Cryptocurrency Exchange Closure Revisited (Again)

Arghya Mukherjee
Tandy School of Computer Science
The University of Tulsa
Tulsa, USA
arghya-mukherjee@utulsa.edu

Tyler Moore
School of Cyber Studies
The University of Tulsa
Tulsa, USA
tyler-moore@utulsa.edu

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***Abstract*—Exchanges serve an essential role in the cryptocurrency ecosystem. It is through exchanges that most people acquire Bitcoin and other cryptocurrencies, often avoiding the blockchain entirely. Because so many customers put their trust and financial resources in exchanges, it is no surprise that they have long been targets of cybercriminal actors. This paper examines 822 cryptocurrency exchanges operational from 2010–2022. We find that 40% of these exchanges subsequently shut down. Using regression and survival analysis, we investigate the factors that could precipitate the closure of exchanges. Consistent with prior work, we find some evidence that experiencing security breaches are associated with closure. However, we find that the strongest effects are connected to how the exchange operates. Exchanges that only trade cryptocurrencies and not fiat face approximately 60% greater odds of shutting down than those that trade both. Trading more coins is negatively associated with failure. Meanwhile, exchanges that permit US customers shut down more quickly, which suggests that the regulatory environment may affect exchange lifetimes.**

***Index Terms*—cryptocurrencies, cybercrime, exchanges, security economics**

I. Introduction and Background

Despite promises of decentralization, cryptocurrencies have long relied upon intermediaries to operate. The most important such intermediary is the cryptocurrency exchange. For most people, exchanges offer the only feasible way to acquire cryptocurrencies. Transactions clear much faster on exchanges than on blockchains, which in turn explains why most trading involving cryptocurrencies happen there rather than directly on blockchains. The services they provide have evolved rapidly as well. Initially, their primary function was to match buyers and sellers of bitcoin. They soon provided integrated services resembling the functions of a bank. They regularly serve as custodian of cryptocurrency assets on behalf of clients. Some offer collateral-backed loans and leveraged trading accounts.

Despite (or perhaps because of) their importance, cryptocurrency exchanges been subjected to attacks and sudden shutdowns for years. Moore and Christin found that 45% of Bitcoin exchanges established before 2013 shut down [1]. More popular exchanges were more likely to be breached, but the primary predictor of an early demise was a low transaction volume. In a follow-up study through 2015, Moore, Christin and Szurdi found consistent results, namely that around half of Bitcoin exchanges subsequently close and that trading volume is associated with longer lifetimes. Additionally, they demonstrated that exchanges that experienced a breach were much more likely to close immediately thereafter.

In this paper, we again study questions around exchange closure. Why revisit the topic? There has been an explosion of innovation and attention paid to cryptocurrencies since 2015. These earlier works focused on Bitcoin exchanges, but today there are many thousands of coins and tokens traded at exchanges. The financial products on offer have expanded too, from stable-coins to derivatives to leveraged trading. Regulators are paying closer attention too, with some exchanges only trading between cryptocurrencies or serving only certain jurisdictions to avoid closer oversight. Finally, decentralized exchanges are now competing for market share with the more traditional centralized platforms.

Just as exchanges have exploded in growth, so too have the attacks and scams involving them. Insider trading at Mt. Gox artificially inflated the price of Bitcoin prior to its collapse [2]. "Exit scams" in which operators suddenly disappear without explanation occur regularly [3]. One journalist tallied 75 exchange closures in 2020 alone [4]. Charoenwong and Bernardi identified public reports of crypto hacks and scams totaling $7 billion USD from 30 events from 2010 to 2020 [5].

Against that backdrop, this paper empirically examines the attributes of exchanges that are associated with their closure. Compared to prior work, we investigate a much larger population of exchanges (822 total) operating in a much more complex environment in terms of financial products offered, regulatory oversight and customer participation. Our results confirm prior findings while shedding new light on how these new attributes affect exchange closure.

Section II explains our data collection methodology and summary statistics regarding the dataset compiled for analysis. Section III presents the analysis on the exchange used to measure lifespan in regards to the attributes provided by each exchange using survival analysis to determine exchange lifespan as well logistic regression to measure certain attributes are correlated with eventual exchange closure.

II. Methodology

We now discuss how our data was compiled for subsequent analysis. First, in Section II-A we compare three data aggregators as prospective sources of exchanges. Second, in Section II-B we discuss how we measured when exchanges

TABLE I
DATA SOURCES FOR EXCHANGE START DATE

Launch Date Source	Alive		Dead
Coinmarketcap	296	(60%)	196
Domain registration	14	(37%)	23
Manual	2	(50%)	2
Left Censored	169	(62%)	101

were started and shut down. Third, in Section II-C we report on how relevant exchange attributes are compiled.

A. Identifying Cryptocurrency Exchanges

We identified sources that independently report on cryptocurrency exchanges and features/attributes provided by them. We investigated three sources in greater detail: cryptowisser.com, coinmarketcap.com, and coingecko.com.

Cryptowisser tracks both active and inactive exchanges, along with several attributes, such as fees and geographic location. For inactive exchanges, it lists a "cause of death" in a free-form text description, as well as when the closure happened.

Coin Gecko reports many additional features of exchanges beyond what Cryptowisser tracks. Finally, we used CoinMarketCap to identify the start of trading for exchanges. We describe these attributes in greater detail below.

For now, we compare the coverage of exchanges across these sources. We compiled a list of all reported exchanges through the end of 2022. Coin Gecko tracks the smallest number of exchanges (610), compared to 822 at Cryptowisser and 1,768 at CoinMarketCap. Figure 1 reports overlap among sources. 180 exchanges appear in all 3 sources, while 311 appear only at Cryptowisser and 1,082 appear only at CoinMarketCap.

There are several possible explanations for the gaps in coverage. First, note that there is no centralized registry of cryptocurrency exchanges, like there is for traditional financial institutions. Exchanges are distributed across the globe, and often close shortly after opening. No single source can identify all exchanges before some inevitably close. Additionally, these tracking services have operated for different amounts of time. CoinMarketCap was established in 2013, while Cryptowisser did not start until December 2016.

B. Identifying Exchange Creation and Closure Times

We relied on Cryptowisser's reporting of whether an exchange has closed to determine when and if it is closed. Establishing when an exchange was created is a bit trickier, as it is not directly tracked by Cryptowisser. In order to conduct survival analysis, we need to identify exchange launch dates. To do so, we queried CoinMarketCap's web API that publishes the first trading dates of exchanges and got 100% coverage on the data.

However, this missed all 330 exchanges tracked by Cryptowisser but not on CoinMarketCap. To close this gap, we gathered the date of an exchange's domain registration in order

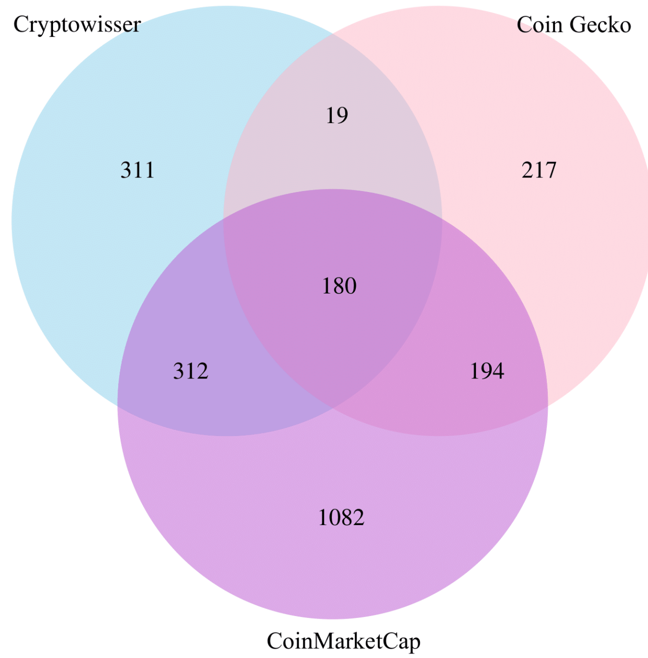

Fig. 1. Venn diagram showing overlap between exchanges across data sources.

to estimate launch dates. We collected domain registration data, using the whoxy.com historical WHOIS API, successfully obtaining domain registration dates for 228 exchanges, 37 of which are included in the Cryptowisser data. In particular, we identified the most recent point in time that the domain name changed registrars or was initially registered, whichever happened later. The rationale is that some domains had been used for other purposes before the exchange was established. Finally, four more exchange dates were manually identified through web investigations.

This leaves 270 exchanges for which we have only an end date but no reliable start date. We still incorporate these exchanges into the survival analysis by censoring the starting date for the exchange. In this case, we set the exchange start date as December 2016, right after Cryptowisser launched. This date is left-censored because we could not determine the true starting date. In the end we left out 82 exchanges from survival analysis where we did not have confidence in the exchange start date reported by the data sources as the reported start dates were later than the exchange's last trading day.

Table I compares the proportions alive versus dead on Cryptowisser-reported exchanges using these different techniques to measure start dates. We can see that all three approaches identify a mix of alive and dead exchanges, though the proportion of dead exchanges is higher for the alternative measurements utilizing domain registrations and manual inspection.

C. Identifying Exchange Attributes

We gathered data from multiple sources to construct attributes of exchanges. These attributes were selected because

TABLE II
EXCHANGE ATTRIBUTES IDENTIFIED FROM MULTIPLE DATA SOURCES, ALONG WITH SUMMARY STATISTICS.

	Variable Type	Variable Source	N	False	True	Active	Inactive	Median	Mean
# Coins	Continuous	Cryptowisser	822			495	327	16	41
US Customers	Categorical	Cryptowisser	822	293	529	495	327		
Crypto Only	Categorical	Manual	822	495	327	495	327		
Breached	Categorical	Manual	822	790	32	495	327		
OECD	Categorical	Manual	822	494	328	495	327		
Fee Maker	Continuous	Cryptowisser	822			495	327	.15	.45
Fee Taker	Continuous	Cryptowisser	822			497	210	.2	.53
Fee Withdrawal	Continuous	Cryptowisser	822			497	210	.0005	.07
Margin	Categorical	Coin Gecko	198	148	50	181	17		
Proof of Funds	Categorical	Coin Gecko	134	85	49	126	6		
Bug Bounty	Categorical	Coin Gecko	132	66	66	126	6		
Wires Accepted	Categorical	Cryptowisser	822	388	434	495	327		
Credit Cards Accepted	Categorical	Cryptowisser	822	388	434	495	327		

we anticipate they could influence whether and when a cryptocurrency exchange closes. Table II reports the exchange attributes, whether continuous or categorical, and source, followed by summary statistics. The six rows above the line show the attributes utilized in the subsequent regressions. Due to dataset incompleteness and correlations between variables, we could not utilize all attributes in the regressions. We discuss them here for completeness and to explain how we determined whether or not to include them in the analysis.

Exchanges choose which coins to trade. By offering more coins, exchanges could attract more customers. Hence, we expect exchanges that trade more coins will survive longer than those that trade fewer.

We also track whether an exchange permits customers from the US. While one might expect successful exchanges to seek out US-based customers given its market size, there are downsides to doing so. Accepting US customers means accepting regulation from US authorities, such as the SEC, CFTC, and FINCEN. These regulators have penalized and even shut down cryptocurrency platforms that flout US law. Moreover, exchanges that offer more exotic financial instruments such as margin trading have tended to shun US customers for fear that it would expose them to US regulators who have taken a dim view of such offerings.

A related attribute is whether the exchange trades only between cryptocurrencies or if it trades between cryptocurrencies and fiat. Trading with fiat creates additional regulatory exposure, such as being regulated as a money-services business. While this would appear to be a positive risk factor for closure, there are also significant risks to exchanges that only traded cryptocurrencies. First, it is easier for such exchanges to avoid regulatory oversight, which may lead to greater risk-taking in operations. Second, it is more feasible to abscond with user funds when there is no connection to the traditional financial system, making "rug pulls" more tempting. Hence, we expect exchanges that only trade cryptocurrencies and not fiat to be more likely to close.

Prior research has found that Bitcoin exchanges experiencing a security breach are more likely to close shortly thereafter [6]. We expect that trend to hold for cryptocurrency exchanges in general. While certainly not all breached exchanges will close, a breach undoubtedly introduces a significant shock that could be difficult for some exchanges to recover from. In order to identify security breaches of exchanges we combined existing data sets from peer reviewed research papers for this [7]–[10] to create a comprehensive dataset [11]. The dataset includes other events such as Breach, Outages, DDoS attacks etc out of which we filtered the events which is labelled as "Breach" for this paper. Note that we only have data on exchange breaches through May 2021. Hence, in our analysis when we consider breaches we constrain ourselves to data during that time frame.

Where an exchange is headquartered may also affect its prospects for survival. We expect that exchanges based in advanced economies will tend to have greater regulatory oversight, and therefore, they are more likely to be shut down for violating the law. They likely also experience a more difficult operating environment. We use countries belonging to the OECD as a proxy for being in an advanced economy.

Exchanges charges typically three kinds of fees: taker fee, maker fee and a withdrawal fee. Trade order gets a maker fee if the trade order is not matched immediately against orders placed on order book which adds liquidity whereas trade order gets the taker fee if the orders are matched immediately and it removes liquidity [12], [13]. Withdrawal fees on the other hand is charged by the exchange if a consumer transfers crypto assets from an exchange to a different exchange or their private wallet address which adds to an exchanges revenue and profit for running the services.

We also noted whether an exchange allows margin trading (i.e, trading using leverage), a risky practice that could threaten the solvency of exchanges if managed poorly and is illegal in many jurisdictions. Hence, we expect that margin trading would be associated with exchange closure.

Coin Gecko also reports on exchange security and provides the scores calculated by cer.live, an independent organiza-

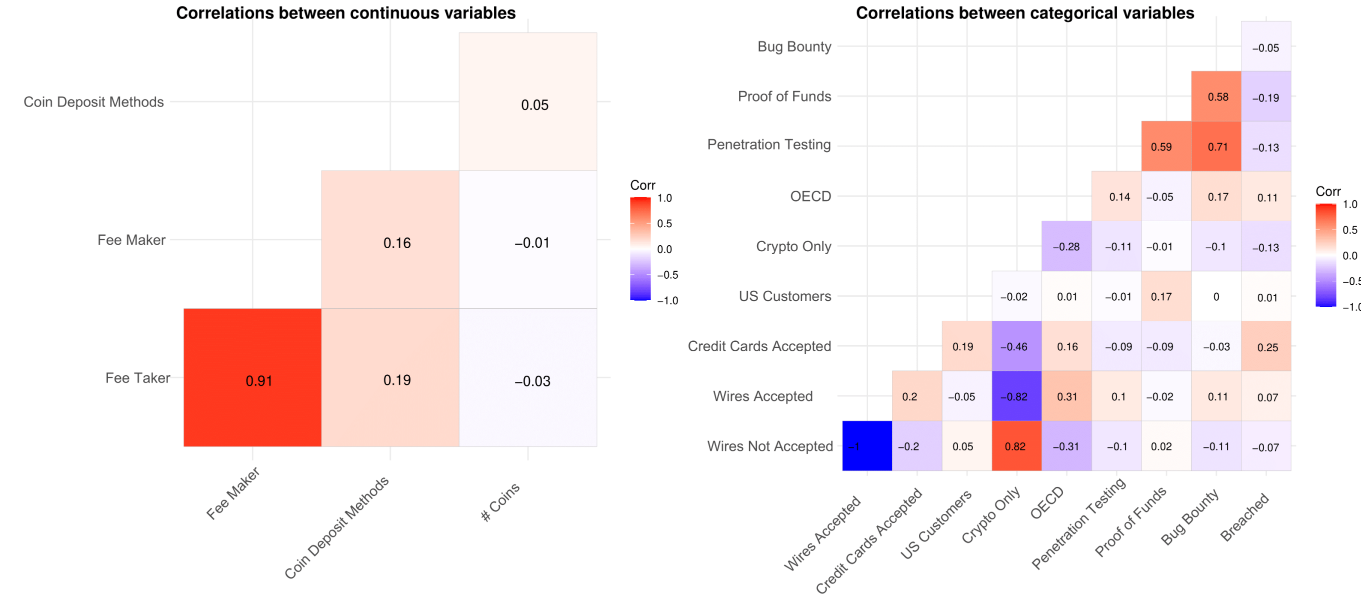

Fig. 2. Matrices showing correlations: categorical and continuous variables

tion which measures security for exchanges. The scores are purportedly based on penetration testing, proof of exchange's liquidity and presence of a bug bounty programs.

How easy it is to deposit fiat currency into exchange accounts may also affect its prospects for survival. Hence, we track whether deposits are permitted by wire transfer or credit card.

Finally, we consider whether exchanges trade less popular coins. We define unpopular coins as coins traded in not more than 5 exchanges. [6] found that Bitcoin exchanges that traded with less popular fiat currencies were more likely to survive, due to the relative lack of competition. We expect the same trend to hold for cryptocurrency exchanges today.

Figure 2 shows the correlations between continuous variables on Left followed by categorical variables on the right. We removed taker fee (highly correlated with maker fee), and pairs (highly correlated with # coins traded) for the analysis. We also excluded variables from Coin Gecko due to their relatively lower incidence compared to Cryptowisser and manual observation.We also removed exchange types (centralized/decentralized) exchanges as decentralized exchanges are relatively new and the dataset was biased towards centralized exchanges.

III. Analysis

We now examine factors that affect the likelihood a cryptocurrency exchange will close. First, we use a logistic regression in Section III-A followed by survival analysis in Section III-B.

A. *Regression Analysis*

We now examine how the attributes of exchanges identified in the previous section relate to whether an exchange is open or closed. We use a logistic regression with a binary response (dependent) variable set to True if the exchange remains active and False if it has closed. The explanatory (independent) variables are indicated in the top six rows of Table II.

Table III presents a series of regressions where we incrementally add more explanatory variables. We start with just the number of coins traded in an exchange. A higher number of coins traded in an exchange is negatively correlated with an exchange closing. Each additional coin traded at the exchange is associated with a one percent reduction in the odds of closing.

The second regression also considers whether US customers are allowed, which is associated with a 48% increase in the odds that an exchange is closed and is consistent over the all the regressions as we add additional variables (regressions 3–5). The "Crypto Only" variable tracking when exchanges do not permit deposits or trading with fiat currencies is highly significant throughout and have a higher significance compared to the variable that denotes whether US customers are allowed. Crypto-only exchanges have a slightly greater odds of being closed than the exchanges that do accept fiat.

Exchanges based out of OECD countries have no significance on exchange closure, however fees charged by exchanges is negatively correlated with continued exchange operation (higher fees charged by exchanges positively effects continued operation), perhaps because the revenue ensures more sustainable operations.

The first five regressions consider all exchanges operational through the end of 2022. We only have data on breaches through May 2022, so the sixth regression only considers behavior through that date. Consequently, the number of included exchanges falls from 752 to 645. Moreover, some of these exchanges alive in May 2021 later closed. Nonetheless, this regression helps us evaluate whether experiencing a breach

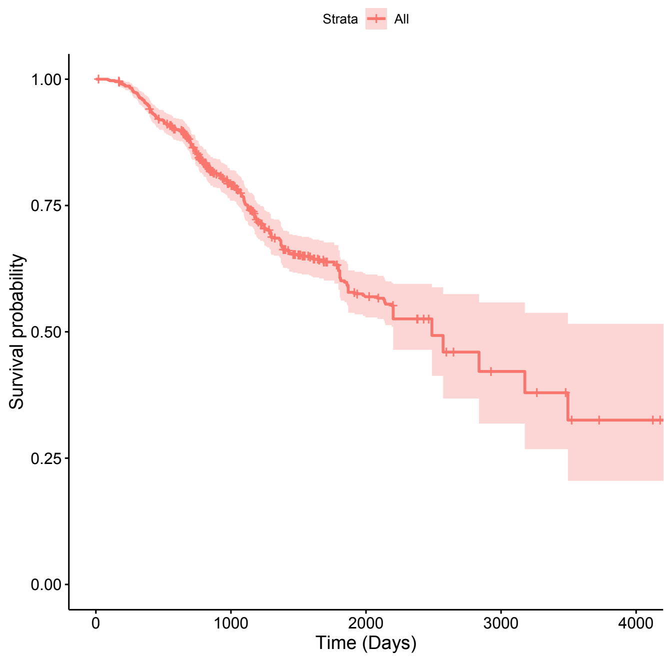

Fig. 3. Kaplan-Meier Curve: Survival probability of exchange closure.

is positively associated with closure. We confirm that it does, though the effect is only weakly significant.

B. Survival Analysis

The previous analysis used whether an exchange is open or closed as the response variable. We are also interested in the time an exchange operates before it closes (if it closes at all). For that, we utilize survival analysis, which helps estimate the expected duration of time until an event occurs. In our case the event is exchange closure. We use survival analysis to estimate what proportion of exchanges are will survive past a certain time and off those which survives at what rate will exchanges close beyond that.

For exchanges that were operational at the time of last data collection (December 2022), we marked the exchange as "right-censored" and set the end date to this most recent observation. We obtained start dates as described in Section II above.

For the entire population under study, we know that 327 of 822 exchanges (40%) close. Within that, there is significant variation in terms of when the closure happens. Survival plots can better show when closure happens for the entire population. Figure 3 demonstrates the derived survival probability for exchanges. The red line shows the survival probability overall. Around 75% of exchanges survive at least 3 years. The median survival is estimated to be closer to 7 years.

We next explore which attributes are associated with exchange closure. To investigate multiple factors simultaneously, we construct a proportional hazards model [14], as set out in Equation 1 (here x_i represents the explanatory variables used in the model).

$$h(t) = h0(t)exp(\beta 1x_1 + \beta 2x_2 + ... + \beta x_p) \quad (1)$$

Table IV presents a series of survival regressions. Overall, we obtain broadly consistent results with the logistic regressions. Coin counts are negatively associated with the hazard rate (and therefore positively correlated with exchange lifetimes). Accepting US customers is positively correlated with the hazard rate, thus negatively associated with exchange lifetimes. The effect remains statistically significant even after additional explanatory variables are added. Moreover, those trading cryptocurrency only fail quicker than those who accept fiat. Hence, both permitting US customers and forbidding fiat are associated with shorter-lived exchanges. Exchanges charging higher fees to buy in crypto assets are negatively associated with short-lived exchanges.

Meanwhile, being headquartered in an OECD country has no statistically significant association with exchange lifetimes.

As before, in order to consider the effect of experiencing a security breach on survival times, we must consider only those exchanges operating until May 2021. Regression 6 in Table IV shows that experiencing a breach does not impact overall exchange lifetimes. Otherwise, the results are mostly consistent with regressions 1–5. One key difference is that the magnitude of the "Crypto Only" variable diminishes substantially with the more recent data. For data through May 2021, only exchanges trading only cryptocurrencies had 752% greater odds of shutting down. For data through the end of 2022, that fell to around 39% greater odds. It appears that more mainstream exchanges that trade fiat shut down during the more tumultuous periods of late 2021 and 2022. Additionally, we observe that the significance of fees diminishes in regression 6.

IV. Conclusion

Since the introduction of Bitcoin, currency exchanges have emerged as key intermediaries supporting the broader ecosystem. They have also been targets for fraud, from thieves stealing currency to scammers absconding with user funds.

Prior research has established that many of these exchanges fail, and that security breaches may hasten their demise [1], [6]. The present work revisits those questions in a related, but markedly different context. First, the cryptocurrency space has exploded in growth since 2015, when the more recent of these two studies was conducted. Whereas these earlier papers studied exchanges that only traded Bitcoin, today exchanges trade between cryptocurrencies as much or more than they do with fiat currencies. New financial instruments, from stablecoins to margin and leveraged trading, make recent cryptocurrency exchanges look rather different from those who came before.

Whereas the earlier papers found that trading volume was a solid predictor of continued success, we have found other indicators matter more. Trading more coins and tokens is associated with continued operations. Compared to prior work, we find that experiencing a security breach is only weakly associated with a higher risk of closure and the effect is less important than other factors. In particular, the rise of exchanges that only trade cryptocurrencies and tokens but not fiat currency is very strongly associated with exchange closure. Trading only crypto increases the odds of closing by approximately 60% as much as exchanges that trade fiat. This points to the fact that there are differences in regulation and the riskiness of financial products offered on crypto-only exchanges. To a lesser extent, the fees charged by the cryptocurrency exchanges to buy and sell crypto assets negatively affect exchange closures but the significance is much lower compared to ”only crypto” exchange. We also found that permitting US customers (and therefore facing greater regulatory oversight and compliance obligations) is associated with shorter lifespans.

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APPENDIX

TABLE III
REGRESSION ANALYSIS

	Dependent variable:					
	Exchange Closed, Data Through December 2022					May 2021
	(1)	(2)	(3)	(4)	(5)	(6)
# Coins	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***	−0.011***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
	[0.992]	[0.993]	[0.992]	[0.992]	[0.993]	[0.989]
US Customers		0.389**	0.340**	0.340**	0.370**	0.318
		(0.155)	(0.156)	(0.156)	(0.163)	(0.216)
		[1.475]	[1.405]	[1.405]	[1.447]	[1.375]
Crypto Only			0.449***	0.449***	0.486***	2.264***
			(0.150)	(0.155)	(0.163)	(0.229)
			[1.567]	[1.567]	[1.625]	[9.618]
OECD				−0.001	−0.007	0.451**
				(0.156)	(0.163)	(0.213)
				[0.998]	[0.993]	[1.570]
Fee Maker					−0.152*	0.005
					(0.080)	(0.095)
					[0.859]	[1.004]
Breached						0.852*
						(0.469)
						[2.345]
Constant	−0.146*	−0.410***	−0.558***	−0.558***	−0.542***	−2.394***
	(0.086)	(0.137)	(0.147)	(0.169)	(0.178)	(0.280)
Observations	817	817	817	817	752	645
Log Likelihood	−534.340	−531.145	−526.623	−526.623	−480.263	−312.991
Akaike Inf. Crit.	1,072.679	1,068.290	1,061.245	1,063.245	972.527	639.981

Note: *p<0.1; **p<0.05; ***p<0.01

TABLE IV
COX PROPORTIONAL HAZARD MODEL FOR SURVIVAL ANALYSIS

	Dependent variable:					
	# Days Exchange Operational, Data Through December 2022					May 2021
	(1)	(2)	(3)	(4)	(5)	(6)
# Coins	−0.005***	−0.005***	−0.005***	−0.005***	−0.004***	−0.008***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)
	[.995]	[.995]	[.995]	[.995]	[.995]	[.991]
US Customers		0.462***	0.416***	0.417***	0.456***	0.300*
		(0.134)	(0.135)	(0.135)	(0.140)	(0.169)
		[1.586]	[1.516]	[1.517]	[1.578]	[1.350]
Crypto Only			0.324***	0.332**	0.329**	2.018***
			(0.123)	(0.130)	(0.134)	(0.198)
			[1.382]	[1.393]	[1.389]	[7.526]
OECD				0.025	−0.004	0.249
				(0.131)	(0.135)	(0.155)
				[1.025]	[0.995]	[1.282]
Fee Maker					−0.178**	−0.004
					(0.074)	(0.076)
					[0.837]	[0.996]
Breached						0.060
						(0.321)
						[1.061]
Observations	735	735	735	735	682	644
R^2	0.028	0.045	0.054	0.054	0.072	0.223
Max. Possible R^2	0.989	0.989	0.989	0.989	0.988	0.967
Log Likelihood	−1,648.856	−1,642.574	−1,639.151	−1,639.132	−1,494.909	−1,013.299
Wald Test	14.320***	26.270***	33.080***	33.120***	40.820***	122.800***
LR Test	21.238***	33.803***	40.648***	40.685***	51.217***	162.282***
Score (Logrank) Test	14.918***	27.127***	33.930***	33.949***	42.180***	157.365***

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$