by Radius.

Cost of Fraud

Monthly Cost

- **Total Loss:** The total amount charge-off amount for an account (hard loss + lost fees).
- **Hard Loss:** The actual amount of money lost from a charge-off (realized loss).
- **Lost Fees:** Fees that Aspiration was owed, but never collected (Deposited Item Reversal Fees, Check Reversal Fees, Over Draft Fees, etc.).

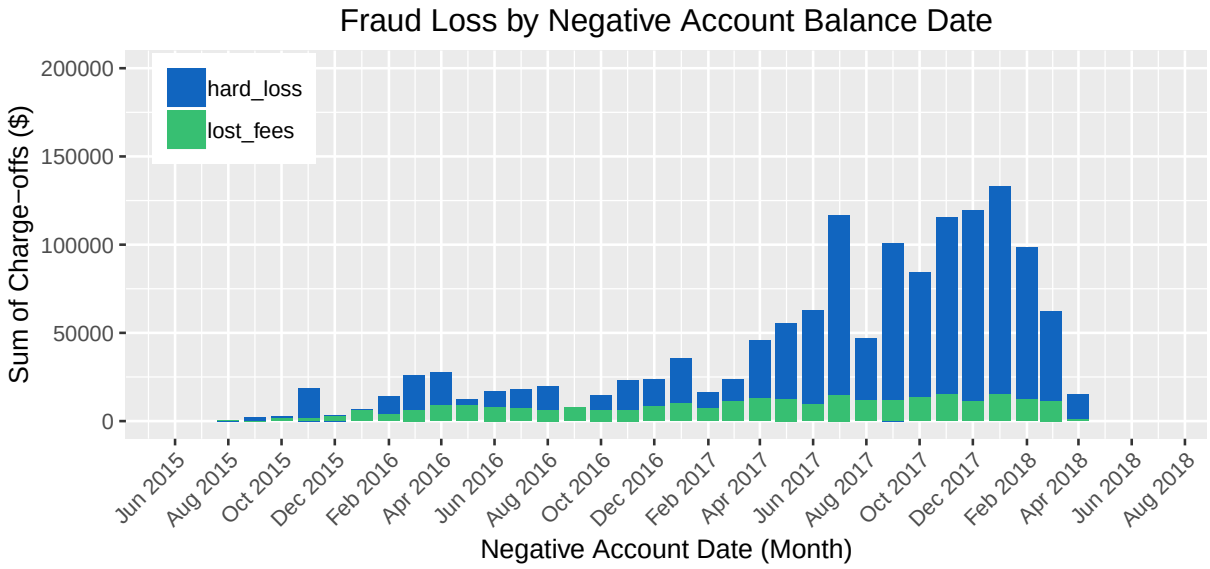
Table 3: Total charged-off losses (fees + hard loss)

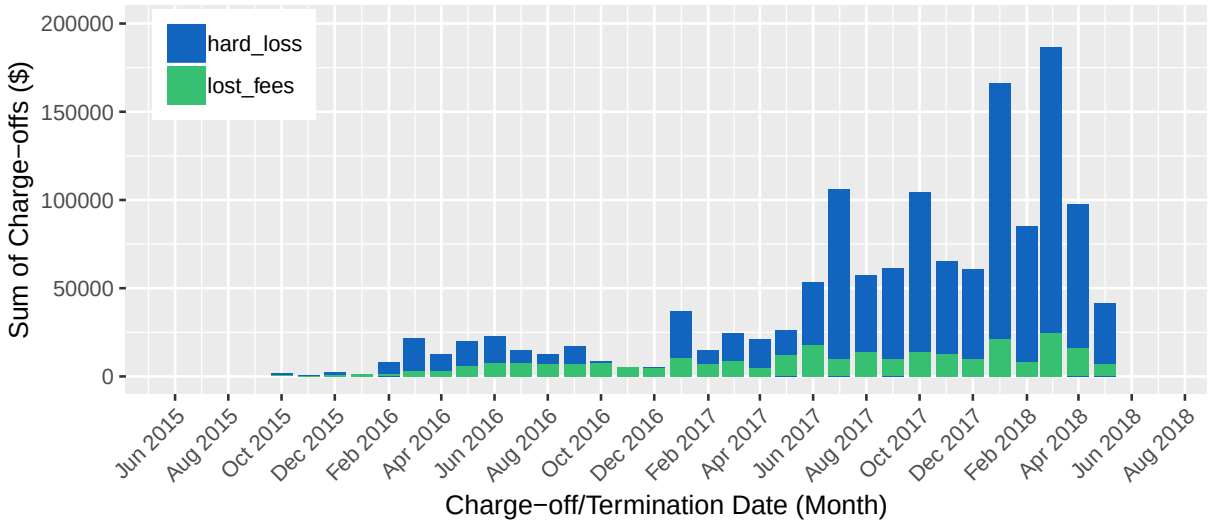
chargeoff_reason	sum	percent	mean	min	q25	q50	q75	max
NSF Behavior	$237,003.91	14.50%	$95.03	$0.01	$15.92	$38.45	$118.99	$8,165.58
Mobile Dep Chargeback	$400,062.11	24.47%	$968.67	$0.07	$193.60	$579.98	$1,329.51	$8,001.67
Ext Tran Chargeback	$848,532.33	51.90%	$703.01	$0.01	$115.02	$216.12	$550.95	$45,765.79
Other/Misc	$27,176.78	1.66%	$1,430.36	$0.03	$106.20	$174.77	$1,627.70	$8,733.81
ATM Dep Chargeback	$122,241.57	7.48%	$1,373.50	$17.04	$313.54	$710.09	$1,343.58	$12,021.23

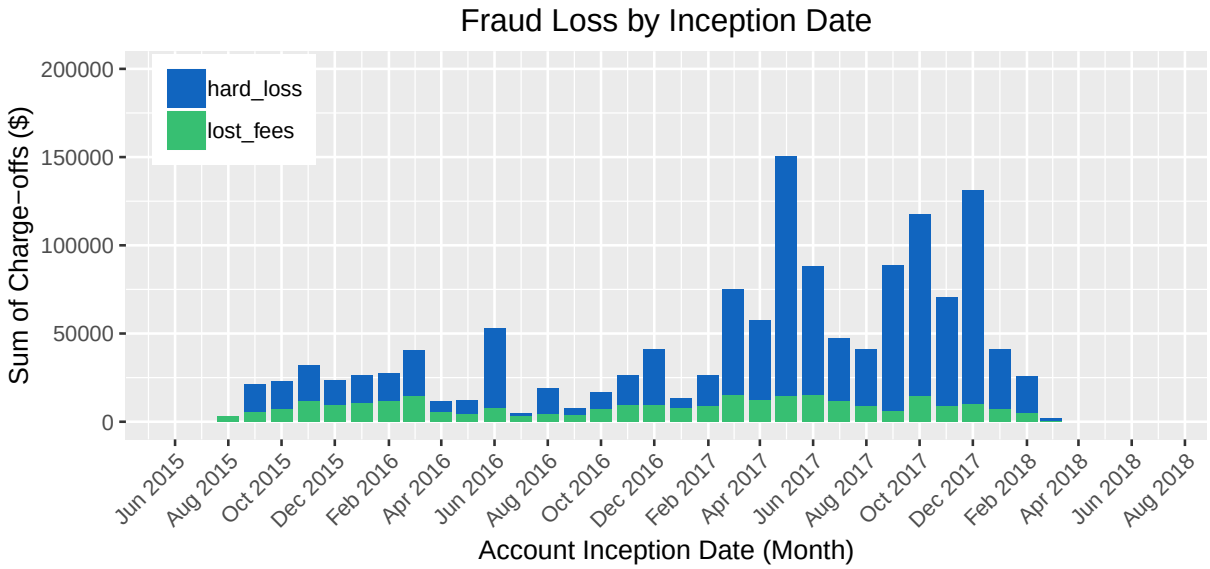
Table 4: Realized charged-off losses (hard loss only)

chargeoff_reason	sum	percent	mean	min	q25	q50	q75	max
NSF Behavior	$110,526.34	8.09%	$44.32	$0.00	$0.85	$15.25	$33.58	$8,075.58
Mobile Dep Chargeback	$366,152.04	26.81%	$886.57	$0.00	$103.47	$481.14	$1,249.51	$7,903.67
Ext Tran Chargeback	$748,748.50	54.82%	$620.34	$0.00	$25.09	$120.06	$465.01	$45,695.79
Other/Misc	$25,940.21	1.90%	$1,365.27	$0.00	$14.49	$146.77	$1,542.70	$8,733.81
ATM Dep Chargeback	$114,470.69	8.38%	$1,286.19	$0.00	$223.54	$620.09	$1,272.10	$11,931.23

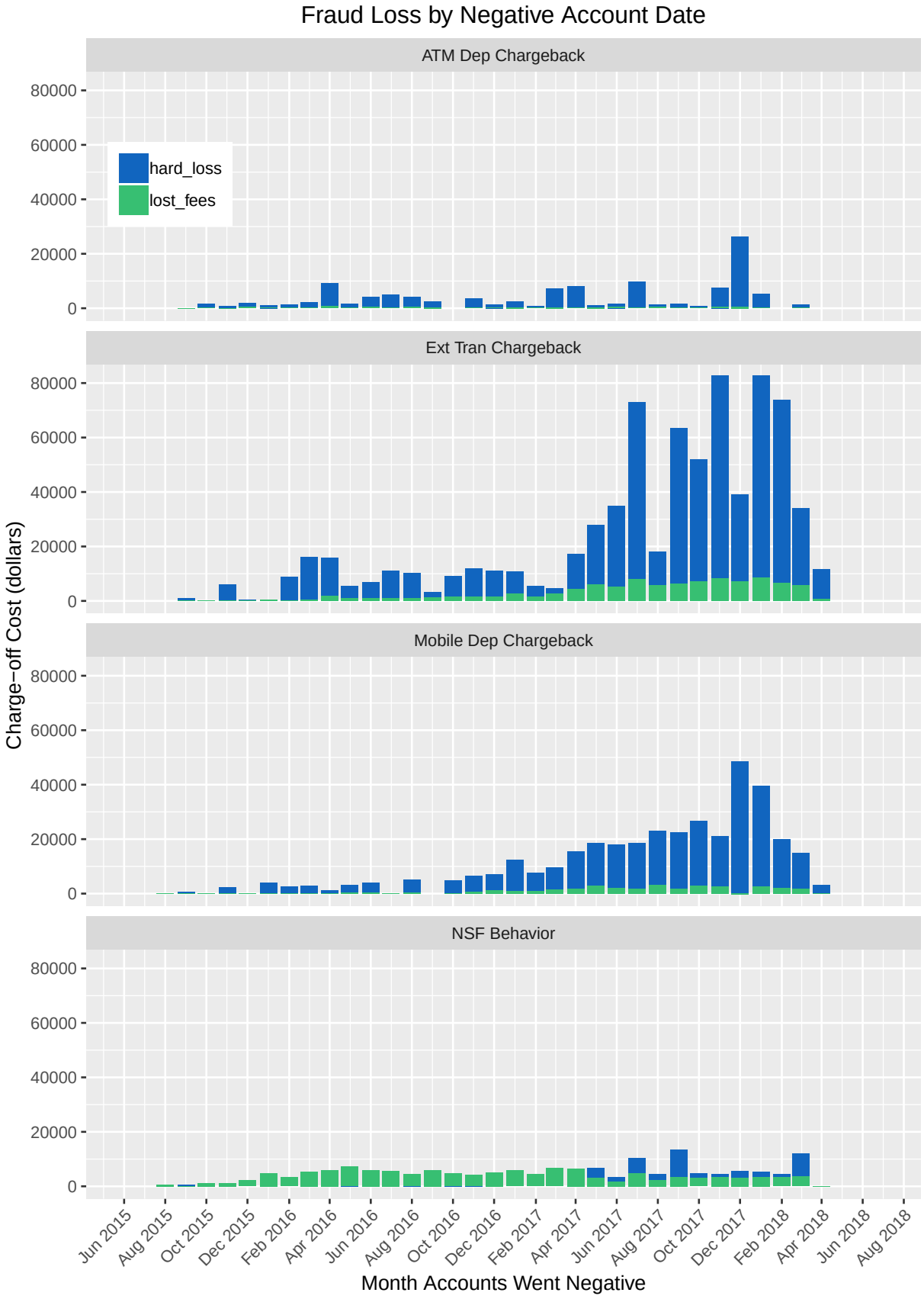
As displayed in the tables above, much of the total losses related to NSF Behavior are not actually realized. While NSF Behavior makes up the majority of volume of charge-offs, it is in fact, one of the least costly, especially when compared to the cost of some of the other charge-off reasons as shown below.


Fraud Loss by Negative Account Balance Date
hard_loss
lost_fees
Sum of Charge−offs ($)
200000
150000
100000
50000
0
Jun 2015
Aug 2015
Oct 2015
Dec 2015
Feb 2016
Apr 2016
Jun 2016
Aug 2016
Oct 2016
Dec 2016
Feb 2017
Apr 2017
Jun 2017
Aug 2017
Oct 2017
Dec 2017
Feb 2018
Apr 2018
Jun 2018
Aug 2018
Negative Account Date (Month)


Fraud Loss by Charge−off Date
hard_loss
lost_fees
Sum of Charge−offs ($)
200000
150000
100000
50000
0
Jun 2015
Aug 2015
Oct 2015
Dec 2015
Feb 2016
Apr 2016
Jun 2016
Aug 2016
Oct 2016
Dec 2016
Feb 2017
Apr 2017
Jun 2017
Aug 2017
Oct 2017
Dec 2017
Feb 2018
Apr 2018
Jun 2018
Aug 2018
Charge−off/Termination Date (Month)


Fraud Loss by Inception Date
hard_loss
lost_fees
Sum of Charge−offs ($)
200000
150000
100000
50000
0
Jun 2015
Aug 2015
Oct 2015
Dec 2015
Feb 2016
Apr 2016
Jun 2016
Aug 2016
Oct 2016
Dec 2016
Feb 2017
Apr 2017
Jun 2017
Aug 2017
Oct 2017
Dec 2017
Feb 2018
Apr 2018
Jun 2018
Aug 2018
Account Inception Date (Month)

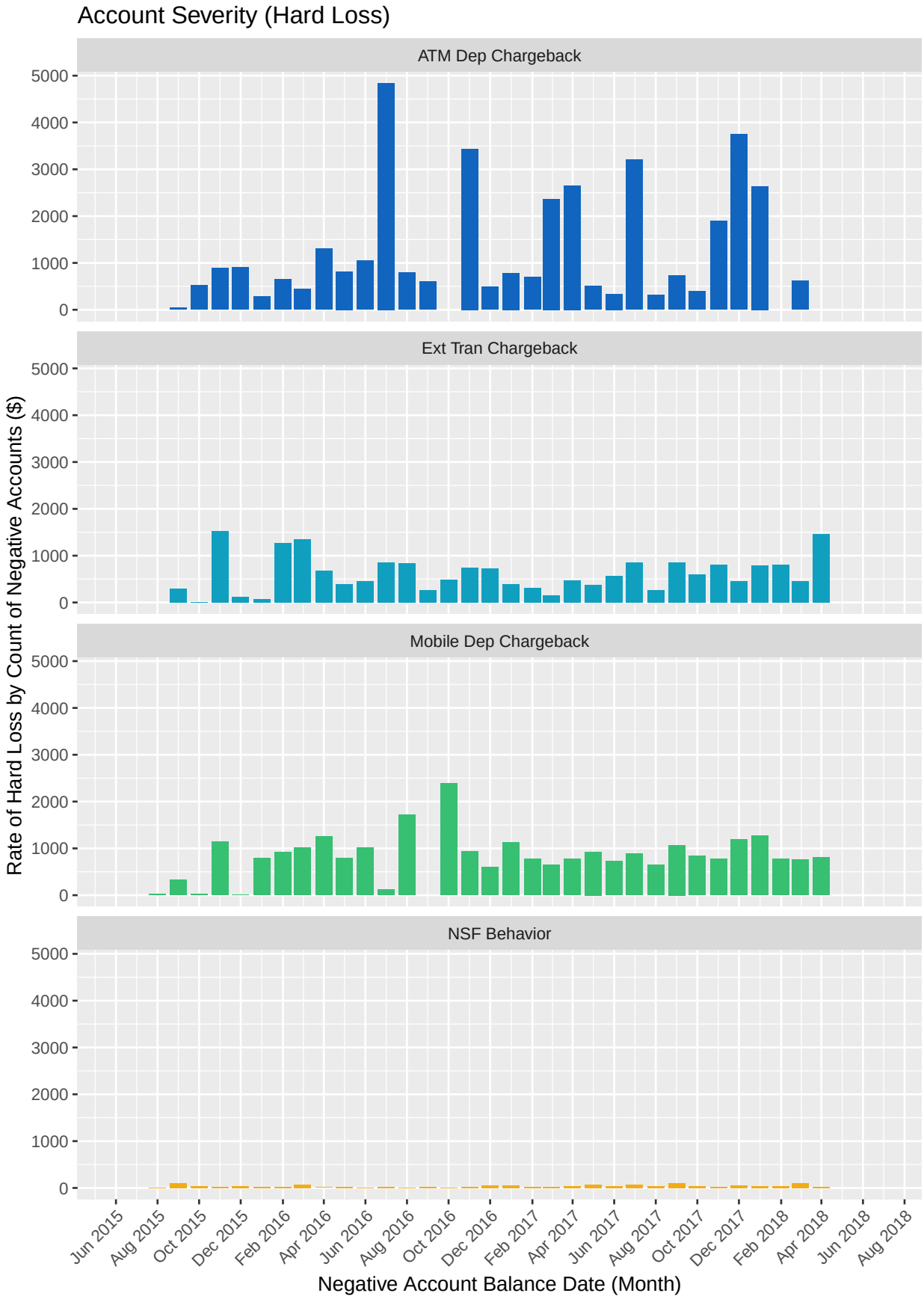
Cost by charge-off type



Note: Bank by Mail / In Person, Opening Dep Chargeback, and Other charge−off reasons remove due to low counts.

Account Severity

Similar to the Fraud Rate, Account Severity refers to rate of hard loss by number of accounts per the given charge-off reason.


Account Severity (Hard Loss)
ATM Dep Chargeback
Ext Tran Chargeback
Mobile Dep Chargeback
NSF Behavior
Rate of Hard Loss by Count of Negative Accounts ($)
0
1000
2000
3000
4000
5000
Jun 2015
Aug 2015
Oct 2015
Dec 2015
Feb 2016
Apr 2016
Jun 2016
Aug 2016
Oct 2016
Dec 2016
Feb 2017
Apr 2017
Jun 2017
Aug 2017
Oct 2017
Dec 2017
Feb 2018
Apr 2018
Jun 2018
Aug 2018
Negative Account Balance Date (Month)

Time Till Fraud/Charge-off Act

Time between account creation and first day an account goes negative and stays negative for at least three days in a row.

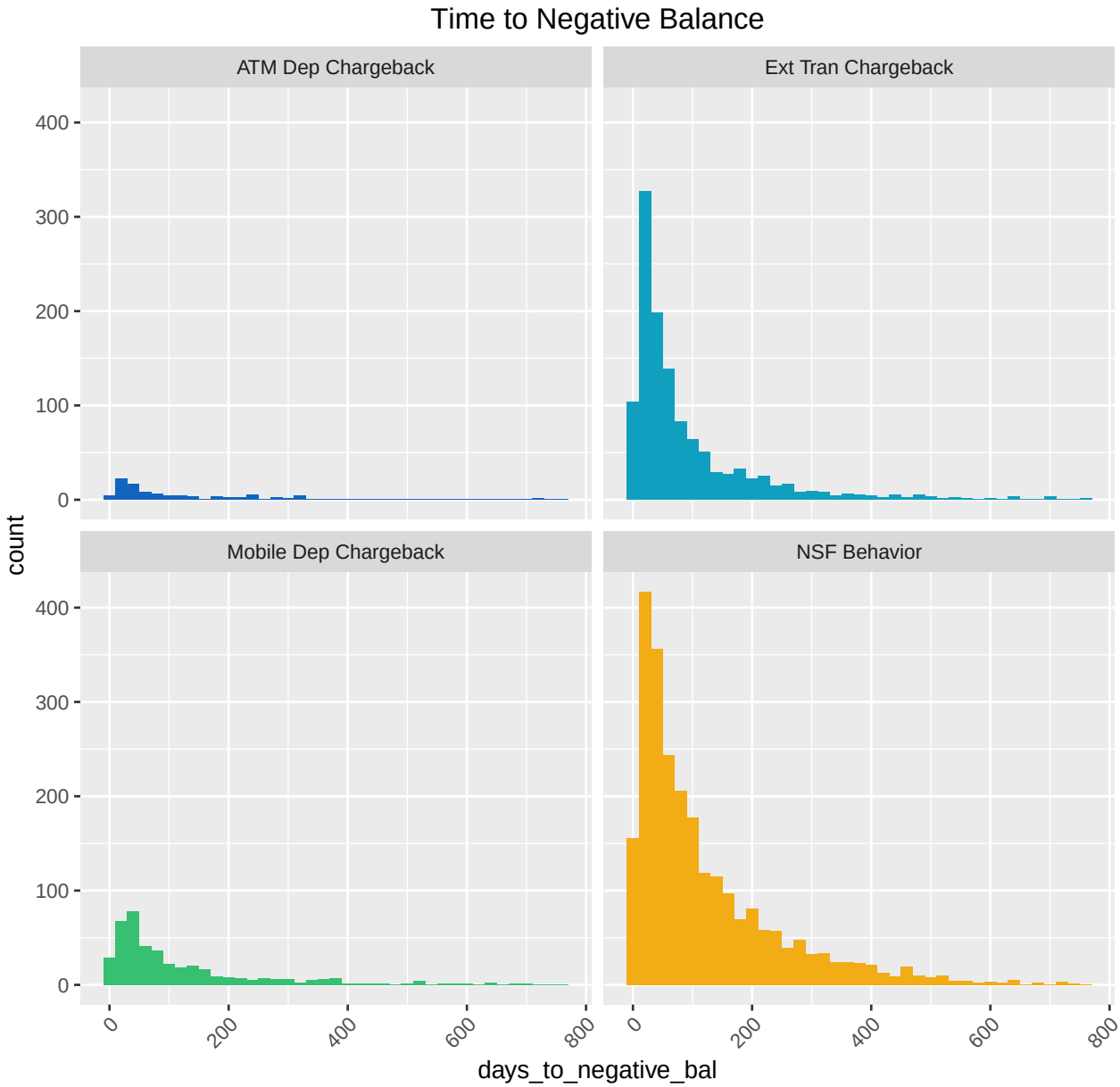
Table 5: Time from account creation to negative balance (Days

chargeoff_reason	mean	min	q25	q50	q75	max
NSF Behavior	120.47	3	32.25	78.00	166.00	731
Mobile Dep Chargeback	113.81	2	33.00	65.00	148.00	700
Ext Tran Chargeback	86.61	2	21.00	47.00	107.00	756
Other/Misc	56.42	0	7.50	38.00	82.50	257
ATM Dep Chargeback	101.06	5	25.75	52.50	140.25	712

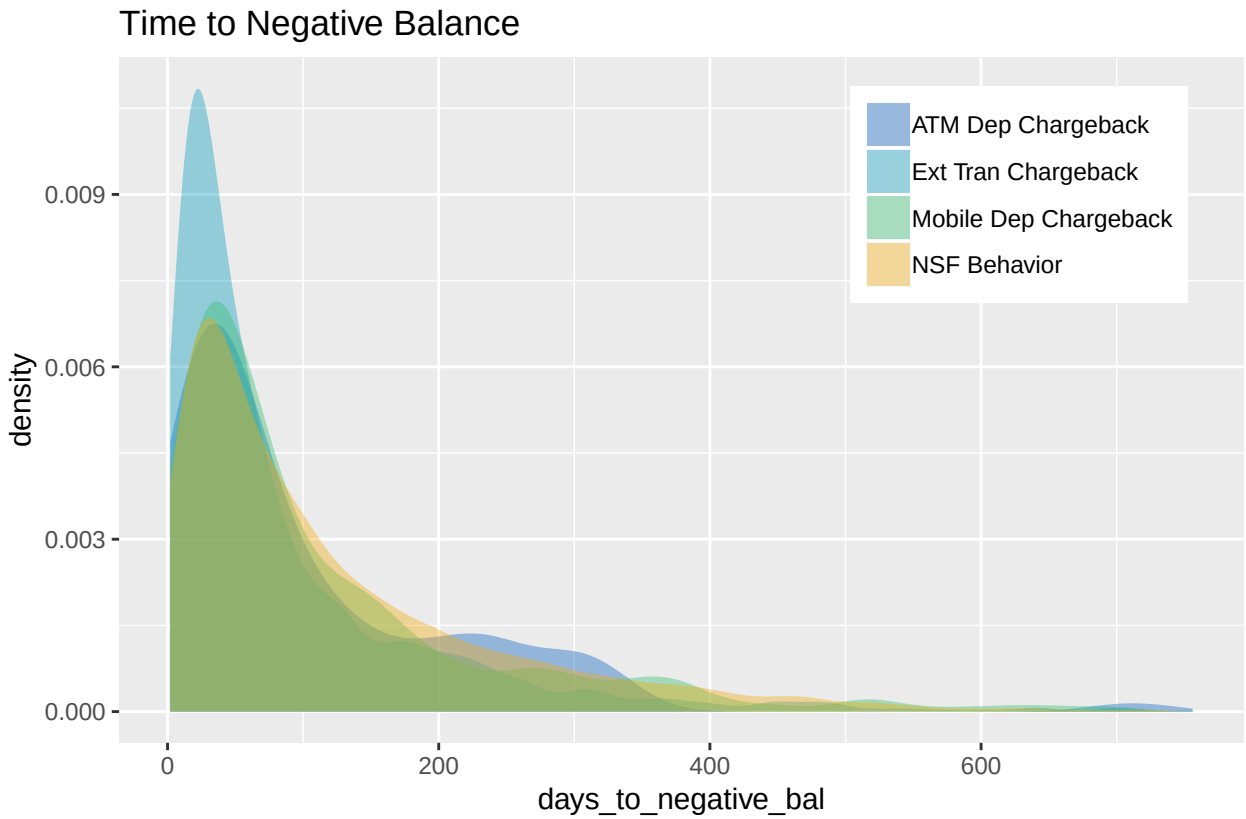
Both External Transfer Chargebacks and NSF Behavior has the larges volume as well as more accounts that have a longer time till committing fraud, though it seems mostly proportional to the other types of chargebacks, mostly differing in volume.

Table 6: Time Till Account Disabled (Mean Days)

chargeoff_reason	days_to_disabled	days_to_termination
Ext Tran Chargeback	29.22	157.83
NSF Behavior	73.39	219.43
Mobile Dep Chargeback	54.94	187.33
ATM Dep Chargeback	70.95	256.26
Other/Misc	5.90	100.70



Note: Bank by Mail / In Person, Opening Dep Chargeback, and Other charge−off reasons remove due to low counts.



Note: Bank by Mail / In Person, Opening Dep Chargeback, and Other charge−off reasons remove due to low counts.

Marketing Channels and Fraud

Table 7: Maketing channel group by customer vs fraud/charge-off

	Affiliates	Organic	PaidMedia	Unattributed
customer	74362 (48.64%)	353 (0.23%)	24619 (16.1%)	53542 (35.02%)
fraud/charge-off	1340 (31.75%)	9 (0.21%)	1421 (33.67%)	1451 (34.38%)

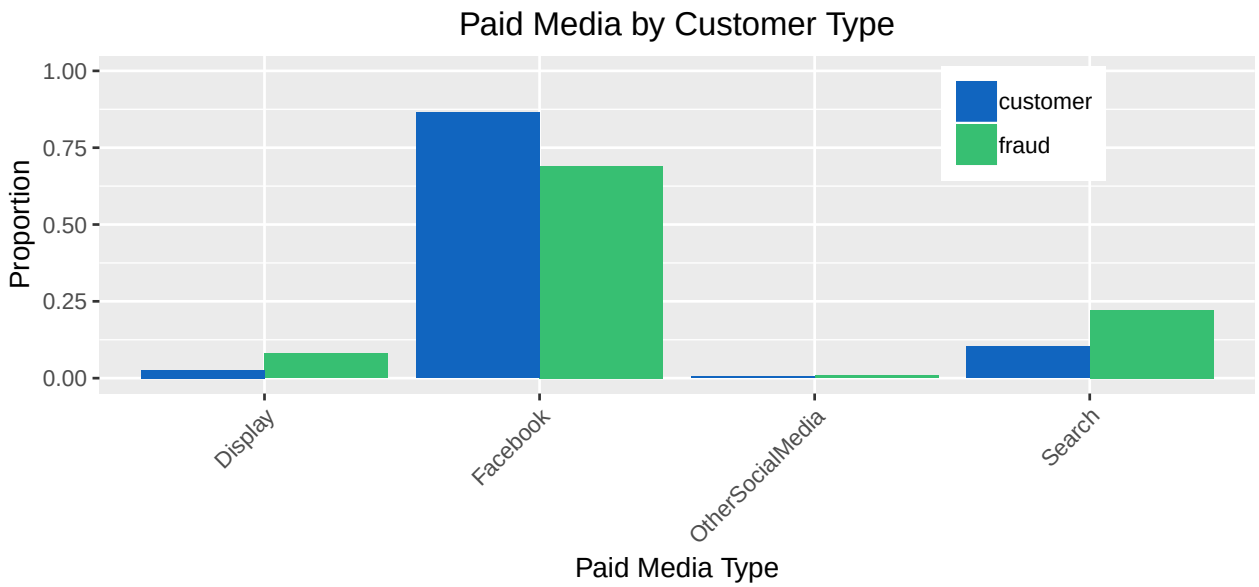
Table 8: Marketing channel group by charged-off reason

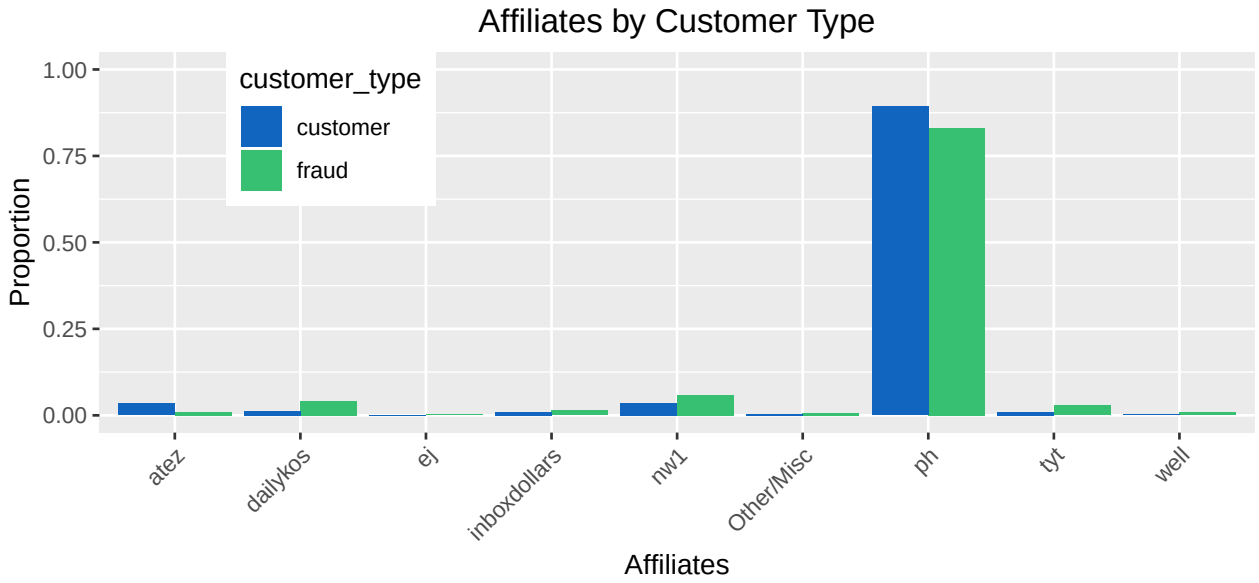
	Affiliates	Organic	PaidMedia	Unattributed
ATM Dep Chargeback	13 (14.61%)	1 (1.12%)	46 (51.69%)	29 (32.58%)
Ext Tran Chargeback	420 (34.8%)	2 (0.17%)	313 (25.93%)	472 (39.11%)
Mobile Dep Chargeback	110 (26.63%)	0 (0%)	143 (34.62%)	160 (38.74%)
NSF Behavior	797 (31.97%)	6 (0.24%)	908 (36.42%)	782 (31.37%)
Other/Misc	0 (0%)	0 (0%)	11 (57.89%)	8 (42.11%)

Both Paid Media and Affiliates seem to have a higher rate among fraudulent and charged-off accounts.

Paid Media

The proportion of Search results is higher among fraudulent/charged-off accounts, which could be a result of users seeking out institutions like Aspiration for more malicious behaviors.


Paid Media by Customer Type
1.00
0.75
0.50
0.25
0.00
Proportion
customer
fraud
Display
Facebook
OtherSocialMedia
Search
Paid Media Type


Affiliates by Customer Type
1.00
0.75
0.50
0.25
0.00
Proportion
customer_type
customer
fraud
atez
dailykos
ej
inboxdollars
nw1
Other/Misc
ph
tyt
well
Affiliates

Negative Account Balance Data by Fraud/Risk Group

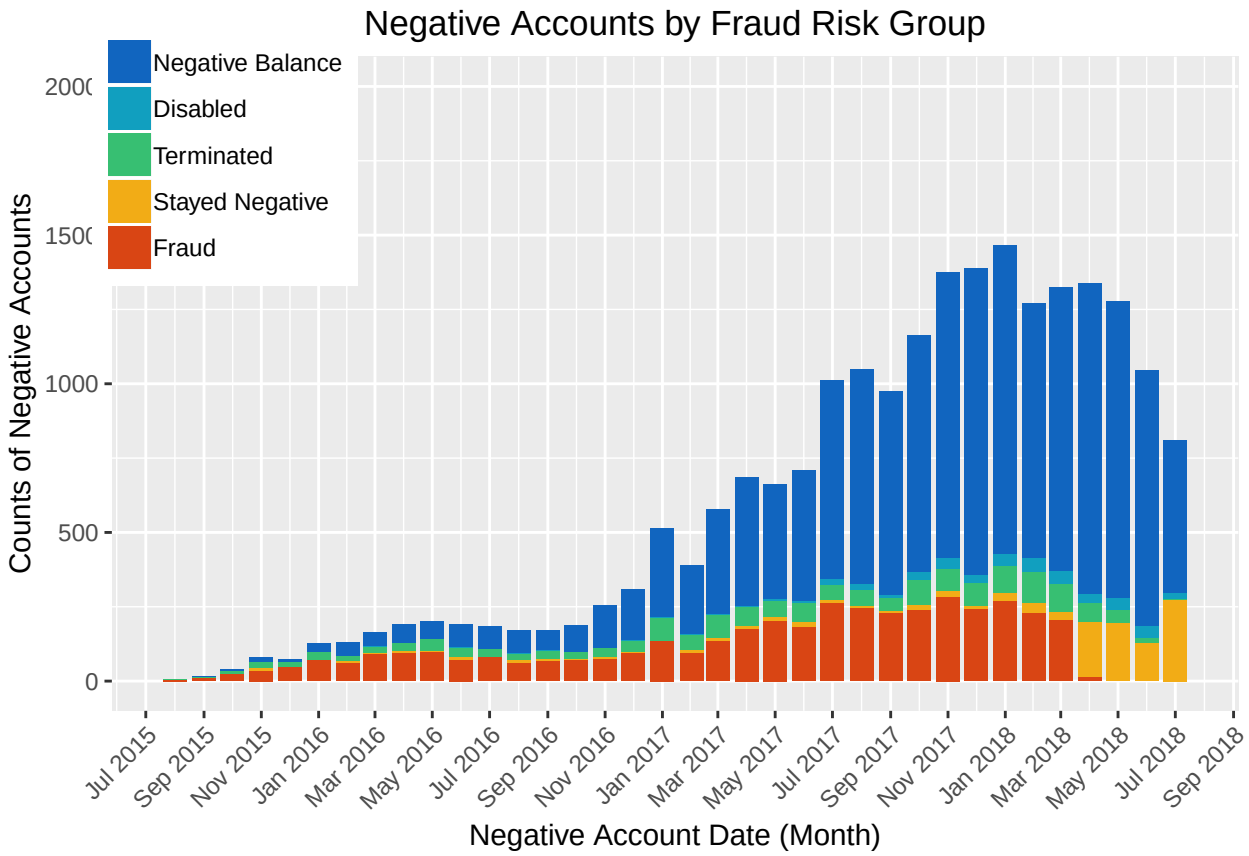


Table 9: Account Usage

customer_type	avg_deposits	median_deposits	avg_withdrawals	median_withdrawals
Customer	13.46	9.00	11.85	4.00
Fraud	6.92	4.00	4.33	1.00

Time to Account Termination/Disabling

The average time between an account going negative and any feature being disable ranges from 30 to 74 days. While radius has a standard of charging off accounts after 30 days of being over drafted, the data shows that they have not always stuck to their deadline, even when it comes to disabling features.

Comparing deposite counts and withdrawals between customers and fraudsters among users who first went negative after 200 days, those who stayed negative, and those who did not.

Table 10: Account activity during first 200 days among accounts that went negative after 200 days

customer_type	avg_deposits	median_deposits	avg_withdrawals	median_withdrawals
Customer	13.46	9.00	11.85	4.00
Fraud	6.92	4.00	4.33	1.00

Table 11: Top 10 States

state	N	Customer	Fraud
California	25213	97.43%	2.57%
Texas	12222	96.73%	3.27%
New York	11367	98.16%	1.84%
Florida	10919	97.05%	2.95%
Illinois	6040	97.37%	2.63%
Pennsylvania	5457	97.07%	2.93%
Georgia	5318	96.39%	3.61%
New Jersey	4848	98.12%	1.88%
Washington	4281	97.29%	2.71%
Ohio	4278	97.29%	2.71%

Table 12: Top 10 Email Domains

email_domain	N	Customer	Fraud
gmail.com	103808	97.47%	2.53%
yahoo.com	19190	96.69%	3.31%
hotmail.com	7176	97.94%	2.06%
aol.com	3072	96.94%	3.06%
outlook.com	2540	94.84%	5.16%
icloud.com	2214	94.76%	5.24%
me.com	1782	96.97%	3.03%
live.com	1772	96.16%	3.84%
comcast.net	1032	98.55%	1.45%
msn.com	949	97.05%	2.95%

Example of a user who continued to commit fraud after going negative the first time

User with email `pbou11@yahoo.com`, overdrafted their account by around $3K due to ACH returns, refunded the account via multiple additional ACH transfer, withdrew the money and had the ACH's all return again, resulting in a chargeoff of over $8K before their account was disabled.

Recomentations

Addressing Fraud

External Transaction Chargebacks make up the majority of realized money loss and should be addressed first in reducing overall fraud loss, while NSF Behavior has the largest volume of charge-offs, the amount of realized loss is one of the smallest costs.

Currently, the loss from External Transaction Chargebacks is due to provisionally crediting an account before the funds transfer which will end after migration. While this will prevent most of the money lost from External Transaction Chargebacks, it will have a negative impact on customer experience. This could be mitigated by partnering with Plaid ID and provisionally credit accounts that verify both ownership and account balance of the linked account.

Steps

1. Partner with Data Team to create reports to assess potential fraud/high-risk activity for Banking Operations to review daily (i.e., pull list of high volumne ACH transfers, users who have a high number of ACH or check returns, . . .).

Table 13: Top 8 Web Browsers (note: there are only 8 in database

browser_name	N	Customer	Fraud
Unknown	114924	96.76%	3.24%
Chrome	31738	98.75%	1.25%
Firefox	4093	99.05%	0.95%
Safari	3545	99.41%	0.59%
IE	1381	98.70%	1.30%
Edge	1198	98.58%	1.42%
Opera	271	98.52%	1.48%
Chromium	31	100.00%	NA%

Table 14: Top 5 states between fraud and non-fraud

is_charged_off	state	N
FALSE	California	24564
FALSE	Florida	10597
FALSE	Illinois	5881
FALSE	Michigan	3590
FALSE	Massachusetts	3489
TRUE	Florida	322
TRUE	New York	209
TRUE	Pennsylvania	160
TRUE	Maryland	100
TRUE	Indiana	58

2. Verify account ownership when linking new accounts (Plaid) and request documentation if user does not appear to own the account they are attempting to link.
3. Verify account balance of linked Plaid accounts at time of tranfser.
4. Use history non-Aspiration Plaid banking data to identify potential high-risk fraudsters for manual review.

Data Quality

Thus far, much, if not all, of the fraud reporting and labeling has been dictated by Radius. Numerous accounts have been found that display fraudulent behaviors, but have not been reported as fraudulent by Radius or have been mislabeled (i.e., NSF Behavior when in fact account is displaying External Transaction Charge backs). Review of such accounts as well as the continued work by the Banking Operations department to take control over the process and procedures around mitigation of risk and fraud (including labeling) will improve the ability to monitor and model fraud.

Banking Operations has begun to label fradulent accounts with the following tags in Zendesk:

- Suspected ID theft
- Confirmed ID theft
- New account fraud
- ACH fraud
- Check fraud
- Card fraud
- Reg E fraud
- Wire fraud
- Fraud loss
- ATO
- Compromised account
- Scam
- Account abuse

- Tax fraud
- Elder abuse

Steps

1. Continue with the new fraud labeling in Zendesk, but explore ways to implement labeling in the database to better detect and report fraud.
2. Create definitions/rules around fraud labeling that can be implemented in the database for reporting and early detection (i.e., behaviors such as depositing a check and spending the money prior to the check being returned counld be tracked in the database with improvements in the data).
3. Create rules/patterns for identifying the above labels that can be applied to historic data and labeled as '[fill in label] - Warning' (i.e., ACH Fraud - Warning, ATO - Warning).
4. Record check numbers from deposited and returned checks in order to link them up for modeling purposes.

Account Lock and Termination

The average time between an account going negative and any feature being disable ranges from 30 to 74 days. While radius has a standard of charging off accounts after 30 days of being over drafted, the data shows that they have not always stuck to their deadline, even when it comes to disabling features.

Steps

1. Automatatically shut down accounts after they have been in overdraft for more than 30 days.
2. Lock and request docs from users who's initial funding deposit is returned.
3. Automatically lock accounts after three or more ACH returns, check returns, or ATM chargebacks have drawn the account negative.

TO DO

- ~~**Compare counts of fraud vs total accounts to see if rate of fraud is increasing or not**~~
- ~~**Charge-off per account incepted**~~
- ~~**Cost by chargeoff reason in a stacked bar - fees vs hard loss by fraud loss type (facet_wrap?)**~~
- ~~**Remove low counts from graphs and add footnote of their removal**~~
- ~~**Switch from histograms to density plots**~~
- ~~**Ignore ignore from marketing tables**~~
- ~~**Look at utm channel type to see what is causing the increase in PaidMedia**~~
- ~~**Add monthly counts of attempted date (aka, negative balance).**~~
- ~~**Break down fraud ratio by chrageoff type**: This turns out to be harder said than done, but working on it~~
- ~~**Look at chargeoff types that have min of $0**~~ This is due mostly to fees charged for OD accounts. Should we include in report?
- ~~**Remove low count of charge off groups**~~
- ~~**Update fraud count graphs to be on same x and y axis**~~

- ~~**Next steps section to include difference between negative account date and charge off date as somethi**~~
- ~~**Look at percentage of accounts that went negative but werent charged off as a comparision/validation**~~ ~~- In process, confirming new data~~ - Figure on page 20 shows much larger amount of negative accounts that were not charged off. Would it be worth while looking at actual transaction patterns for fraud? i.e., accounts that deposited a check and then spent the money or withdrew it from an ATM and then had the check return?
- ~~**Show graph of % of fraud inception**~~
- **If I were to make a recommendation what would it be? Filter all the charts like that**
- ~~**Collapse into 5 grouops, call it other/Misc**~~
- ~~**trend of fraud by inception month/overall fraud by, what is industry**~~ Industry has been reported as ~10%, though some FinTechs have been reportedly closer to 35%. Current Aspiration rates seem very low, perhaps due to not actively on-boarding? Or failure to correctly label all fraud due to Radius?
- ~~**2 fraud rates: fraud by counts and fraud by dollars**~~
- ~~**Note about no way to distinguish 1st vs 3 vs synthestic fraud**~~
- ~~**Account severity: loss of 18K in External transfer and it was 10 people to see if it really increasing or**~~
- ~~**Add graph of counts by inception date**~~
- ~~**call out data mislabeling**~~
- ~~**Look at affiliate fraud for marketing like done for paid media**~~
- ~~**Move script and all coding to the end for an appendix**~~

Follow ups from Andrei

- ~~**Ask Stephen or Valarie if we pay for all of the farud losses (including NPS)**~~ Going forward, we wil pay for all losses starting from July. Prior, we only paid for ACH loss initiated through our website.
- ~~**Distribution of accounts by states (counts of accounts vs fraud)**~~ Shows top 5 states by chargedoff vs not
- ~~**Profiling fraud vs non with account origination data**~~
- ~~**Break down also by browser (chrome, etc)**: Data seems to be in `web_db.user_browser_fingerprint` table, but doesn't list actual browser names, just coded variables. Waiting for hear back on what the dummy labels correspond to.~~
- **Look at edge cases, give some qualitative insight**
- ~~**Why do some people wait so long? After 200 days - compare customers who regularly engage account**~~
- **Bring back more purposals of processes we are trying to change** (before meeting with Ops team)
- ~~**Bring back examples of people committing fraud between being going nedagive and being diabled**~~ ~~Added 1 user, but need to figure out way to quantify it (need to link up users who went negative, and had an additional return of some kind, how to do this since Radius does not give timestamps back with transactino data, i.e., not sure of the actual order of transactions)~~
- ~~**Purpose hard cuttoff for disabling accounts (example if they go negative once, we forgive, but twice w**~~ ~~- dependent on the above~~

- ~~**Why is ATM Severity higher the highest severity**~~ May be easier to do dual check presentment since mobile deposit forces you to write "For Mobile Deposit Only" on it

Follow ups from Ravi

- ~~**what are you trying to say re: table 11 (sleeper accoutns). Compare fraud after 200 days to non-dfrau**~~ - 39% of customers had no activity for first 200 days compared to 16% of fraudsters who had no activity. If looking at low activity (3 or less deposits or withdrawals) it was 65% vs 35%
- ~~**ask brandon or someone who is unknown browser**~~ - waiting to hear back from Brandon. Anthony thinks something might not be getting parsed right.
- ~~**Add comment about timestamps and transaction data about not being real time and how it could help**~~
- ~~**look at by percentage of fraud, same for browser, same for states, email domain**~~