Borsa Istanbul Review 25 (2025) 206–226

Contents lists available at ScienceDirect

Borsa Istanbul Review

journal homepage: www.elsevier.com/journals/borsa-istanbul-review/2214-8450

# An analysis of crypto-asset trade, enforcement, and estate planning

Sirajo Aliyu [a,b,*], Norazlina Abd Wahab [c], Nur Syaedah Kamis [d]

[a] Institute of Shariah Governance and Islamic Finance (IsGaIF), Islamic Business School, Universiti Utara Malaysia Sintok, Malaysia
[b] Department of Banking and Finance, School of Business Studies Federal Polytechnic Bauchi, Nigeria
[c] Institute of Shariah Governance and Islamic Finance, Islamic Business School, College of Business, Universiti Utara Malaysia, Malaysia
[d] Universiti Islam Antarabangsa Tuanku Syed Sirajuddin, Perlis, Malaysia

ARTICLE INFO

*Keywords:*
Crypto assets
Enforcement
Estate planning
Survival analysis
Trade

ABSTRACT

This study examines crypto-asset trading, focusing on regulatory violations that lead to enforcement actions and the impact of estate planning after a digital asset holder's death. We review the literature on crypto-asset estate planning and explore lessons from Islamic finance regarding crypto assets. We then use quantitative analysis to compare price-volume relationships in Islamicoin and Bitcoin. To strengthen our analysis, we employ the Kaplan-Meier survival estimate, parametric survival analysis, and the Probit model. Our findings show that Islamicoin's trade volume predicts market price changes more often than Bitcoin's, which seems to be influenced by factors other than trade volume. Further investigation reveals that securities regulators are increasingly enforcing rules against crypto-trading violations. These violations typically occur when trading activity decreases while prices increase. We also find that widespread price changes tend to motivate people to violate the regulations over time. Recently, positive price changes, rather than trade volume, have been the main factor influencing regulatory violations. However, trade effects were observed later in some of our models. Given these findings, we conclude that regulators need to improve digital assets Act to address estate planning issues, in addition to protecting investors. The paper ends with policy recommendations and suggestions for future research.

## 1. Introduction

The rise in the adoption of cryptocurrency worldwide shows the popularity of crypto assets. Therefore, we examine the effect of cryptocurrency prices, estate planning, trading volumes, price spreads, and market price volatility on the enforcement actions taken by the US Securities and Exchange Commission (SEC) and assess the likelihood of mitigating these risks. Even though crypto assets are associated with higher volatility risk, this has not dampened the unprecedented interest of investors in global markets (Adrian et al., 2022; Ayedh et al., 2021; Das, 2022). The number of crypto-asset owners grew by nearly 580 million worldwide by the end of 2023, which indicates an increase over the number in 2022 of 34 percent (Crypto.com, 2024). Brazil and Indonesia have the highest crypto-asset ownership in the world, followed by the United Arab Emirates (UAE) and Singapore. Following this trend, the adoption of crypto assets in Malaysia is also booming, as reported by the Securities Commissions (SC) of Malaysia, where more than 450,000 digital assets exchange (DAX) accounts have been opened to date across the three DAX platforms: LUNO, Sinergy, and Tokenize Exchange (Fintech News Malaysia, 2022; Veerasingam & Teoh, 2022). The growing acceptance of crypto assets worldwide confirms that they have become a new norm in ownership of digital assets. In September 2021, El Salvador was the first country to adopt Bitcoin as legal tender (Lopez & Livni, 2021; Santaolalla, 2024). Then, in April 2022, the Central African Republic became the second country to adopt Bitcoin as legal tender (Browne, 2022; Santaolalla, 2024). However, because of transaction difficulties, legal and regulatory issues, and financial stability concerns, the two countries ceased to consider Bitcoin legal tender (Hacibedel & Perez Saiz, 2023). Although other countries have not recognized crypto as legal tender, as of November 2021, 103 countries were identified as applying tax laws and anti–money laundering and counterfinancing of terrorism laws (AML/CFT laws) to cryptocurrency, including member states of the European Union, the UAE, and Malaysia (Law Library of Congress, 2021).

The volatility of Bitcoin and its nonlinearity in predicting price-volume relations have become an issue of concern to academics and practitioners (Aalborg et al., 2019; Conlon & McGee, 2020; El Alaoui et al., 2019; Gemici & Polat, 2019; Palamalai et al., 2021; Raza et al.,

* Corresponding author. Institute of Shariah Governance and Islamic Finance (IsGaIF), Islamic Business School, Universiti Utara Malaysia Sintok, Malaysia.
*E-mail addresses:* sirajoaliyu@yahoo.com, sirajo.aliyu@uum.edu.my (S. Aliyu), norazlina.aw@uum.edu.my (N. Abd Wahab), nursyaedah@gmail.com (N.S. Kamis).

https://doi.org/10.1016/j.bir.2024.12.008
Received 11 February 2024; Received in revised form 2 October 2024; Accepted 26 December 2024
Available online 2 January 2025
2214-8450/© 2025 Borsa İstanbul Anonim Şirketi. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

2022b; Sahoo et al., 2019; Szetela et al., 2021; Shen et al., 2024). Specifically, Szetela et al. (2021) indicate that Bitcoin prices are not determined by the volume of transactions in the market, especially in the long run. A press release by SEC, denying the approval of spot Exchange Traded Fund (ETF) of Bitcoin and identifying it as a "speculative, volatile asset that's also used for illicit activity including ransomware, money laundering, sanction evasion, and terrorist financing" (United States Securities and Exchange Commission, 2024b). The SEC sees crypto assets as being involved in unfair and untruthful disclosure in the market, where regulations and enforcement have to be strengthened to prevent fraud and manipulation. This led to enforcement actions against those who use other mechanisms to influence market performance and take undue advantage of investors. Fig. 2 depicts the cumulative increase in enforcement since December 2014, which supports the findings of Mola (2023) indicating a cumulative increase of enforcements in recent time. However, the effect of the risk of violating digital law has not been empirically explored in the literature. Thus, it is not clear whether the activities of bad actors that lead to enforcement actions in the crypto-asset market are influenced by market mechanisms based on price-volume relations. Other studies argue that Bitcoin's return volatility cannot be ascertained by its trade volume (Balcilar et al., 2017), which contravenes Islamic finance principles that do not permit excessive speculation not determined by market fundamentals in trading activities. Therefore, in this study, we investigate crypto assets to advance understanding of them and offer insights into appropriate policy directions.

In the evolution of the crypto-asset ecosystem, the most neglected concern is that of inheritance of those assets. Many crypto-asset owners or investors need to prepare better for their untimely demise and consider planning for inheritance of those assets (Conway & Grattan, 2017; Mali & Prakash, 2020). Without proper planning, these crypto assets could be orphaned and thus unable to be inherited by legal beneficiaries (Paulger, 2022). The fundamental issue in this context is the implication of the loss of crypto assets in the absence of proper planning by crypto owners, despite appreciation in its value in the financial market, as Beyer (2019) asserts.

In addition, this study also analyzes Islamic financial provisions on wealth preservation and management, especially regarding estate planning, which must be considered in the development of guidelines and frameworks for Islamic crypto assets. The nature of crypto assets makes them difficult to pass down to legal beneficiaries (Klasiček & Šimleša Vučemilović, 2019), which makes this issue especially important to study, especially since the introduction of sharia-compliant crypto assets. We analyze the effect of risk exposure for crypto assets, which operate with and without market mechanisms. Therefore, we employ survival estimates by Kaplan and Meier (1958) to evaluate changes in prices and trade volumes on a time-to-event analysis of market enforcement actions. Notwithstanding these price-trade volume estimates, we then analyze the proportional risk of market mechanisms, such as price, trade volume, and price volatility, on the reported enforcement activities. Doing so empirically offers new insights into recent market activities, especially estate planning, that protect investors' digital data securities even after death. Based on our findings, we recommend that estate planning regulations for crypto assets be enhanced from the perspective of both conventional and Islamic finance. In addition, we suggest that Islamic finance comply with sharia-based principles while developing and enhancing guidelines and frameworks for Islamic crypto assets.

The paper makes four contributions to the literature on crypto assets. First, we discuss the issues related to crypto assets in estate planning and enforcement due to violations of SEC regulations. We also cover contemporary issues related to crypto-asset transactions, especially estate planning, by offering other insights on Islamic crypto assets. Second, the study contributes to the literature on the effect of trade volume in predicting prices in the crypto market, a fundamental principle in Islamic finance. Fig. 1 shows that price changes indicate higher volatility in the Islamicoin than Bitcoin from the time of its establishment through the period under review. Therefore, we regress and compare Bitcoin with Islamicoin and obtain consistent findings between April 2022 and December 2023 based on daily data comprising 640 observations. The third contribution is related to recent concerns about the cumulative violations in cryptocurrency transactions. Fig. 2 depicts the SEC's incremental enforcement, which has increased exponentially. Thus, we employ the Kaplan-Meier survival estimate and evaluate the survivability of crypto assets, although the time to events influences transaction activities based on increases (decreases) in the price and trade volume in the market. The fourth contribution concerns the extent of hazard from violations that lead to litigation and administrative proceedings (Mola, 2023), which includes issues related to estate planning and is analyzed using the Weibull distribution of survival parametrization model. We predict the effect of estate planning through amendment of the law on digital assets (Sy, 2016; Walker, 2017), which gives

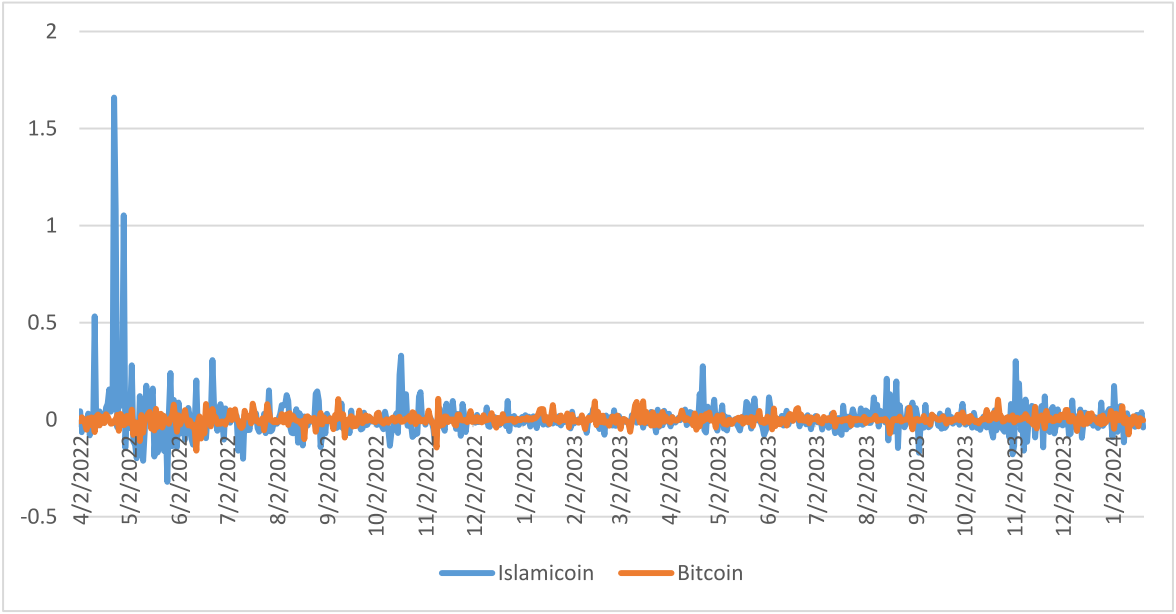



**Fig. 1.** Performance comparison of Bitcoin versus Islamicoin.

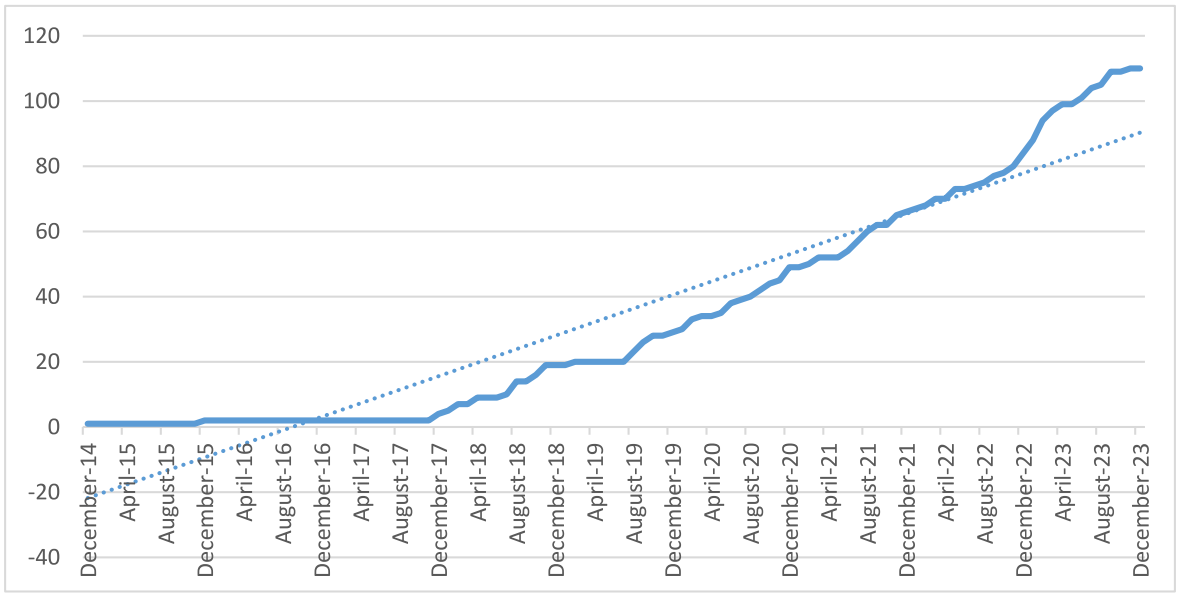



**Fig. 2.** Cumulative SEC crypto-asset enforcement actions, 2014-2023
*Sources*: Authors' calculations based on data from Cornerstone Research (Mola, 2023) and press releases on SEC cryptocurrency enforcement actions (United States Securities and Exchange Commission, 2024a).

beneficiaries access to the digital assets after the death of their owner, as a proxy for a reduction in regulatory violations over time in the cryptocurrency market. As identified in Fig. 2, total enforcement actions increased between the end of 2017 and 2023. Therefore, we construct an indicator for recent activities in the market, which indicates persistent hazards in the system that require other policy recommendations to strengthen the activities of the Securities Commission in a way that would reduce regulatory violations (Aggarwal & Wu, 2006). Finally, we identify the effect of recent activities through their interactions with changes in price and trade volumes.

In Section 2, we discuss the concept of crypto assets and review related literature. Sections 3 and 4 focus on our methods, data, and results, respectively. Finally, we conclude the paper in Sion 5 with policy recommendations and suggestions for future research.

## 2. The conceptual framework of crypto assets

The essential features of crypto assets and how blockchain explains its structure are reported in several articles by scholars and practitioners. The World Bank sees crypto assets as "digital currencies that rely on cryptographic techniques to achieve consensus 'about their value', for example Bitcoin and Ether" (Houben & Snyers, 2018, p. 22). It considers them a subset of digital currency, that is, as a digital representation of value denominated in a specific unit of account, unlike e-money, a digital payment mechanism represented and denominated in fiat money (Krause et al., 2017). The Committee on Payments and Market Infrastructures (CPMI) of the Bank for International Settlements (BIS) considers crypto assets a digital currency with the following main characteristics.

- Their value is determined by supply and demand, as with commodities such as gold, which have no intrinsic value.
- They make use of distributed ledgers to allow remote peer-to-peer exchanges of the electronic value in the absence of trust between parties, without the need for intermediaries, and
- They are not operated by any specific individual or institution. (Bank for International Settlements, 2015)

In other words, crypto assets are developed based on blockchain technology (Katuk, 2019), which is a distributed database or public ledger that contains records of all transactions and is shared with all participating parties (Micheal et al., 2016). For instance, Bitcoin maintains a network that holds wallets for all clients, and a distributed blockchain database is stored on every client's computer. Blockchain technology enables a client to view a registry of all the operations in the system using the wallet or the web interface of special monitoring services from anywhere in the world. It also offers complete transparency on settlements, and this kind of information is never deleted from the database (Saleh et al., 2020).

Transactions related to crypto assets such as Bitcoin use blockchain technology. First, when a new transaction is initiated, it is broadcast to all miners (also called nodes). Miners are computer nodes that share their computing resources to verify a transaction and generate a block, and they are awarded Bitcoins for their contribution. When a new block is created, miners receive proof of work for that transaction, in the form of an answer or a solution to a mathematical puzzle. Then, the first miner provides this evidence and broadcasts the block to the network, and then other miners verify it. Thus newly created blocks are added to the chain, along with a timestamp and a link to previous blocks. This process is repeated for all new transactions (Ghimire & Selvaraj, 2018).

Second, an owner of crypto assets must have a wallet with the individual or institution that has custody of crypto coins and tokens, which can be a third-party service. Owners set up accounts in order to effectuate exchanges, submitting information, such as their name and passport or ID number. After this crypto wallet is created, owners can purchase crypto assets or obtain them through other methods, such as participation in the network (mining and staking),[1] earning them in payment for work or airdrops, in which coins and tokens are randomly

[1] Mining and staking generate cryptocurrency rewards in different ways. The former uses the computational ability to process transactions and create new blocks, while the latter uses the number of coins held within the blockchain network to earn rewards. Proof of work through an active approach is attached to mining, and proof of staking that is passive in nature is related to the staking approach. Mining is costly and offers substantive rewards compared to staking, which depends on the time and number of coins staked. https://contabo.com/blog/crypto-staking-vs-crypto-mining/#:~:text=Mining%20is%20hardware%2Dintensive%20and,%2C%20goals%2C%20and%20risk%20tolerance. (accessed 2-Oct-24).

distributed to wallets, or faucets, which is a way to collect small quantities of crypto for free (Carlson et al., 2021).

Third, crypto assets can only be accessed using a very long and complex password held by the owner called a private key or seed phrase (sequence of random words use to access crypto wallets and block chains). Crypto assets can be used only with this key, which is used to authorize the transfer of crypto assets from one owner to another; that person's public key is needed in order to use these assets in payment for goods and services or as a gift or use them in any way. Some wallets reside on a commercial exchange. In that case, the crypto asset is accessible to anyone who knows the username and password of its owner, answers security questions correctly, or successfully navigates the steps in the wallet's verification process (Beyer, 2019). Saleh et al. (2020) state that crypto assets are depersonalized (not control by single user), and the proof of ownership cannot be obtained from or defined in any registry, where token ownership is identified. Thus, the ability to own, use, and manage crypto assets depends on the availability of the crypto wallet and the private key or password needed to access it. No one can access a crypto-asset wallet without the password, even with the owner's consent or a court decision (Saleh et al., 2020).

### 2.1. Existing framework for estate planning with crypto assets

Specific plans must be incorporated into managing crypto assets in order for them to be passed down to the next generation. The unique qualities and characteristics of crypto assets require special treatment regarding estate planning. The main issue that must be considered regarding crypto-asset estate planning is access (Paulger, 2022). Similarly, Saleh et al. (2020) state that, depending on the characteristics of crypto assets, they can be inherited through traditional estate planning, technological means, or a combination of methods.

People are legally allowed to transfer their assets to any beneficiaries (except in some cases based on sharia rulings) by drafting a will or bequest. In general, people might or might not give the details about cryptocurrency wallets and access keys to them in a traditional will (Saleh et al., 2020). However, if they do not give the details, the beneficiaries will have difficulty in accessing these assets because of the requirement for credentials, such as passwords (Seres et al., 2020). However, Beyer (2019) do not recommend mentioning information, such as the private key for crypto-asset wallets, because it will become public information when the will is probated.

Therefore, those writing wills should not include information about private keys but, rather, keep them secure using methods such as a safety deposit box, accompanied by clear and complete instructions on how to access the account with the credential access information (Paulger, 2022; Saleh et al., 2020).

Crypto assets, wallets, and private keys can be transferred to legal beneficiaries by storing this information in encrypted electronic storage based on blockchain technology. This technology enables this information on an owner's crypto assets to be passed to an assigned third party upon submission of a death certificate (Singh et al., 2022).

Another standard method of estate planning is forming a trust, in other words, the owner of crypto assets entrusts digital assets to another person or institution. A trust can be either revocable or irrevocable, which the owner might determine depending on the net worth of the crypto assets—that is, a revocable trust might be preferable if the assets have low net worth and vice versa. The assertion is consistent with the two scenarios identified by Noonan, 2015, who argues that revocable trusts benefit investors by allowing them to buy and sell digital assets with low net worth. Conversely, irrevocable trusts are preferred when the assets realize appreciation throughout the trust, which is not tantamount to more taxes. However, others believe that it might be risky to put crypto assets in a trust, as a trustee could try to sell them without the consent of the owner, creating risk exposure in the absence of the proper steps to curb this risk. Further, the volatility in the price of crypto assets might require the trustee to sell assets within the trust (Saleh et al., 2020).

Another way is by combining traditional methods and technology, in which an owner of crypto assets gives sufficient instructions to the executor or beneficiaries about how and where to obtain the information needed for accessing crypto assets, including private keys. This access information can be stored electronically, such as on a disk or storage application on a phone or online (cloud storage). Online storage and tools enable a crypto-asset owner to configure the account settings so that the access information can be transferred to beneficiaries (Kirillova et al., 2020). However, doing so is subject to an agreement (Klasiček & Šimleša Vučemilović, 2019) with the service provider or subscription fees.

### 2.2. Issues and challenges in estate planning related to crypto assets

The emergence of crypto assets creates a challenge for their owners in terms of effective management because the characteristics of crypto investment differ from those of other assets—such as land, real estate, and cash deposits at banks—chiefly, the lack of proof of ownership in any records and the inability to obtain it, unless provided by the owner (Saleh et al., 2020). The information needed to access crypto assets, such as passwords and keys, are confidential and known only to the owner. Without this information, in effect, crypto assets cannot be passed down to legal heirs or beneficiaries, even with the owner's consent or a court order.

The first challenge in estate planning regarding crypto assets is whether those who own these assets are aware of or knowledgeable about its importance (Conway & Grattan, 2017; Mali & Prakash, 2020). Many owners do not consider the implications of crypto assets in estate planning, so they often disregard it, without considering the value of the assets that could be passed down to their legal heirs or beneficiaries (Conway & Grattan, 2017; Genders & Steen, 2017; Mali & Prakash, 2020; Pasztor, 2020). The implication arises when accessing the assets in the event of death. Consequently, if legal heirs are unaware of the existence of crypto assets and their owners fail to make provisions in their will to pass the assets down their legal beneficiaries after their death, these assets could remain idle indefinitely (Brucker-Kley et al., 2013; McKinnon, 2011).

The second challenge is financial, that is, the value of the crypto assets. It fluctuates continually, so beneficiaries, trustees, or executors need to have some knowledge about crypto assets in order for them to be liquidated and distributed wisely (Farmer & Tyszka, 2014). Distributing them to heirs is not easy, and Islamic finance emphasizes the avoidance of excessive speculation, especially when it does not come from trading activities.

The third challenge concerns the legal aspects of estate planning as they relate to crypto assets. Most papers emphasize that the law governing the use of crypto assets is incomplete or not comprehensive (Beyer, 2019, 2020; Beyer and G. Nipp, 2020; Carter, 2016; Chomczyk, 2020; Conway & Grattan, 2017; Howden, 2015; Mali & Prakash, 2020; Noonan, 2015). Therefore, we study this issue using the Revised Uniform Fiduciary Access to Digital Assets Act (RUFADAA), which was developed under the Uniform Law Commission (ULC) for states' adoption as a model law (Sheridan, 2020). The Act was initiated as Uniform Fiduciary Access to Digital Assets Act (UFADAA) in 2014 and adopted by the state of Delaware; due to some criticism and resistance, it was revised in 2015 (Sy, 2016). Although Delaware continues to use UFADAA (Walker, 2017), other states have adopted RUFADAA except

Louisiana, Oklahoma and Massachusetts. RUFADAA integrated many considerations, especially in the absence of the deceased's expression of commands in the will, other records, power of attorney, trust, or any clear direction on the digital assets.[2] Similarly, digital access is only authorized by the user's permission or court order and is drafted based on federal laws.

Moreover, most of the other countries do not have any laws about the inheritance of crypto assets (Alston, 2021; Conway & Grattan, 2017; Farmer & Tyszka, 2014; Gilden, 2019; Moorefield-Lang & Lang, 2020; Saleh et al., 2020; Seres et al., 2020; Sylvester, 2021; Załucki, 2020).

The fourth challenge, related to the third, concerns the process of managing estate planning regarding crypto assets in the absence of a proper procedure or systematic management for distributing crypto assets after the owner's death (Farmer & Tyszka, 2014; Holt et al., 2021; Noonan, 2015).

Likewise, the fifth challenge concerns two security issues related to estate planning regarding crypto assets. The first issue encompasses access to a crypto wallet in the event that the private key is lost or the location of the wallet is unknown after the owner's death (Farmer & Tyszka, 2014). The second issue involves data privacy and the potential for identity theft (Holt et al., 2021; Mali & Prakash, 2020). The SEC reported that it had levied penalties on perpetrators of fraud regarding crypto assets and cyber manipulation in the financial market (Mola, 2023), which are the basis of the indicators in our analysis.

In contrast to the conventional view presented in the literature, we believe that some of these challenges could be overcome by adopting Islamic finance fundamentals based on sharia principles.

### 2.3. A sharia perspective on estate planning

The principles of wealth accumulation in Islamic finance differ significantly from the conventional perspective, which emphasizes pure wealth maximization without the restrictions in Islamic finance. For instance, Islamic finance prohibits interest, gambling, excessive speculation, indecency, and consumption of other people's wealth without their consent (Hasan et al., 2020; Hassan & Aliyu, 2018; Hassan et al., 2022). It upholds the principles of justice, trust, benevolence, and giving out charity (*zakat)* and does not allow the creation of wealth through usury and other evil activities. Islamic finance holds that wealth and any other property on earth and beyond are ultimately owned by the creator, and thus people are responsible for managing them properly. Therefore, sharia laws guide people to use their property and wealth to please the creator.[3] However, sharia allows them to work hard, hold wealth, and obey the creator, which includes extending happiness to others and assisting those in need or financial distress. Therefore, the scope of Islamic law extends to inheritance to heirs from those who accumulate wealth, upon their demise.[4] Thus Islamic law does not limit the possession and creation of wealth through investment and trade; rather, it elaborates on the preservation, distribution, and purification of wealth of the resources accumulated. Nowadays, wealth comes in several forms, including digital ones, which is acceptable as long as it does not contravene sharia (Rosele et al., 2022). However, it must follow sharia guidelines and principles, whose goals include respective public rights and interests and go beyond pure wealth maximization (Aliyu et al., 2017).

With regard to the transfer of wealth upon the demise of an owner of crypto assets, Sharia mandates the transfer of wealth to heirs without consuming their property illegally, which is becoming difficult in the case of crypto assets.[5] Sharia scholars unanimously agree that the preservation of wealth must accord with sharia objectives, which allow for a variety of financial activities (Dusuki & Bouheraoua, 2011). Noticeably, Islamic laws forbid handing over wealth to those who cannot manage it wisely until they are in a position to do so effectively (Q4: 5–6; see Appendix 1A for detail).[6]

As highlighted in prior papers, wealth accumulation and economic growth can be achieved through inheritance with crypto-asset estate planning (Zuleika & Desinthya, 2013). Islamic laws on inheritance are based on sharia principles to achieve a proper economic order of society, in addition to the principles of trust, property rights, and ownership (Mawdudi, 2011; Ali, 2003). Therefore, Islamic crypto assets, initiated only recently, must follow sharia rulings that transfer wealth to heirs after the death of its owner. Some of the existing challenges in the market might also apply to Islamic crypto assets.

Furthermore, Islamic crypto assets are subject to *zakat* and other charitable deductions (Muneeza et al., 2022). This has implications, especially when there is a delay in transferring wealth to heirs in fulfillment of the will of its owner. To prevent *zakat* from taking a large proportion of the wealth, especially when the heirs cannot manage the assets, consistent monitoring of the performance of the assets is needed. Although the traditional method of estate planning is weakened, especially as the bequest will become a public document (Saleh et al., 2020; Beyer & Nipp, 2022), there is a high risk of breach of trust when proper measures are not taken to prevent it (Saleh et al., 2020). Therefore, because of current technological advancements, a mixture of technical and traditional estate planning methods can mitigate the risk of breach of trust.

However, other papers indicate that the use of third-party online storage may have costs and is subject to agreement with the service provider (Klasiček & Šimleša Vučemilović, 2019; Saleh et al., 2020). However, adopting the Islamic finance concept of trust has to be applied in consideration of other legal documentation. Indeed, regulators and policy makers must provide sufficient guidelines about crypto assets to minimize systemic risk, which affects the global financial and economic system (Chen et al., 2007).

## 3. Methodology

This study adopts a unique approach in reviewing the literature on crypto assets, which encompasses estate planning, speculation, and violations of securities exchange regulations. These issues are subject to enforcement by the proper authorities. Our comprehensive financial market survey closely studies investment interactions, performance, and investor reactions, in the professional and academic context in the past few decades (Hassan et al., 2019). Our research is based on the Dow theory, a historically significant pillar founded on a thorough analysis of market interaction and return-volume relations dating back over a century (Yamani, 2023). We build on the earlier assumption of a mixture of distribution hypotheses on the price-volume relation analysis (Clark, 1973; Darolles et al., 2017; Grammatikos & Saunders, 1986; Karpoff, 1987; Tauchen & Pitts, 1983; Ying, 1966).

Our regression analyses cover Islamicoin and Bitcoin, with a more robust estimation based on quantile regression to account for outliers and nonlinearity in crypto-asset data (Chu et al., 2023; Koenker &

[2] https://bequest.com/blog/ufadaa-revised-what-is-rufadaa; and https://content.next.westlaw.com/practical-law/document/I1c2fc9d9d57311eabea4f0dc9fb69570/Pennsylvania-Enacts-Uniform-Act-for-Digital-Assets-RUFADAA?viewType = FullText&transitionType = Default&contextData=(sc.Default); (accessed 2-October 2024).

[3] Sharia sees wealth as a mere adornment of worldly life (Q18:46) that should be used to please the creator.

[4] Sharia provides a comprehensive guide to inheritance (Q4:11-12).

[5] Sharia, in its protective stance, strictly prohibits the consumption of heirs' wealth (Q4:2; Sahih Al-Bukhari, vol. 4, Hadith no. 28). This prohibition serves as a safeguard, ensuring the rightful distribution and preservation of wealth.

[6] Sharia guides the guardians in managing heirs' wealth with the utmost care and their capability to handle it (Q4:5-6; Sahih Al-Bukhari, vol. 3, Hadith no. 591).

Bassett, 1978; Rubbaniy et al., 2022). The method estimates the median and extreme tail quartile effects of the explanatory variables, with inclusive interconnectivity between variables (Raza et al., 2022b; Raza, et al., 2022a). We hypothesize a correlation between price changes and trade volume estimated on different quantiles apart from the median (Chu et al., 2023). The assumption of a relationship between price and volume supports the perspective of Islamic finance that trade should be allowed to influence transaction performance, rather than excessive market speculation (El-Ashkar, 1995).

Fig. 1 depicts price changes in Bitcoin and Islamicoin, in which the latter is more volatile than the former. Therefore, we adopt a mixture of distribution hypotheses that evaluate price-volume trade relations to explore whether the price changes and fluctuations are based on trade volume. We compare conventional Bitcoin and Islamicoin to determine how changes in trade volume influence price changes. According to Sim and Zhou (2015), ordinary least squares (OLS) regression analysis does not provide sufficient information, unlike quantile regression, which can affect price-volume relations in crypto-asset transactions because of volatility of market prices. Therefore, we estimate the following model:

$$logprice_t^{\theta} = \vartheta_0^{\theta} + \vartheta_1^{\theta} volume_t + \vartheta_2^{\theta} volatility_t + \vartheta_3^{\theta} \Delta price_{t-1} + e_t^{\theta} \quad (1)$$

The three explanatory variables in the model are trade volume (*volume*), which expressed in logarithm; volatility (*volatility*), the daily divisor of high and low prices traded in the market (Engle & Gallo, 2006; Opschoor & Lucas, 2021); and price changes ($\Delta price$), calculated as $\left(\frac{P_t}{P_{t-1}} - 1\right)$. Next, we construct Equation (2), which is expressed based on the price change ($\Delta price$) for the explanatory variables in Equation (1).

$$\Delta price_t^{\theta} = \vartheta_0^{\theta} + \vartheta_1^{\theta} volume_t + \vartheta_2^{\theta} volatility_t + \vartheta_3^{\theta} \Delta price_{t-1} + e_t^{\theta} \quad (2)$$

Our research is built on the early literature on quantile regression, in which $logprice_t^{\theta}$ and $\Delta price_t^{\theta}$ are estimated based on the conditional quantile of price and price changes of the dependent variable, crypto assets. The conditional quantile $\theta$ is within the range of $0 \leq \theta \leq 1$, whereas $\vartheta_0^{\theta}$, $\vartheta_1^{\theta}$, $\vartheta_2^{\theta}$,*and* $\vartheta_3^{\theta}$ are estimated coefficients as functions of the conditional quantile $\theta$, and the error term $e_t^{\theta}$ has zero quantiles (Sim & Zhou, 2015). Our research also draws on a mixture of distribution hypotheses that assume a joint common direction of events in the market (Clark, 1973; Grammatikos & Saunders, 1986; Karpoff, 1987; Tauchen & Pitts, 1983; Ying, 1966). This methodology ensures the reliability and validity of our findings. We compared conventional and Islamic crypto assets to examine the closest price-volume relation between the two crypto assets traded on the market. Fig. 2 shows that cumulative enforcement continually increases because of violations of trade regulations in the crypto-asset markets, leading to excessive speculation outside market mechanisms. To further investigate the rise of manipulation in the trading of crypto assets, which has led to various enforcement actions, we use data from the SEC to analyze the hazard effect on the price, trade volume, price spread, recent activities, positive and negative changes in prices and trade volume, and interaction of the variables with "recent" activities. We use the crypto assets popularly traded in the US that have been subject to enforcement actions. SEC data in public press releases on enforcement activity is used as a dummy variable, which takes a value of one if litigation or administrative proceedings are reported within the month; otherwise, zero (Mola, 2023). Therefore, investors are susceptible to nefarious activities, which depend on the time of the event. Consequently, we use the time to event based on the SEC enforcement reports beginning in December 2014 as a time-dependent variable in months. Therefore, we use Bitcoin data from December 2014 to December 2023. We use survival analysis to align with our data structure, with time to the event and categorical enforcement binary variable of one if the event happened within a month and zero otherwise to explore the effect of risk exposure on market mechanisms.

In the finance literature, survival analysis is used to predict proportionate hazards and survival estimates based on the time to a particular event. The methodology was initially used in the pure sciences and later in actuarial, finance, and related management sciences. The earliest finance literature applied the Cox (1972) proportionate hazard model and other models in the survival analysis family (Alandejani et al., 2017; Aliyu and Yusof, 2017; Lane et al., 1986; Pappas et al., 2017; Whalen, 1991; Wheelock & Wilson, 2000). In practice, survival analysis influences covariance at the time of the event and efficiently accommodates censored observations. (Deville & Riva, 2007). In this context, we consider a cryptocurrency enforcement action as an event at a particular time based on a violation of SEC regulations, leading to market fraud and manipulation, in which time asymmetry is sensitive to price changes in the market (Jarrow, 1992). Therefore, we adopt a categorical identification of enforcement events reported at a time between 2014 and 2023. Royston and Lambert (2011) discuss the three fundamental relationships in survival analysis, which emanate from the change of survival $S(t)$ into a hazard function $h(t)$ and a cumulative $H(t)$ of the hazard function that exists before an event. Therefore, following Kalbfleisch and Prentice (2002), we perform a nonparametric survival analysis of the Kaplan-Meier survival function (Kaplan & Meier, 1958):

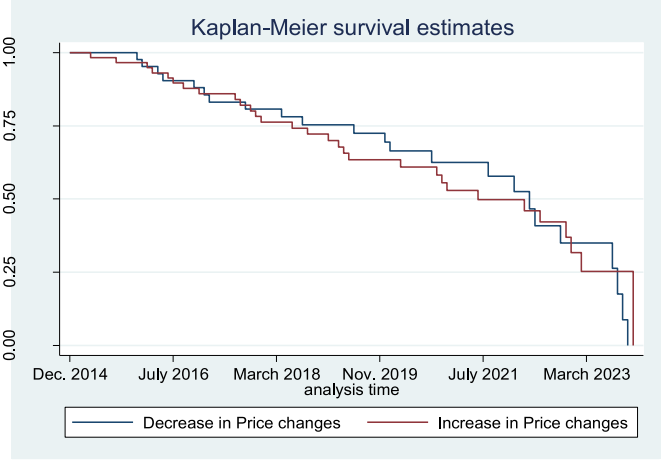



**Fig. 3.** Price changes and crypto-asset survival
*Sources*: Authors' calculations based on data from Cornerstone Research (Mola, 2023), SEC press releases on cryptocurrency enforcement, and the Yahoo finance database.

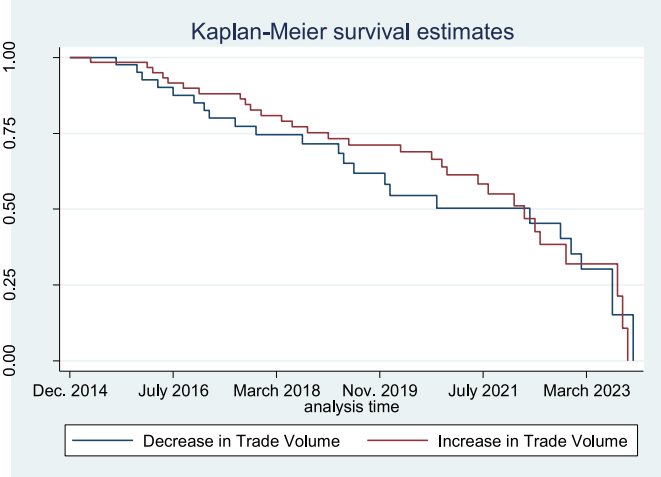



**Fig. 4.** Trade volume changes and crypto-asset survival
*Sources*: Authors' calculations based on data from Cornerstone Research (Mola, 2023), SEC press releases on cryptocurrency enforcement, and the Yahoo finance database.

$$S(t) = \prod_{i:t_i \le t} \left(1 - \frac{f_i}{n_i}\right) \quad (3)$$

Our study applies the survival analysis methodology to the crypto-currency market, to gain insights into the probability that crypto-asset market activity will survive for a longer time than ($t_i$), and ($t_i$) is the time in the period when at least one enforcement action ($f_i$) occurred during a particular month in our sample between December 2014 and December 2023. Moreover, $n_i$ is a period when an enforcement action was not recorded in the period ($t_i$). We compare positive and negative changes in price and trade volumes transacted during the sample period using a categorical dummy variable for Kaplan-Meier survival estimates (see Figs. 3 and 4). We evaluate the possible event of an increase (decrease) in trade volume that might influence a decrease (increase) in price at a given survival rate to account for its persistence in the crypto market. The same procedure used for price changes is applied to trade volume. As discussed in a review on hedonic time and imputation dummies, the price change dummy application methodology traces back to 1939 in economic studies (Diewert et al., 2009). Correspondingly, price and volume changes are applied to survival estimates in recent literature (Alvarez et al., 2021). Like other studies, our case is related to the modelling survival curve, which has a categorical binary of one and

**Table 1**
Description of data sources.

| Variables | Description | Sources |
|---|---|---|
| Time/months | The time frame for the enforcement, reported or otherwise, is in months, with at least one event per month. | Cornerstone research (Mola, 2023)[a] SEC press releases on cryptocurrency enforcement[b] |
| Enforcement/event | The categorical variable equals one if the SEC announces enforcement in a particular month, indicating administrative proceedings or litigation due to cryptocurrency exchange violations, and zero otherwise. | Cornerstone research (Mola, 2023)[a] SEC press releases on cryptocurrency enforcement[b] |
| Recent | A dummy variable that equals one for the period between December 2017 and December 2023 | Cornerstone research (Mola, 2023)[c] SEC press releases on cryptocurrency enforcement[b] |
| Price | Log of the closing price of cryptocurrency traded in a particular month | Yahoo finance database |
| Price spread | Difference between higher and lower prices traded on a particular period | Yahoo finance database |
| Volume | Log of the closing trade volume of cryptocurrency trade in a particular month | Yahoo finance database |
| Price volatility | The standard deviation of daily prices per month (in percentage) | Yahoo finance database |
| Digital assets Act | A dummy variable for the period between 2015 and 2023, revised uniform fiduciary access to digital assets Act (RUFADAA | Holt et al., 2024; Sy, 2016; Walker, 2017 [e] |
| Price difference | Difference between the current and previous prices of cryptocurrency traded in a period | Yahoo finance database |
| Positive price difference | Positive price asymmetry of the first difference | Yahoo finance database |
| Negative price difference | Negative price asymmetry of the first difference | Yahoo finance database |
| Recent × price difference | Interaction between recent period dummy and the price difference | Interaction[d] |
| Recent × positive price difference | Interaction between recent period dummy and positive price asymmetry of the first difference | Interaction[d] |
| Recent × negative price difference | Interaction between recent period dummy and negative price asymmetry of the first difference | Interaction[d] |
| Volume difference | Difference between the current and previous volume of cryptocurrency traded in a period | Yahoo finance database |
| Positive volume difference | Positive volume asymmetry of the first difference | Yahoo finance database |
| Negative volume difference | Negative volume asymmetry of the first difference | Yahoo finance database |
| Recent × volume difference | Interaction between recent period dummy and volume difference | Interaction[d] |
| Recent × positive volume difference | Interaction between recent period dummy and positive volume asymmetry of the first difference | Interaction[d] |
| Recent × negative volume difference | Interaction between recent period dummy and negative volume asymmetry of the first difference | Interaction[d] |
| Price change | Change between the current and previous price of cryptocurrency trade in a period | Yahoo finance database |
| Positive price change | Positive price change asymmetry of cryptocurrency trade between periods | Yahoo finance database |
| Negative price change | Negative price change asymmetry of cryptocurrency trade between periods | Yahoo finance database |
| Recent × price change | Interaction between recent period dummy and price change | Interaction[d] |
| Recent × positive price change | Interaction between recent period dummy and positive price change asymmetry | Interaction[d] |
| Recent × negative price change | Interaction between recent period dummy and negative price change asymmetry | Interaction[d] |
| Volume change | Change between the current and previous volume of cryptocurrency trade in a period | Yahoo finance database |
| Positive volume change | Positive volume change asymmetry of cryptocurrency trade between periods | Yahoo finance database |
| Negative volume change | Negative volume change asymmetry of cryptocurrency trade between periods | Yahoo finance database |
| Recent × volume change | Interaction between recent period dummy and volume change | Interaction[d] |
| Recent × positive volume change | Interaction between recent period dummy and positive volume change asymmetry | Interaction[d] |
| Recent × negative volume change | Interaction between recent period dummy and negative volume change asymmetry | Interaction[d] |

*Notes*.
[a] Enforcement data from Cornerstone, December 2014to December 2022.
[b] Enforcement data extracted qualitatively based on SEC press releases for 2023.
[c] A dummy variable for "recent" (Royston & Lambert, 2011).
[d] Interaction of data variable from Yahoo finance database and Cornerstone Research (Mola, 2023), with SEC press releases on cryptocurrency enforcement.
[e] A dummy variable is used between 2015 and 2023 for the period when the Revised Uniform Fiduciary Access to Digital Assets Act (RUFADAA) was approved.

**Table 2**
Descriptive analysis: Quantile regression.

| Statistics | Bitcoin | | | | | Islamicoin | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Price | Volatility | Volume | Price change | Price change lag | Price | Volatility | Volume | Price change | Price change lag |
| Mean | 10.1591 | 1.0355 | 23.7654 | 0.0002 | 0.0002 | −7.3364 | 1.1507 | 13.1627 | 0.0010 | 0.0011 |
| Standard deviation | 0.2615 | 0.0268 | 0.5038 | 0.0276 | 0.0276 | 0.5599 | 0.1954 | 1.3443 | 0.0541 | 0.0541 |
| Maximum | 10.7498 | 1.2102 | 25.5023 | 0.1074 | 0.1074 | −5.0199 | 3.6631 | 15.5002 | 0.9260 | 0.9260 |
| Minimum | 9.6670 | 1.0036 | 22.3968 | −0.1597 | −0.1597 | −8.6622 | 1.0025 | 4.7274 | −0.3816 | −0.3816 |
| Median | 10.1853 | 1.0281 | 23.8018 | −0.0005 | −0.0005 | −7.4062 | 1.1026 | 13.3416 | −0.0007 | −0.0006 |
| Skewness | 0.1873 | 2.3250 | −0.0825 | −0.3405 | −0.3399 | 1.2760 | 6.9653 | −2.6784 | 7.8931 | 7.9077 |
| Kurtosis | 2.3768 | 10.9536 | 2.8561 | 8.1204 | 8.1077 | 5.8021 | 72.8675 | 13.7380 | 146.1957 | 146.4978 |
| *N* | 640 | 640 | 640 | 639 | 638 | 640 | 640 | 640 | 639 | 638 |

*Note*: Price and volume converted into logarithms.
*Sources*: Authors' calculation based on the Yahoo finance database.

**Table 3**
Descriptive analysis: Survival and Probit models.

| Variable | Obs. | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| Time/Months | 109 | 55 | 31.6096 | 1 | 109 |
| Enforcement/event | 109 | 0.486239 | 0.502119 | 0 | 1 |
| Recent | 109 | 0.669725 | 0.472485 | 0 | 1 |
| Price | 109 | 8.656327 | 1.733344 | 5.382033 | 11.02384 |
| Price spread | 109 | 7.341502 | 1.894417 | 2.956524 | 10.26944 |
| Volume | 109 | 25.42816 | 2.659591 | 20.13105 | 28.44955 |
| Price volatility | 109 | 7.733056 | 4.508364 | 1.47566 | 20.24919 |
| Digital assets Act | 109 | 0.917431 | 0.276501 | 0 | 1 |
| Price difference | 108 | 0.045211 | 0.207569 | −0.47431 | 0.528443 |
| Positive price difference | 108 | 0.106915 | 0.135263 | 0 | 0.528443 |
| Negative price difference | 108 | 0.061704 | 0.107104 | 0 | 0.474314 |
| Recent × price difference | 108 | 0.013132 | 0.171708 | −0.47431 | 0.471561 |
| Recent × positive price difference | 108 | 0.06338 | 0.112485 | 0 | 0.471561 |
| Recent × negative price difference | 108 | 0.050248 | 0.101988 | 0 | 0.474314 |
| Volume difference | 108 | 0.066424 | 0.350367 | −0.81624 | 1.256002 |
| Positive volume difference | 108 | 0.16263 | 0.252674 | 0 | 1.256002 |
| Negative volume difference | 108 | 0.096206 | 0.165312 | 0 | 0.816237 |
| Recent × volume difference | 108 | 0.015137 | 0.241292 | −0.81624 | 1.070099 |
| Recent × positive volume difference | 108 | 0.079297 | 0.157373 | 0 | 1.070099 |
| Recent × negative volume difference | 108 | 0.064161 | 0.152266 | 0 | 0.816237 |
| Price change | 108 | 0.068642 | 0.221428 | −0.37769 | 0.696288 |
| Positive price change | 108 | 0.123528 | 0.164943 | 0 | 0.696288 |
| Negative price change | 108 | 0.054886 | 0.090209 | 0 | 0.377688 |
| Recent × price change | 108 | 0.028076 | 0.17762 | −0.37769 | 0.602493 |
| Recent × positive price change | 108 | 0.072572 | 0.132825 | 0 | 0.602493 |
| Recent × negative price change | 108 | 0.044496 | 0.085953 | 0 | 0.377688 |
| Volume change | 108 | 0.141609 | 0.474536 | −0.55791 | 2.511354 |
| Positive volume change | 108 | 0.222269 | 0.415062 | 0 | 2.511354 |
| Negative volume change | 108 | 0.080659 | 0.129293 | 0 | 0.557907 |
| Recent × volume change | 108 | 0.045815 | 0.280282 | −0.55791 | 1.915668 |
| Recent × positive volume change | 108 | 0.098585 | 0.23321 | 0 | 1.915668 |
| Recent × negative volume change | 108 | 0.05277 | 0.116917 | 0 | 0.557907 |

*Note:* Price and volume are converted into logarithm.
*Sources*: Authors' calculation are based on data from Cornerstone Research (Mola, 2023), SEC press releases on cryptocurrency enforcement, and the Yahoo finance database.

zero to distinguish two different events on price and volume changes (Evrensel, 2008; Iwasaki et al., 2021; Lee & Kim, 2014; Royston & Lambert, 2011). The survival estimates are depicted in Figs. 3 and 4. Then, the asymmetry in price and volume changes (difference) is generated and decomposed into positive and negative. We account for the asymmetric effect of change (Tables 6 and 7) and the first difference (Appendixes Tables 3 and 4) on the parametric survival analysis and Probit model, which is consistent with recent studies (Allison, 2019; Gietzmann et al., 2016; York & Light, 2017). The findings of the two estimations (based on changes and first difference) are consistently the same in our models, except for the size of the coefficients.

Building on Deville and Riva (2007), we employ a parametric survival analysis, focusing on the Weibull distribution in our financial market analysis. This distribution allows us to comprehensively account for the effect of covariates on violations of crypto-asset regulations over time, particularly those for which the SEC enforces a penalty. The Weibull distribution is adopted for the parameterization estimate, considering the cumulative enforcement trend in various trade events highlighted in Fig. 2, which increases exponentially over time. The proportionate hazard of the Weibull model is expressed as $h(t) = p\gamma t^{p-1}$ where $p > 0$, which is the shape of the parameter, and $\gamma > 0$ is the scale parameter (StataCorp, 2023). We then add covariates to explain the time to enforcement as a linear relationship, following the approach by Deville and Riva (2007). Equation (4) is as follows:

$$h_i(t, x; T \sim Weibull) = p\gamma(\gamma t)^{p-1} \; exp(x_i\beta), \tag{4}$$

where $x_i$ is the vector of covariates, and $\beta$ is the coefficient; the interactive effects reflect the heterogeneity of events observed in the market, that is, the covariate interactive effect $exp(x_i\beta)$ does not change the shape of the distribution in time $T$; rather, it changes the scale, therefore, it expresses the proportionate hazard perspective in the model. Following Royston and Lambert (2011), we next perform a robust analysis using the Probit model, beginning with Equation (5), and described the Probit model into the survival probability scale, where $\varphi(\bullet)$ is the function of the standard normal cumulative distribution, and its inverse, $\varphi^{-1}(\bullet)$, is the Probit link function (Rabe-Hesketh & Skrondal, 2012; Liu, 2012). The link function of the Probit model, which appears to follow a standard normal distribution, enables us to confirm the results of our parametric estimations (Agresti, 2015; Royston & Lambert, 2011; Royston & Parmar, 2002). Prior studies use these two models (survival and Probit) to check the robustness of their findings (Albornoz et al., 2016; Brown et al., 2001; Chevalier & Ellison, 1999). Therefore, we build on the Royston and Lambert (2011) estimation of the probit equation, as follows:

$$-\varphi^{-1}\{Pr(y=1|x)\} = \beta_0 + x\beta \tag{5}$$

The constant $\beta_0$ is substituted by the transformed baseline survival function $-\varphi^{-1}\{S_0(\ln t)\}$. Therefore, we can revise it as follows:

$$-\varphi^{-1}\{S(\ln t)\} = \gamma_0 + \gamma_1 \ln t + x\beta \tag{6}$$

**Table 4**
Price-volume relations: Quantile regression.

| Variables | Bitcoin | | | | Islamicoin | | | |
|---|---|---|---|---|---|---|---|---|
| | 0.25q | 0.5q | 0.75q | 0.95q | 0.25q | 0.5q | 0.75q | 0.95q |
| | log_price-Bit | log_price-Bit | log_price-Bit | log_price-Bit | log_price-Isl | log_price-Isl | log_price-Isl | log_price-Isl |
| Volume | −0.255*** | −0.232*** | −0.0185 | 0.245*** | 0.431*** | 0.406*** | 0.280*** | 0.209*** |
| | (0.0170) | (0.0128) | (0.0435) | (0.0460) | (0.0409) | (0.0513) | (0.0456) | (0.0312) |
| Volatility | 2.408*** | 3.223*** | 0.296 | −3.299*** | 0.303** | 0.565** | 1.394*** | 2.279*** |
| | (0.501) | (0.611) | (0.912) | (0.791) | (0.124) | (0.264) | (0.277) | (0.754) |
| Price changes lag | 0.891* | 0.692** | 0.0351 | 0.422 | 0.256 | −0.216 | −0.177 | −0.770 |
| | (0.489) | (0.315) | (0.418) | (0.522) | (1.039) | (1.126) | (0.801) | (0.872) |
| Constant | 13.57*** | 12.31*** | 10.44*** | 8.195*** | −13.63*** | −13.40*** | −12.47*** | −11.85*** |
| | (0.437) | (0.594) | (0.441) | (0.821) | (0.581) | (0.665) | (0.587) | (1.060) |
| Observations | 638 | 638 | 638 | 638 | 638 | 638 | 638 | 638 |

*Notes:* Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
*Sources*: Authors' calculation based on data from the Yahoo finance database.

where $\gamma_1 = \frac{1}{\sigma}$ and $\gamma_0 = \frac{-\beta_0}{\sigma}$, and we generalize it in a similar direction:

$$-\varphi^{-1}\{S(\ln t)\} = s(\ln t;\gamma) + x\beta \tag{7}$$

where $x$ is a vector of covariates with a coefficient $\beta$ that is modelled using a normal scale based on the degree of freedom.

### 3.1. Data and sample

The data in this study mainly come from the Yahoo finance database, Cornerstone Research Institute (Mola, 2023), and press releases on SEC cryptocurrency enforcement actions. Table 2 defines the variables used in the study, for the sample period December 2014 to December 2023. However, in Tables 4 and 5, the comparative analysis of Bitcoin and Islamicoin uses the sample period April 2022 to December 2023, when Islamicoin was introduced in the market, a period that is similar to the one used in a study on cryptocurrency markets by Nimalendran et al. (2024). Therefore, we predict the price of crypto assets based on trade volume, volatility, and lagged price changes over that period, with a total of 640 observations (based on the availability of data on the Islamicoin, which began to report activity in 2022). The price and trade volume data in Table 1 come from the Yahoo finance database. We enhance the analysis on Bitcoin, which has sufficient data and recorded other enforcement actions by the SEC. Therefore, the Kaplan-Meier survival estimates, Weibull parameterization survival analysis, and the Probit model for robust analysis use data from December 2014 to December 2023.

The time-to-event categorical data are derived from qualitative information from Cornerstone Research (Mola, 2023) and SEC press releases on cryptocurrency enforcement actions. As in several prior studies, we use a dummy variable to identify events during the sample period, such as financial crises (Aliyu et al., 2023; Beck et al., 2013), initial coin offerings (Adhami et al., 2018), prices (Diewert et al., 2009), and the period and calendar time (Aliyu et al., 2024; Butler & Cornaggia, 2011; Kinateder & Papavassiliou, 2021). Therefore, we construct "recent" variables following previous studies using a dummy to represent an identified event (Kinateder & Papavassiliou, 2021; Louwers et al., 1999; Royston & Lambert, 2011). This study considers a recent period, between December 2017 and December 2023, when cumulative enforcement began to rise at an increasing rate (see Fig. 2). Moreover, to explore the extent of recent activities in the market, we interact the dummy for recent variables with price and trade volume changes (difference) and for negative and positive changes (difference) with price and trade volume. We then use price and trade volume as they influence each other in the crypto-asset market (Conlon et al., 2024), and they are expressed in logarithm (Bandi et al., 2024; Sigaux, 2024).

Consequently, changes in the price and trade volume are calculated based on the time difference $\Delta y_n = \left(\frac{y_t}{y_{t-1}} - 1\right)$. Although some studies use dummy variables to express changes (Ante et al., 2021; Urquhart, 2017), we calculate the changes and decompose them into negative and positive price and trade volume, based on previous studies (Allison, 2019; York & Light, 2017), to evaluate the hazard exposure to different conditions when these changes occur. Following Baig et al. (2019), the price spread variable is the difference in the logarithm of high and low traded prices for a particular monthly market transaction, used in studies exploring investors' trade sentiment behavior (Kim & Kauffman, 2024). Furthermore, the standard deviation of the daily price per month is used to measure the price volatility risk (in survival and probit models) in each month of transactions (Liu & Tsyvinski, 2021). Consequently, we proxy for the release of a proposed digital law to protect the security and privacy of the holder of a digital asset even after death (Holt et al., 2024; Sy, 2016; Walker, 2017). Therefore, we construct a dummy variable for "digital assets Act," which equals one after September 28, 2015, when the final text of the Revised Uniform Fiduciary Access to Digital Assets Act (RUFADAA) was released, to the end of the sample period, and zero otherwise. Finally, we generate interactive variables between changes (difference) and recent events to account for the influence of a recent increase in enforcement actions on those variables.

## 4. Results and discussion

The section shows the trends in Bitcoin and Islamicoin and provides a descriptive analysis. As of August 2022, the total number of crypto assets in circulation worldwide was as much as 20,676, and the global crypto capital market totaled $1.03 trillion (CoinMarketCap, 2022). One of these crypto assets is the Islamic Coin (Islamicoin), the world's first sharia-compliant crypto asset. Trading in it in the UAE began at the end of March 2022. The leading authorities gave a *fatwa* (legal opinion in Islamic law) on it based on its use of proof-of-stake mining, dedication to charity, and its decentralized nature based on the Haqq blockchain (PR, 2022). Therefore, price changes in the Islamic crypto asset are assumed to reflect the volume of transactions and other markets' momentum, which predicts genuine trading activity. Daily trading activity in Bitcoin and Islamicoin shows that the latter appreciates more than the former with respect to price changes. Fig. 1 indicates higher performance by Islamicoin based on daily price changes, especially in 2022 and the first quarter of 2023, and fluctuation in the last quarter of 2023 through early 2024, respectively.

The change in Islamicoin prices increases from 53 percent on April 11, 2022, to 166 percent two weeks later. Although it recorded a slight drop to 105 percent on April 29, 2022, it continues to appreciate more

**Table 5**
Price changes and volume Relations: Quantile Regression.

| Variables | Bitcoin | | | | Islamicoin | | | |
|---|---|---|---|---|---|---|---|---|
| | 0.25q | 0.5q | 0.75q | 0.95q | 0.25q | 0.5q | 0.75q | 0.95q |
| | Price_changes-Bit | Price_changes-Bit | Price_changes-Bit | Price_changes-Bit | Price_changes-Isl | Price_changes-Isl | Price_changes-Isl | Price_changes-Isl |
| Volume | 0.00245 | −0.000886 | −0.00279* | −0.000238 | 0.00715*** | 0.00337** | −0.000084 | −0.0141*** |
| | (0.00161) | (0.00276) | (0.00166) | (0.00119) | (0.00204) | (0.00160) | (0.00160) | (0.00475) |
| Volatility | −0.704*** | 0.00933 | 0.793*** | 0.938*** | −0.00274 | 0.0205*** | 0.0399*** | 0.111* |
| | (0.0906) | (0.173) | (0.0809) | (0.0335) | (0.0113) | (0.00657) | (0.00998) | (0.0576) |
| Price changes lag | 0.00693 | −0.0693* | −0.0349 | −0.0451* | −0.0983 | −0.0732 | −0.0685 | 0.165 |
| | (0.0380) | (0.0412) | (0.0425) | (0.0269) | (0.0762) | (0.0686) | (0.103) | (0.158) |
| Constant | 0.652*** | 0.0106 | −0.735*** | −0.935*** | −0.102*** | −0.0685*** | −0.0358* | 0.0958 |
| | (0.0664) | (0.125) | (0.0642) | (0.0231) | (0.0250) | (0.0201) | (0.0202) | (0.0606) |
| Observations | 638 | 638 | 638 | 638 | 638 | 638 | 638 | 638 |

*Notes:* Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
*Sources*: Authors' calculation based on data from the Yahoo finance database.

than the price of Bitcoin in May and October. However, the Bitcoin price changes reveal relatively stable market momentum, with higher performance than Islamicoin in June, July, and September 2022, as well as January 2024. The price changes for Islamicoin exhibit higher volatility, which might create other concerns, primarily when they come from excessive speculation that is not due to trading activity. This motivates our focus on assessing the price-volume relation to examine its compliance with sharia fundamentals, as discussed in prior literature (El-Ashkar, 1995).

Furthermore, the positive growth and development of crypto assets gave rise to real-world questions about the inheritance of crypto assets after the death of their owner. Ownership of conventional crypto assets presents significant challenges in estate planning and inheritance planning (Szwajdler, 2023). As mentioned earlier, only the owners of conventional crypto assets know the credential information, such as a password or private key, needed to access them; the crypto-asset wallet is inaccessible without this information, even with a court order. About four million bitcoins are reportedly orphaned indefinitely because of the death of their the owners, who did not reveal the private key to the beneficiaries of their estate (Qureshi, 2022). In addition, some crypto assets are lost due to identity theft or fraud perpetrated by scammers. In 2021, losses due to crypto-related crimes totaled $14 billion, an increase of 79 percent over the level in 2020, driven by a spike in theft and scams (Sigalos, 2022).

Fig. 2 indicates a constant increase in administrative proceedings and litigation against those who try to influence market performance through illegal activities, such as unfair trading and market manipulation (Allen & Gale, 1992), resulting in enforcement actions by the SEC. It shows a sharp rise in enforcement activity, increasing to double digits starting at the end of 2017 and increasing exponentially until the end of the sample period in 2023. Thus, in 127 lawsuits and administrative proceedings on cryptocurrency cases, the SEC levied $2.61 billion in penalties (Mola, 2023). The Cornerstone Research report (Mola, 2023) identifies issues related to SEC's trading rules violations due to unregistered offerings to non-eligible contracts and participants in the securities exchange, promoting securities with hidden compensation, and fraudulent sales of securities. Therefore, to evaluate the likelihood of reducing these risks, we explore the risk effect of the crypto price, trade volume, price spread, and market price volatility on the SEC's cryptocurrency enforcement activity between 2014 and 2023.

Consequently, the digital asset Act is used to investigate how it prevents cryptocurrency fraud and manipulation of the market, as well as protecting investors' digital data even after death. Thus, it is related to activities concerning crypto assets after the demise of their owner as well as the absence of regulations or laws that govern passing down crypto assets to legal heirs or beneficiaries of that owner (Beyer, 2019, 2020; Beyer and G. Nipp, 2020). To date, no comprehensive legal framework has been developed to support inheritance of crypto assets (Conway & Grattan, 2017; Saleh et al., 2020; Zalucki, 2020), creating concerns for estate planners globally about managing crypto assets (Farmer &Tyszka, 2014). Hence, owners must devise various ways to ensure that their crypto assets will be given to their heirs (Heilweil, 2022; Noonan, 2015). We explore the data to evaluate the trade-volume relationship and analyze the effect of market mechanisms on the time to events and the extent to which market manipulation that leads to enforcement activity by the SEC exposes investors to risk hazards.

Table 2 gives a descriptive analysis of the data using quantile regression, in which the price and trade volume are expressed in logarithm. Because most of the prices for Islamicoin traded daily are less than one, conversion to logarithm causes their values for the mean, median, and minimum to be negative, which is not the case for Bitcoin.

Table 2 describes the data used in the first comparative analysis (see Tables 4 and 5). A sample of 640 daily data points was used except for price change and lagged price change, for which the data were converted to the time difference. Then, the table lists other information related to skewness and kurtosis, and the latter shows the trend of excessive volatility on Islamicoin (price changes and lag of price changes, which is more than 146, respectively) compared to Bitcoin (price changes and lagged price changes, which is more than 8) as depicted in Fig. 1. As explained by its wider price dispersion from the mean, Islamicoin has higher price volatility (0.56) than Bitcoin (0.26), reflecting the trend seen in Fig. 1. Thus, the kurtosis of the price change differentials indicates more significant concerns for Islamicoin than Bitcoin (see Fig. 1), primarily if the trade volume does not determine the price fluctuations. In Tables 4 and 5, we investigate how trade volume predicts price changes in the two types of crypto assets.

Table 3 gives a descriptive analysis of different measures based on monthly data for 109 Bitcoin observations. For instance, the data is categorically generated based on one and zero, including time to enforcement events and the proposed digital assets Act. Thus, these data sets have a minimum value of zero and a maximum of one, with relative dispersion from the mean of 31.61. However, we obtain negative and positive price and trade volume changes (difference) based on the asymmetric change and differences in transaction (Allison, 2019; York & Light, 2017).

Variables such as price and trade volume are expressed in logarithm, and the trade volume has a higher volatility rate than prices traded in the market. Similarly, the price spread is the difference between the bid and ask prices for a particular transaction. It was recorded at an average of 7.34 with dispersion from a mean of 1.894, which was not up to its minimum value of 2.957 in the sample. At the same time, we have 108 observations of price and trade volume changes (difference) in their

interactions because they are based on a one-period change (difference) between the negative and positive changes. These changes are identified by the minimum −0.38 (−0.56) and maximum 0.696 (2.511) for the price (trade volume). However, price volatility has a minimum of 1.476 and maximum of 20.249. Lastly, Table 3 shows the interactions of recent time activities with positive and negative changes (difference) in price and trade volume and fundamental changes in price and trade volume, respectively. Therefore, those with a dummy variable for recent time activities, digital law, and enforcement events have a minimum of zero and a maximum of one. In contrast, later interaction variables have a minimum of zero because of interaction between the variables with a maximum that is different from that of the earlier price and trade volume change (difference), accounting only for events between December 2017 and December 2023.

### 4.1. Comparative analysis of crypto assets

As digital assets become part of global finance traded in different jurisdictions and regions, financial market operations become faster and more complex. Recently, Islamicoin, the sharia-compliant coin, was introduced in Islamic finance. It has distinctive characteristics, including avoidance of excessive speculation, gambling, and interest, and sharia-compliant estate-planning guidelines, similar to those for other Islamic financial assets (El-Ashkar, 1995; Kamali, 1996; Wahab et al., 2021).

Appendix Tables 1 and 2 on Islamicoin and Bitcoin, respectively, present a linear estimation of trade volume based on the asset price.

Tables 4 and 5 present a comparative analysis between Bitcoin and Islamicoin traded between April 2022 and December 2023 based on 638 daily observations (2 of which are for the difference due to price change calculations), confirming prior literature. Table 4 shows the relationship between price and trade volume for the two different crypto assets on four different quantiles for the same period. Our findings for the Islamicoin estimations reveal a positive relationship between price and trade volume for all quantiles in Table 4. In contrast, Bitcoin indicates a negative relationship in the first two quantiles with no significant relations at the third quantile. The positive findings are consistent with those in prior literature (Grammatikos & Saunders, 1986; Karpoff, 1987). The results support the mixture of distribution hypotheses, which claim that persistent economic activity is explained by market activities derived from the volume of transactions, as argued in prior literature (Ying, 1966). The finding supports the Islamic finance principle about acceptable speculative activities that form trading activities and use available information to predict price changes in financial securities (El-Ashkar, 1995).

However, our findings regarding Bitcoin are insignificant, especially in Table 5. Similarly, Table 5 presents three quantiles with insignificant results for Bitcoin compared to Islamicoin based on the price changes to volume relationship. The findings are consistent with those on Bitcoin in a similar analysis (Szetela et al., 2021) using a vector error correction model, which yields long- and short-run projections. Their inferences reveal an insignificant relationship between price changes and trade volume in the long run, with weak dependence in the short run. However, the two assets have similar volatility behavior in the two estimations. Thus, sometimes prices in the Bitcoin market do not show a linear relationship (Aalborg et al., 2019; Conlon & McGee, 2020; El Alaoui et al., 2019; Gemici & Polat, 2019; Palamalai et al., 2021; Raza et al., 2022b; Sahoo et al., 2019; Szetela et al., 2021)—meanwhile, other papers express concern about market manipulation, rather than trading activities (Mola, 2023; SEC, 2024). Therefore, we extend the analysis with survival estimates and parameterization models on market mechanisms on the time to the enforcement event.

### 4.2. Parametric and nonparametric survival analysis

In this study, we perform a survival analysis to estimate the level of survivability of crypto-asset transactions in the market despite manipulation that leads to litigation and administrative proceedings by the SEC (Mola, 2023). However, the enforcement actions indicate violations of trade regulations in the financial market, which indicates a high likelihood of other risk exposure to digital asset holders and the economy in general. Nevertheless, despite the equal potential for risk exposure in the crypto-asset market, aggressive investors are eager to acquire more crypto because of the volatile nature of the market, which increases investors' expectation and confidence about earning higher income in the future. This supports the prospect theory (Kahneman & Tversky, 1979) argument that investors' perception of gain influences their decision to invest despite the riskiness of crypto assets.

Therefore, we estimate the survival of crypto assets during the time-to-enforcement events and analyze the price and trade volume changes in two scenarios. Then, we compare decreases and increases in price and trade volume. Fig. 3 indicates a higher survival rate when price changes decrease, which means a lower likelihood of market regulatory violations and reductions in enforcement. This corresponds with the potential for higher trading activity on the market, as depicted in Fig. 4. Fig. 4 illustrates that the survival rate is higher when trading activity increases than when trade volume in the market decreases. Therefore, risk exposure from crypto assets might be reduced when the market mechanism is controlled by instruments that drive the market, rather than by market manipulation that violates SEC regulations. We extend the analysis using parametric survival analysis to evaluate the likelihood of risk exposure from market mechanisms.

#### 4.2.1. The parameterization of weibull distribution

In this section, we perform further analysis by considering the earlier cumulative distribution structure of the enforcement actions illustrated in Fig. 2. Fig. 2 shows that the cumulative structure resembles that of the sharps $(p > 0)$ in the Weibull distribution, which we adopt and model based on the survival parametric analysis families. Consistent with our prior expectations, the results in Table 4 demonstrate a significant logarithm sharp parameter ($ln_p$) for each estimated model that is greater than zero, as explained in Equation (4). Table 6 estimated recent time activities, crypto-asset prices, price spread, trade volume, and price volatility using the baseline model. Each subsequent model adds another variable to the baseline and evaluates its behavior, which includes proposed digital assets Act, changes in price and trade volume (differences), and moderating interactions. Consistent with the trend in Fig. 2, recent market activities indicate a persistent increase in risk exposure, in which the enforcement rate substantially increases. We identify a higher increase in risk exposure when our model accounts for price changes and their interactions. This indicates that those who violate exchange regulations are motivated to manipulate market activities through influencing price changes in the market. This is clear in fraudulent offerings, which cause excessive price volatility (Goforth, 2020), and a recent hack of SEC social media accounts, which resulted in higher Bitcoin prices.[7] Therefore, it is challenging for securities exchange regulators ensure cybersecurity and enforce regulations so as to protect the interests of investors. However, the findings reveal that complying with regulations through fair dealing in trading activities based on derived prices reduces risk exposure in the market. Therefore, the price, trade volume, and volatility based on fair trading activities will likely reduce the risk exposure to regulatory violations that can lead to securities exchange enforcement actions over time.

However, price spreads drive regulatory violations, which result in enforcement actions through either litigation or administrative

[7] "Fake SEC social media post puts security practices of Wall Street watchdog in spotlight," https://www.investopedia.com/fake-sec-social-media-post-puts-security-practices-of-wall-street-watchdog-in-spotlight-8424778/; "SEC probing fake post on its X account, bitcoin ETFs not yet approved," https://www.reuters.com/technology/us-sec-has-not-approved-bitcoin-etfs-social-media-account-compromised-2024-01-09/.

**Table 6**
Risk exposure and market mechanisms: Survival analysis.

| Variables | Model_1 | Model_2 | Model_3 | Model_4 | Model_5 | Model_6 | Model_7 | Model_8 | Model_9 | Model_10 | Model_11 | Model_12 | Model_13 | Model_14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Recent | 2.394* | 2.641* | 3.289** | 3.056* | 3.589** | 3.082* | 2.789* | 3.679** | 2.522 | 2.652 | 2.690* | 2.645* | 2.653* | 2.627* |
| | (1.313) | (1.530) | (1.619) | (1.602) | (1.643) | (1.629) | (1.613) | (1.638) | (1.592) | (1.627) | (1.578) | (1.572) | (1.574) | (1.581) |
| Price | −3.620*** | −3.718*** | −5.100*** | −4.879*** | −5.439*** | −5.066*** | −4.844*** | −5.444*** | −4.603*** | −4.558*** | −4.741*** | −4.581*** | −4.566*** | −4.737*** |
| | (0.798) | (0.820) | (0.885) | (0.873) | (0.920) | (0.882) | (0.868) | (0.923) | (0.882) | (0.878) | (0.899) | (0.881) | (0.879) | (0.897) |
| Price spread | 2.332*** | 2.373*** | 3.374*** | 3.175*** | 3.660*** | 3.343*** | 3.141*** | 3.667*** | 2.925*** | 2.896*** | 3.064*** | 2.910*** | 2.917*** | 3.060*** |
| | (0.761) | (0.781) | (0.849) | (0.832) | (0.880) | (0.845) | (0.828) | (0.882) | (0.822) | (0.825) | (0.834) | (0.822) | (0.829) | (0.832) |
| Volume | −0.763** | −0.692** | −0.924*** | −0.880*** | −0.940*** | −0.913*** | −0.868*** | −0.944*** | −0.771** | −0.783** | −0.796** | −0.776** | −0.802** | −0.794** |
| | (0.304) | (0.313) | (0.339) | (0.336) | (0.337) | (0.339) | (0.336) | (0.337) | (0.326) | (0.327) | (0.327) | (0.325) | (0.327) | (0.327) |
| Price volatility | −0.167** | −0.173** | −0.243*** | −0.249*** | −0.206** | −0.240*** | −0.246*** | −0.207** | −0.215*** | −0.215*** | −0.224*** | −0.215*** | −0.218*** | −0.224*** |
| | (0.0772) | (0.0789) | (0.0803) | (0.0817) | (0.0802) | (0.0801) | (0.0813) | (0.0803) | (0.0816) | (0.0820) | (0.0820) | (0.0816) | (0.0820) | (0.0819) |
| Digital assets Act | | −5.285*** | | | | | | | | | | | | |
| | | (1.524) | | | | | | | | | | | | |
| Price change | | | 1.677** | | | | | | | | | | | |
| | | | (0.697) | | | | | | | | | | | |
| Positive price change | | | | 1.905* | | | | | | | | | | |
| | | | | (1.052) | | | | | | | | | | |
| Negative price change | | | | | −5.948*** | | | | | | | | | |
| | | | | | (1.966) | | | | | | | | | |
| Recent × price change | | | | | | 1.665** | | | | | | | | |
| | | | | | | (0.700) | | | | | | | | |
| Recent × positive price change | | | | | | | 1.897* | | | | | | | |
| | | | | | | | (1.063) | | | | | | | |
| Recent × negative price change | | | | | | | | −5.914*** | | | | | | |
| | | | | | | | | (1.970) | | | | | | |
| Volume change | | | | | | | | | −0.301 | | | | | |
| | | | | | | | | | (0.557) | | | | | |
| Positive volume change | | | | | | | | | | 0.00242 | | | | |
| | | | | | | | | | | (0.810) | | | | |
| Negative volume change | | | | | | | | | | | 1.067 | | | |
| | | | | | | | | | | | (0.985) | | | |
| Recent × volume change | | | | | | | | | | | | −0.178 | | |
| | | | | | | | | | | | | (0.582) | | |
| Recent × positive volume change | | | | | | | | | | | | | 0.374 | |
| | | | | | | | | | | | | | (0.868) | |
| Recent × negative volume change | | | | | | | | | | | | | | 1.086 |
| | | | | | | | | | | | | | | (0.985) |
| ln_p | 1.797*** | 1.835*** | 2.055*** | 2.040*** | 2.076*** | 2.053*** | 2.037*** | 2.076*** | 2.011*** | 2.008*** | 2.015*** | 2.010*** | 2.008*** | 2.015*** |
| | (0.113) | (0.112) | (0.108) | (0.109) | (0.107) | (0.108) | (0.109) | (0.107) | (0.109) | (0.109) | (0.109) | (0.109) | (0.109) | (0.109) |
| Constant | 8.793 | 11.53* | 10.67 | 9.693 | 11.18 | 10.59 | 9.644 | 11.17 | 7.553 | 7.648 | 8.063 | 7.539 | 8.018 | 8.096 |
| | (6.385) | (6.418) | (7.257) | (7.210) | (7.150) | (7.249) | (7.201) | (7.163) | (6.936) | (6.953) | (6.975) | (6.937) | (6.995) | (6.970) |
| Observations | 109 | 109 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 |

*Notes*: Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
*Sources*: Authors' calculations based on data from Cornerstone Research (Mola, 2023), SEC press releases on cryptocurrency enforcement, and the Yahoo finance database.

**Table 7**
Risk exposure and markets mechanism: Probit model.

| Variables | Model_1 | Model_2 | Model_3 | Model_4 | Model_5 | Model_6 | Model_7 | Model_8 | Model_9 | Model_10 | Model_11 | Model_12 | Model_13 | Model_14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Recent | 2.356*** | 1.963** | 3.001*** | 2.784*** | 2.506** | 2.637** | 2.338** | 3.083*** | 2.015** | 2.093** | 1.938** | 2.022** | 1.955** | 1.877* |
| | (0.868) | (0.956) | (1.048) | (1.038) | (0.997) | (1.033) | (1.015) | (1.047) | (0.986) | (0.989) | (0.963) | (0.971) | (0.974) | (0.973) |
| Price | −1.378** | −1.688*** | −4.280*** | −4.037*** | −3.110*** | −4.215*** | −3.978*** | −4.377*** | −3.367*** | −3.366*** | −3.407*** | −3.368*** | −3.393*** | −3.402*** |
| | (0.575) | (0.603) | (0.761) | (0.749) | (0.456) | (0.754) | (0.739) | (0.762) | (0.690) | (0.690) | (0.692) | (0.690) | (0.691) | (0.692) |
| Price spread | 1.047* | 1.196** | 2.986*** | 2.797*** | 1.810*** | 2.927*** | 2.742*** | 3.033*** | 2.227*** | 2.230*** | 2.232*** | 2.240*** | 2.257*** | 2.226*** |
| | (0.550) | (0.573) | (0.675) | (0.668) | (0.335) | (0.669) | (0.660) | (0.673) | (0.624) | (0.624) | (0.625) | (0.624) | (0.624) | (0.625) |
| Volume | −0.767*** | −0.593*** | −0.993*** | −0.958*** | −0.849*** | −0.975*** | −0.939*** | −0.976*** | −0.807*** | −0.820*** | −0.780*** | −0.825*** | −0.835*** | −0.777*** |
| | (0.214) | (0.226) | (0.248) | (0.247) | (0.237) | (0.248) | (0.247) | (0.246) | (0.239) | (0.239) | (0.238) | (0.239) | (0.238) | (0.238) |
| Price volatility | −0.0587 | −0.0635 | −0.198*** | −0.204*** | | −0.191*** | −0.197*** | −0.141** | −0.126* | −0.128* | −0.121* | −0.131* | −0.134** | −0.120* |
| | (0.0624) | (0.0642) | (0.0705) | (0.0739) | | (0.0700) | (0.0729) | (0.0667) | (0.0668) | (0.0666) | (0.0668) | (0.0669) | (0.0667) | (0.0668) |
| Digital assets Act | | −4.217*** | | | | | | | | | | | | |
| | | (0.784) | | | | | | | | | | | | |
| Price change | | | 1.982*** | | | | | | | | | | | |
| | | | (0.666) | | | | | | | | | | | |
| Positive price change | | | | 2.306** | | | | | | | | | | |
| | | | | (0.977) | | | | | | | | | | |
| Negative price change | | | | | −5.851*** | | | | | | | | | |
| | | | | | (1.719) | | | | | | | | | |
| Recent × price change | | | | | | 1.984*** | | | | | | | | |
| | | | | | | (0.675) | | | | | | | | |
| Recent × positive price change | | | | | | | 2.350** | | | | | | | |
| | | | | | | | (1.004) | | | | | | | |
| Recent × negative price change | | | | | | | | −6.072*** | | | | | | |
| | | | | | | | | (1.755) | | | | | | |
| Volume change | | | | | | | | | 0.0161 | | | | | |
| | | | | | | | | | (0.341) | | | | | |
| Positive volume change | | | | | | | | | | 0.164 | | | | |
| | | | | | | | | | | (0.393) | | | | |
| Negative volume change | | | | | | | | | | | 0.774 | | | |
| | | | | | | | | | | | (0.929) | | | |
| Recent × volume change | | | | | | | | | | | | 0.246 | | |
| | | | | | | | | | | | | (0.386) | | |
| Recent × positive volume change | | | | | | | | | | | | | 0.591 | |
| | | | | | | | | | | | | | (0.476) | |
| Recent × negative volume change | | | | | | | | | | | | | | 0.830 |
| | | | | | | | | | | | | | | (0.942) |
| Restricted cubic splines (df_1) | 2.327*** | 2.969*** | 5.340*** | 5.195*** | 5.171*** | 5.315*** | 5.177*** | 5.436*** | 4.875*** | 4.887*** | 4.895*** | 4.899*** | 4.948*** | 4.893*** |
| | (0.237) | (0.297) | (0.536) | (0.523) | (0.513) | (0.532) | (0.519) | (0.541) | (0.487) | (0.488) | (0.489) | (0.489) | (0.494) | (0.488) |
| Constant | 21.89*** | 23.21*** | 38.49*** | 36.96*** | 32.59*** | 38.19*** | 36.72*** | 38.44*** | 31.73*** | 31.95*** | 31.31*** | 32.13*** | 32.48*** | 31.29*** |
| | (4.647) | (4.939) | (6.352) | (6.285) | (5.536) | (6.344) | (6.279) | (6.270) | (5.802) | (5.796) | (5.781) | (5.816) | (5.824) | (5.781) |
| Observations | 109 | 109 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 |

*Notes*: Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. df = degree of freedom.
*Sources*: Authors' calculations based on data from Cornerstone Research (Mola, 2023), SEC press releases on cryptocurrency enforcement, and the Yahoo finance database.

proceedings. This effect has influenced the market through price changes, as shown by Aggarwal and Wu (2006). In this way, risk exposure might increase due to price manipulation affected by the market's wide price spreads. It is particularly evident when the model accounts for price change and its interaction. However, the proposed digital assets Act will likely reduce the threat of regulatory violations that lead to enforcement actions in the crypto-asset market. We find an inverse relation between the proposed digital assets Act, which preserves the digital information of investors even after their death, and risk exposure to regulatory violations. In this way, the proxy variable for crypto-asset estate planning highlights the need to strengthen regulations that allow the transfer of assets to beneficiaries if all necessary conditions are met. This enables beneficiaries to claim digital assets in court because the law protects the assets in question. In addition, protecting the accounts of the deceased holders of digital assets against hacking intended to fraudulently claim ownership also preserves the wealth of potential beneficiaries. Market mechanisms influence trading activities, which, in turn, affect financial securities and economic performance. Our findings show the significant influence of price changes (differences) in increasing risk exposure that leads to enforcement actions due to regulatory violations. Nevertheless, changes in trade volume (differences) are insignificant (see models 9–14 in Tables 6 and 7, and Appendixes Tables 3 and 4). However, the sign supports the initial survival estimate in Fig. 4, where an increase in trading volume has a higher survival rate than influencing market performance without direct trading in the market.

The results in Table 6 analyze the interactions between recent activities and price changes (difference), asymmetrical indicators for positive and negative prices, and change in trade volume (difference). Hence, our findings show that price changes (differences) have increased enforcement events, especially those that are positive. In contrast, negative price changes (differences) have reduced the motivation and likelihood of regulatory violations. Although the estimation of recent time activities in Models 9 and 10 and its interactions in Models 9 to 14 are insignificant, they provide consistent policy implications. Thus, a change in trade volume reduces the risk hazard that can lead to enforcement actions, especially when the change is positive. However, negative changes in trade volume when market activities are manipulated through other regulatory violations influence the likelihood of SEC enforcement actions over time. Therefore, regulators must continue to monitor trade volume movements and their effect on price changes to identify early warning signals about criminal activities in the crypto-asset market.

### *4.3. Probit model: a robustness analysis*

The study introduces another procedure using the Probit model in estimating Equation (7). The model assumes an inverse normal distribution derived from the initial survival function. It considers recent time activities, crypto-asset prices, trade volume, price spread, and price volatility as foundational model requirements in all estimations. Consistent with earlier findings and other similar studies, the robustness analysis in Table 7 presents the same results as Table 6, with some exceptions in a few places where the volatility result is insignificant in Model (1) and recent activities in Models (9) and (10) are significant.

Price changes remain a significant influencer on the likelihood of enforcement action over time, especially with positive price changes. Table 7 also presents consistent findings on the price, trade volume, price volatility, and the proposed digital assets Act throughout the table. These factors are likely to reduce the tendency of risk exposure to regulatory violations that can lead to enforcement actions by the SEC. However, the price volatility variable has insignificant findings when the models include the recent time interaction of trade volume with signs that are consistent with the estimation in Table 6.

Table 7 has significant findings for recent time interactions on price changes and positive asymmetric interactions in price changes. Nevertheless, despite the insignificant results on the interactions of other recent time activities with trade volume, they report the same signs as those in Table 6, except for positive and negative asymmetry in trade volume. Further studies should also investigate this phenomenon and explore the influence of recent time activities on trade volume.

## 5. Conclusion

Digital assets have become normalized in modern financial market transactions, and investors are eager to try them. We investigate crypto-asset trade with respect to regulatory violations that lead to enforcement action and the effect of estate planning after the demise of an owner of digital assets. If such owners of crypto assets die without giving their password to beneficiaries, a considerable amount of investment could be indefinitely idle, rather than passed down. Currently, more laws about crypto assets are needed in many places, so that the assets will be able to be used effectively, especially when it comes to estate planning and distribution.

Our findings illustrate that the trade volume of Islamicoin predicts a price change in the market more than Bitcoin, which indicates that the price of the latter asset is explained with mechanisms other than trade volume. Further analysis demonstrates persistent enforcement actions by the SEC and other regulators against crypto-trade violations, especially recently. These violations result in enforcement action when a change in trading activity declines with corresponding increases in price changes in the market.

Our parametric survival analysis shows that recent crypto-asset market activity has increased the risk of regulatory violations and enforcement actions against them over time. Widespread price changes motivate regulatory violations over time and are noticeably more likely to occur when the price change is positive rather than negative. Enhancing digital assets Act is likely to reduce the risk of exposure to regulatory violations.

Policy makers should create regulations to enhance investor protection and protect the entire system from future financial crises. Regulators must improve digital assets laws to encompass estate planning beyond the protection of investors' securities. Future researchers could consider variables beyond the fundamental market mechanisms in the models and explore other methodologies in order to obtain more insights.

## CRediT authorship contribution statement

**Sirajo Aliyu:** Background, Conceptualization, Methodology, Formal analysis, Data curation, Writing – review & editing, Results and Discussion and Conclusion. **Norazlina Abd Wahab:** Writing – original draft, Funding acquisition. **Nur Syaedah Kamis:** Writing – original draft, Funding acquisition.

## Conflict of interest

There is no conflict of interest regarding this submission.

## Acknowledgement

This research was made possible by the invaluable support of the Ministry of Higher Education (MOHE) of Malaysia through the Fundamental Research Grant Scheme (FRGS/1/2021/SS01/UUM/02/9). We deeply thank Cornerstone Research for its generous data sharing and the US Securities Exchange Commission's openness to making data available.

## Appendix. Appendix 1A

The Appendix 1 A expands on other explanations of sharia issues and provides an analysis. The Islamic finance concept states, "Wealth and children are the adornments of this worldly life, but the everlasting good deeds are far better with your Lord in reward and in hope" (Q18:46). Hence, these should be used to please the Creator, without exploiting those who are disadvantaged. Wealth management and preservation extend to heirs, and guardians are advised to handle it properly. "Allah commands you regarding your children: the share of the male will be twice that of the female. If you leave only two or more females, their share is two-thirds of the estate. But if there is only one female, her share will be one-half. Each parent is entitled to one-sixth if you leave offspring. But if you are childless and your parents are the only heirs, then your mother will receive one-third. But if you leave siblings, then your mother will receive one-sixth—after the fulfillment of bequests and debts. Be fair to your parents and children, as you do not fully know who is more beneficial to you. This is an obligation from Allah. Surely Allah is All-Knowing, All-Wise" (Q4:11). "You will inherit half of what your wives leave if they are childless. But if they have children, then your share is one-fourth of the estate—after the fulfillment of bequests and debts. And your wives will inherit one-fourth of what you leave if you are childless. But if you have children, then your wives will receive one-eighth of your estate—after the fulfillment of bequests and debts. And if a man or a woman leaves neither parents nor children but only a brother or a sister from their mother's side, they will each inherit one-sixth, but if they are more than one, they all will share one-third of the estate—after the fulfillment of bequests and debts without harm to the heirs. This is a commandment from Allah. And Allah is All-Knowing, Most Forbearing" (Q4:12).

As such, "Give orphans their wealth when they reach maturity, and do not exchange your worthless possessions for their valuables, nor cheat them by mixing their wealth with your own. For this would indeed be a great sin" (Q4:2). Consistently, Abu Hurairah related that the Prophet said, "Avoid the seven great destructive sins." The people asked, "O Allah's Messenger! What are they?" He said, "(1) To join others in worship along with Allah, (2) to practice sorcery, (3) to kill a person which Allah has forbidden except for a just cause (according to Islamic law), (4) to consume *riba* (usury), (5) to consume an orphan's wealth, (6) to show one's back to the enemy and flee from the battlefield at the time of fighting, (7) and to accuse chaste women, who never even think of anything touching their chastity and are true believers" (Sahih Al-Bukhari, Vol. 4, Hadith No. 28). Subsequently, "Do not entrust the incapable among your dependents with your wealth which Allah has made a means of support for you—but feed and clothe them from it, and speak to them kindly" (Quran 4:5). Therefore, rational decision-making in wealth management is necessary for those who possess it. This is further emphasized as the law also advises those with wealth not to waste it through extravagance and a lack of wisdom (Sahih Al-Bukhari, Vol. 3, Hadith No. 591). Consequently, "Test the competence of the orphans until they reach a marriageable age. Then if you feel they are capable of sound judgment, return their wealth to them. And do not consume it wastefully and hastily before they grow up to demand it. If the guardian is well-off, they should not take compensation; but if the guardian is poor, let them take a reasonable provision. When you give orphans back their property, call in witnesses. And Allah is sufficient as a vigilant Reckoner" (Q4:6).

Sharia prohibits the illegal acquisition of wealth and encourages trade with mutual consent. "O believers! Do not devour one another's wealth illegally, but rather trade by mutual consent. And do not kill each other or yourselves. Surely Allah is ever Merciful to you" (Q4:29). Therefore, we developed a regression analysis based on mutual consent, positing that price changes in transactions are influenced by the volume of transactions in the market to avoid excessive speculation and market manipulation. We obtained daily data from April 2022 to December 2023 using Yahoo Finance's database. Our regression analyses cover the relationship between Islamicoin and Bitcoin price-trade volume. We follow earlier work on the mixture of distribution hypotheses that suggest a correlation between price changes and trade volume, causing a joint direction of market events (Clark, 1973; Grammatikos & Saunders, 1986; Karpoff, 1987; Tauchen & Pitts, 1983; Ying, 1966). This supports the Islamic finance view that allows trade to determine the returns of transactions, rather than excessive speculative activities in the market (El-Ashkar, 1995). Appendix Tables 1 and 2 (Islamicoin and Bitcoin) present the linear results of bivariate regression similar to the work of Aggarwal and Wu (2006) and George et al. (1991), which support the earlier findings in Tables 4 and 5, indicating that the former is more inclined to the price-volume relation than the latter.

**Appendix Table 1**
Islamicoin

| Month | Coefficient | Constant | se_coefficient | _se_constant | R2 | Adj_R2 | Obs | t_value | P_value |
|---|---|---|---|---|---|---|---|---|---|
| April 2022 | 1.0165 | −20.5640 | 0.0284 | 0.3603 | 0.9786 | 0.9779 | 30 | 35.8192 | *** |
| May 2022 | 0.2731 | −9.8638 | 0.2498 | 3.7408 | 0.0396 | 0.0065 | 31 | 1.0932 | |
| June 2022 | 0.4504 | −13.1589 | 0.0478 | 0.6940 | 0.7605 | 0.7520 | 30 | 9.4302 | *** |
| July 2022 | 0.7841 | −17.9962 | 0.0890 | 1.2709 | 0.7281 | 0.7188 | 31 | 8.8134 | *** |
| August 2022 | 0.1733 | −9.3795 | 0.0553 | 0.7718 | 0.2528 | 0.2270 | 31 | 3.1321 | *** |
| September 2022 | 0.4602 | −13.4806 | 0.0686 | 0.9309 | 0.6167 | 0.6030 | 30 | 6.7121 | *** |
| October 2022 | 0.3767 | −12.5274 | 0.0680 | 0.9152 | 0.5145 | 0.4977 | 31 | 5.5435 | *** |
| November 2022 | 0.3259 | −11.8725 | 0.0451 | 0.6189 | 0.6510 | 0.6385 | 30 | 7.2265 | *** |
| December 2022 | 0.1186 | −9.0351 | 0.0343 | 0.4668 | 0.2917 | 0.2673 | 31 | 3.4560 | *** |
| January 2023 | 0.3354 | −12.0358 | 0.0920 | 1.2405 | 0.3145 | 0.2908 | 31 | 3.6474 | *** |
| February 2023 | 0.3097 | −11.7942 | 0.0664 | 0.8797 | 0.4553 | 0.4344 | 28 | 4.6621 | *** |
| March 2023 | 0.1472 | −9.7233 | 0.0319 | 0.4164 | 0.4229 | 0.4030 | 31 | 4.6098 | *** |
| April 2023 | −0.1187 | −6.1985 | 0.0375 | 0.4710 | 0.2636 | 0.2373 | 30 | −3.1659 | *** |
| May 2023 | −0.0032 | −7.2851 | 0.0137 | 0.1773 | 0.0019 | −0.0325 | 31 | −0.2348 | |
| June 2023 | 0.0171 | −7.5597 | 0.0540 | 0.7143 | 0.0036 | −0.0320 | 30 | 0.3161 | |
| July 2023 | 0.6980 | −16.6219 | 0.0700 | 0.9069 | 0.7742 | 0.7665 | 31 | 9.9726 | *** |
| August 2023 | 0.7503 | −17.2634 | 0.0543 | 0.7180 | 0.8682 | 0.8636 | 31 | 13.8192 | *** |
| September 2023 | 0.3302 | −11.6054 | 0.0746 | 0.9979 | 0.4119 | 0.3909 | 30 | 4.4285 | *** |
| October 2023 | 0.0643 | −8.2105 | 0.0111 | 0.1377 | 0.5362 | 0.5202 | 31 | 5.7900 | *** |
| November 2023 | −0.0139 | −7.6856 | 0.0069 | 0.0699 | 0.1263 | 0.0951 | 30 | −2.0117 | * |
| December 2023 | 0.0841 | −9.0083 | 0.0201 | 0.2332 | 0.3763 | 0.3548 | 31 | 4.1827 | *** |

*Notes*: Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

**Appendix Table 2**
Bitcoin

| Month | Coefficient | Constant | se_coefficient | _se_constant | R2 | Adj_R2 | Obs | t_value | P_value |
|---|---|---|---|---|---|---|---|---|---|
| April 2022 | 0.0349 | 9.7926 | 0.0424 | 1.0180 | 0.0236 | −0.0113 | 30 | 0.8228 | |
| May 2022 | −0.0198 | 10.8387 | 0.0567 | 1.3743 | 0.0042 | −0.0302 | 31 | −0.3491 | |
| June 2022 | −0.0220 | 10.6160 | 0.1020 | 2.4569 | 0.0017 | −0.0340 | 30 | −0.2160 | |
| July 2022 | 0.1468 | 6.4393 | 0.0407 | 0.9801 | 0.3098 | 0.2860 | 31 | 3.6081 | *** |
| August 2022 | −0.1087 | 12.6280 | 0.0550 | 1.3231 | 0.1187 | 0.0883 | 31 | −1.9765 | * |
| September 2022 | 0.0165 | 9.4916 | 0.0336 | 0.8161 | 0.0086 | −0.0269 | 30 | 0.4914 | |
| October 2022 | 0.0548 | 8.5654 | 0.0110 | 0.2644 | 0.4622 | 0.4437 | 31 | 4.9923 | *** |
| November 2022 | 0.0775 | 7.8883 | 0.0345 | 0.8384 | 0.1527 | 0.1224 | 30 | 2.2459 | ** |
| December 2022 | 0.0357 | 8.8966 | 0.0112 | 0.2647 | 0.2583 | 0.2328 | 31 | 3.1783 | *** |
| January 2023 | 0.2376 | 4.2638 | 0.0416 | 0.9874 | 0.5298 | 0.5136 | 31 | 5.7166 | *** |
| February 2023 | 0.0504 | 8.8484 | 0.0286 | 0.6841 | 0.1070 | 0.0726 | 28 | 1.7647 | * |
| March 2023 | 0.0027 | 10.0610 | 0.0504 | 1.2084 | 0.0001 | −0.0344 | 31 | 0.0530 | |
| April 2023 | 0.0238 | 9.7097 | 0.0218 | 0.5135 | 0.0407 | 0.0065 | 30 | 1.0904 | |
| May 2023 | 0.0470 | 9.1234 | 0.0188 | 0.4381 | 0.1781 | 0.1498 | 31 | 2.5068 | ** |
| June 2023 | 0.0723 | 8.5352 | 0.0375 | 0.8783 | 0.1173 | 0.0857 | 30 | 1.9287 | * |
| July 2023 | 0.0196 | 9.8557 | 0.0112 | 0.2601 | 0.0954 | 0.0643 | 31 | 1.7493 | * |
| August 2023 | −0.0096 | 10.4560 | 0.0240 | 0.5598 | 0.0054 | −0.0289 | 31 | −0.3981 | |
| September 2023 | −0.0048 | 10.2880 | 0.0113 | 0.2621 | 0.0063 | −0.0292 | 30 | −0.4221 | |
| October 2023 | 0.1044 | 7.8606 | 0.0325 | 0.7576 | 0.2628 | 0.2374 | 31 | 3.2153 | *** |
| November 2023 | 0.0084 | 10.3094 | 0.0163 | 0.3845 | 0.0094 | −0.0260 | 30 | 0.5148 | |
| December 2023 | 0.0124 | 10.3628 | 0.0199 | 0.4751 | 0.0131 | −0.0209 | 31 | 0.6211 | |

*Notes*: Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

## Appendix 1B

Appendix 1 B presents alternative measurements of the changes, using different measurements of prices and trade volumes for survival analysis and the Probit model.

**Appendix Table 3**
Risk exposure and markets mechanism: Survival analysis

| Variables | Model_1 | Model_2 | Model_3 | Model_4 | Model_5 | Model_6 | Model_7 | Model_8 | Model_9 | Model_10 | Model_11 | Model_12 | Model_13 | Model_14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Recent | 2.394* | 2.641* | 3.323** | 3.037* | 3.591** | 3.139* | 2.773* | 3.673** | 2.532 | 2.492 | 2.699* | 2.647* | 2.650* | 2.651* |
| | (1.313) | (1.530) | (1.622) | (1.604) | (1.639) | (1.630) | (1.612) | (1.634) | (1.582) | (1.606) | (1.578) | (1.575) | (1.571) | (1.579) |
| Price | −3.620*** | −3.718*** | −5.135*** | −4.877*** | −5.409*** | −5.102*** | −4.841*** | −5.414*** | −4.666*** | −4.555*** | −4.734*** | −4.641*** | −4.556*** | −4.731*** |
| | (0.798) | (0.820) | (0.889) | (0.873) | (0.919) | (0.886) | (0.869) | (0.922) | (0.888) | (0.877) | (0.900) | (0.886) | (0.878) | (0.899) |
| Price spread | 2.332*** | 2.373*** | 3.401*** | 3.169*** | 3.631*** | 3.370*** | 3.135*** | 3.638*** | 2.984*** | 2.876*** | 3.067*** | 2.962*** | 2.888*** | 3.065*** |
| | (0.761) | (0.781) | (0.852) | (0.833) | (0.878) | (0.849) | (0.828) | (0.880) | (0.824) | (0.822) | (0.838) | (0.823) | (0.825) | (0.836) |
| Volume | −0.763** | −0.692** | −0.927*** | −0.875*** | −0.943*** | −0.918*** | −0.863** | −0.946*** | −0.776** | −0.764** | −0.801** | −0.777** | −0.778** | −0.800** |
| | (0.304) | (0.313) | (0.338) | (0.336) | (0.336) | (0.338) | (0.335) | (0.336) | (0.326) | (0.327) | (0.327) | (0.326) | (0.327) | (0.327) |
| Price volatility | −0.167** | −0.173** | −0.237*** | −0.248*** | −0.199** | −0.234*** | −0.244*** | −0.199** | −0.218*** | −0.212*** | −0.224*** | −0.217*** | −0.214*** | −0.224*** |
| | (0.0772) | (0.0789) | (0.0800) | (0.0817) | (0.0800) | (0.0799) | (0.0813) | (0.0801) | (0.0817) | (0.0820) | (0.0821) | (0.0816) | (0.0820) | (0.0820) |
| Digital assets Act | | −5.285*** | | | | | | | | | | | | |
| | | (1.524) | | | | | | | | | | | | |
| Price difference | | | 1.829** | | | | | | | | | | | |
| | | | (0.725) | | | | | | | | | | | |
| Positive price difference | | | | 2.234* | | | | | | | | | | |
| | | | | (1.227) | | | | | | | | | | |
| Negative price difference | | | | | −5.136*** | | | | | | | | | |
| | | | | | (1.712) | | | | | | | | | |
| Recent × price difference | | | | | | 1.808** | | | | | | | | |
| | | | | | | (0.727) | | | | | | | | |
| Recent × positive price difference | | | | | | | 2.204* | | | | | | | |
| | | | | | | | (1.238) | | | | | | | |
| Recent × negative price difference | | | | | | | | −5.108*** | | | | | | |
| | | | | | | | | (1.714) | | | | | | |
| Volume difference | | | | | | | | | −0.473 | | | | | |
| | | | | | | | | | (0.517) | | | | | |
| Positive volume difference | | | | | | | | | | −0.494 | | | | |
| | | | | | | | | | | (1.075) | | | | |
| Negative volume difference | | | | | | | | | | | 0.741 | | | |
| | | | | | | | | | | | (0.723) | | | |
| Recent × volume difference | | | | | | | | | | | | −0.405 | | |
| | | | | | | | | | | | | (0.528) | | |
| Recent × positive volume difference | | | | | | | | | | | | | −0.144 | |
| | | | | | | | | | | | | | (1.110) | |
| Recent × negative volume difference | | | | | | | | | | | | | | 0.753 |
| | | | | | | | | | | | | | | (0.722) |
| ln_P | 1.797*** | 1.835*** | 2.058*** | 2.040*** | 2.075*** | 2.056*** | 2.037*** | 2.076*** | 2.014*** | 2.010*** | 2.014*** | 2.012*** | 2.009*** | 2.013*** |
| | (0.113) | (0.112) | (0.108) | (0.109) | (0.107) | (0.108) | (0.109) | (0.107) | (0.109) | (0.109) | (0.109) | (0.109) | (0.109) | (0.109) |
| Constant | 8.793 | 11.53* | 10.74 | 9.592 | 11.16 | 10.67 | 9.552 | 11.15 | 7.725 | 7.380 | 8.169 | 7.607 | 7.529 | 8.198 |
| | (6.385) | (6.418) | (7.244) | (7.200) | (7.132) | (7.237) | (7.191) | (7.144) | (6.947) | (6.951) | (6.979) | (6.935) | (6.986) | (6.976) |
| Observations | 109 | 109 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 |

*Notes*: Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
*Sources*: Authors' calculation based on data from Cornerstone Research (Mola, 2023), SEC press releases on cryptocurrency enforcement, and the Yahoo finance database.

**Appendix Table 4**
Risk exposure and markets mechanism: A Probit model

| Variables | Model_1 | Model_2 | Model_3 | Model_4 | Model_5 | Model_6 | Model_7 | Model_8 | Model_9 | Model_10 | Model_11 | Model_12 | Model_13 | Model_14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Recent | 2.356*** | 1.963** | 3.016*** | 2.772*** | 2.988*** | 2.685*** | 2.321** | 3.074*** | 1.554 | 1.994** | 1.941** | 1.998** | 1.991** | 1.891* |
| | (0.868) | (0.956) | (1.049) | (1.037) | (1.044) | (1.034) | (1.013) | (1.045) | (0.951) | (0.988) | (0.963) | (0.968) | (0.971) | (0.972) |
| Price | −1.378** | −1.688*** | −4.305*** | −4.047*** | −4.347*** | −4.231*** | −3.971*** | −4.329*** | −2.347*** | −3.369*** | −3.409*** | −3.370*** | −3.381*** | −3.405*** |
| | (0.575) | (0.603) | (0.760) | (0.748) | (0.755) | (0.753) | (0.738) | (0.756) | (0.389) | (0.690) | (0.693) | (0.690) | (0.690) | (0.692) |
| Price spread | 1.047* | 1.196** | 2.995*** | 2.801*** | 2.994*** | 2.931*** | 2.732*** | 2.984*** | 1.208*** | 2.227*** | 2.239*** | 2.225*** | 2.254*** | 2.234*** |
| | (0.550) | (0.573) | (0.673) | (0.667) | (0.666) | (0.667) | (0.658) | (0.668) | (0.278) | (0.624) | (0.625) | (0.625) | (0.625) | (0.625) |
| Volume | −0.767*** | −0.593*** | −0.993*** | −0.953*** | −0.975*** | −0.978*** | −0.934*** | −0.979*** | −0.685*** | −0.803*** | −0.784*** | −0.801*** | −0.830*** | −0.781*** |
| | (0.214) | (0.226) | (0.247) | (0.246) | (0.246) | (0.248) | (0.246) | (0.246) | (0.233) | (0.240) | (0.237) | (0.239) | (0.239) | (0.237) |
| Price volatility | −0.0587 | −0.0635 | −0.189*** | −0.203*** | −0.132** | −0.182*** | −0.195*** | −0.132** | | −0.125* | −0.122* | −0.125* | −0.131** | −0.121* |
| | (0.0624) | (0.0642) | (0.0693) | (0.0735) | (0.0665) | (0.0690) | (0.0725) | (0.0666) | | (0.0668) | (0.0667) | (0.0669) | (0.0668) | (0.0667) |
| Digital assets Act | | −4.217*** | | | | | | | | | | | | |
| | | (0.784) | | | | | | | | | | | | |
| Price difference | | | 2.163*** | | | | | | | | | | | |
| | | | (0.695) | | | | | | | | | | | |
| Positive price difference | | | | 2.775** | | | | | | | | | | |
| | | | | (1.155) | | | | | | | | | | |
| Negative price difference | | | | | −5.290*** | | | | | | | | | |
| | | | | | (1.498) | | | | | | | | | |
| Recent × price difference | | | | | | 2.136*** | | | | | | | | |
| | | | | | | (0.701) | | | | | | | | |
| Recent × positive price difference | | | | | | | 2.759** | | | | | | | |
| | | | | | | | (1.179) | | | | | | | |
| Recent × negative price difference | | | | | | | | −5.219*** | | | | | | |
| | | | | | | | | (1.505) | | | | | | |
| Volume difference | | | | | | | | | −0.311 | | | | | |
| | | | | | | | | | (0.419) | | | | | |
| Positive volume difference | | | | | | | | | | −0.0377 | | | | |
| | | | | | | | | | | (0.650) | | | | |
| Negative volume difference | | | | | | | | | | | 0.579 | | | |
| | | | | | | | | | | | (0.705) | | | |
| Recent × volume difference | | | | | | | | | | | | −0.0509 | | |
| | | | | | | | | | | | | (0.447) | | |
| Recent × positive volume difference | | | | | | | | | | | | | 0.528 | |
| | | | | | | | | | | | | | (0.737) | |
| Recent × negative volume difference | | | | | | | | | | | | | | 0.618 |
| | | | | | | | | | | | | | | (0.711) |
| Restricted cubic splines (df_1) | 2.327*** | 2.969*** | 5.371*** | 5.202*** | 5.453*** | 5.340*** | 5.173*** | 5.440*** | 4.682*** | 4.874*** | 4.893*** | 4.873*** | 4.901*** | 4.892*** |
| | (0.237) | (0.297) | (0.538) | (0.523) | (0.543) | (0.534) | (0.519) | (0.542) | (0.465) | (0.487) | (0.488) | (0.487) | (0.489) | (0.488) |
| Constant | 21.89*** | 23.21*** | 38.59*** | 36.88*** | 38.45*** | 38.29*** | 36.62*** | 38.38*** | 26.66*** | 31.66*** | 31.38*** | 31.61*** | 32.24*** | 31.36*** |
| | (4.647) | (4.939) | (6.339) | (6.260) | (6.261) | (6.335) | (6.261) | (6.266) | (5.156) | (5.798) | (5.775) | (5.804) | (5.825) | (5.776) |
| Observations | 109 | 109 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 | 108 |

*Notes*: Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Df = degree of freedom.
*Sources*: Authors' calculation based on data from Cornerstone Research (Mola, 2023), SEC press releases on cryptocurrency enforcement, and the Yahoo finance database.

## References


Aalborg, H. A., Molnár, P., & de Vries, J. E. (2019). What can explain the price, volatility and trading volume of Bitcoin? *Finance Research Letters, 29*, 255–265.

Adhami, S., Giudici, G., & Martinazzi, S. (2018). Why do businesses go crypto? An empirical analysis of initial coin offerings. *Journal of Economics and Business, 100*, 64–75.

Adrian, T., Iyer, T., & SQureshi, M. S. (2022). *Crypto prices move more in sync with stocks, posing new risks*. International Monetary Fund. https://www.imf.org/en/Blogs/Articles/2022/01/11/crypto-prices-move-more-in-sync-with-stocks-posing-new-risks/.

Aggarwal, R. K., & Wu, G. (2006). Stock market manipulations. *Journal of Business, 79*(4), 1915–1953.

Agresti, A. (2015). *Foundations of linear and generalised linear models*. John Wiley & Sons.

Alandejani, M., Kutan, A. M., & Samargandi, N. (2017). Do Islamic banks fail more than conventional banks? *Journal of International Financial Markets, Institutions and Money, 50*, 135–155.

Albornoz, F., Fanelli, S., & Hallak, J. C. (2016). Survival in export markets. *Journal of International Economics, 102*, 262–281.

Ali, E. R. A. (2003). Re-defining property and property rights in Islamic law of contract. *Jurnal Syariah, 11*(1), 47–60. https://ejournal.um.edu.my/index.php/JS/article/view/22879/.

Aliyu, S., Hassan, M. K., Mohd Yusof, R., & Naiimi, N. (2017). Islamic banking sustainability: A review of literature and directions for future research. *Emerging Markets Finance and Trade, 53*(2), 440–470.

Aliyu, S., Mohammad, A. R. I., & Abd Wahab, N. (2023). Bank diversification, stability and oil price in MENA region. *Journal of Islamic Accounting and Business Research*. https://doi.org/10.1108/JIABR-09-2022-0234

Aliyu, S., Mohammad, A. R., & Wahab, N. A. (2024). Probability of default and political instability in the MENA region. *Managerial Finance, 50*(3), 473–497.

Aliyu, S., & Yusof, R. M. (2017). A panel survival analysis for Islamic banks. *International Journal of Economics, Management and Accounting, 25*(2), 381–410.

Allen, F., & Gale, D. (1992). Stock-price manipulation. *Review of Financial Studies, 5*(3), 503–529.

Allison, P. D. (2019). Asymmetric fixed-effects models for panel data. *Socius, 5*, Article 2378023119826441.

Alvarez, F. E., Borovičková, K., & Shimer, R. (2021). *Consistent evidence on duration dependence of price changes. No. w29112*. National Bureau of Economic Research.

Ante, L., Fiedler, I., & Strehle, E. (2021). The impact of transparent money flows Effects of stablecoin transfers on the returns and trading volume of Bitcoin. *Technological and Social Change, 170*, Article 120851.

Ayedh, A., Echchabi, A., Battour, M., & Omar, M. (2021). Malaysian Muslim investors' behaviour towards the blockchain-based Bitcoin cryptocurrency market. *Journal of Islamic Marketing, 12*(4), 690–704.

Baig, A., Blau, B. M., & Sabah, N. (2019). Price clustering and sentiment in Bitcoin. *Finance Research Letters, 29*, 111–116.

Balcilar, M., Bouri, E., Gupta, R., & Roubaud, D. (2017). Can volume predict bitcoin returns and volatility? A quantiles-based approach. *Economic Modelling, 64*, 74–81.

Bandi, F. M., Pirino, D., & Renò, R. (2024). Systematic staleness. *Journal of Econometrics, 238*(1), Article 105522.

Bank for International Settlements. (2015). Digital currencies. https://www.bis.org/Cpmi/Publ/D137.pdf.

Beck, T., Demirgüç-Kunt, A., & Merrouche, O. (2013). Islamic vs. conventional banking: Business model, efficiency and stability. *Journal of Banking & Finance, 37*(2), 433–447.

Beyer, G. W. (2019). Cryptocurrency: What estate planners need to know. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3314161

Beyer, G. W. (2020). Technology's impact on the changing future of the trusts and estate practice. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3528403

Beyer, G. W., & Nipp, K. G. (2020). Planning in the digital age. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2166422

Beyer, G. W., & Nipp, K. G. (2022). Cyber Estate Planning and Administration. *SSRN*. https://doi.org/10.2139/ssrn.2166422

Brown, S. J., Goetzmann, W. N., & Park, J. (2001). Careers and survival: Competition and risk in the hedge fund and CTA industry. *The Journal of Finance, 56*(5), 1869–1886.

Browne, R. (2022). Central African Republic became the second country to adopt Bitcoin as legal tender. *CNBC*. https://www.cnbc.com/2022/04/28/central-african-republic-adopts-bitcoin-as-legal-tender.html.

Brucker-Kley, E., et al. (2013). Passing and passing on in the digital world: Issues and solutions for the digital estate. *IADIS*. https://doi.org/10.5451/UNIBAS-EP76197

Butler, A. W., & Cornaggia, J. (2011). Does access to external finance improve productivity? Evidence from a natural experiment. *Journal of Financial Economics, 99*(1), 184–203.

Carlson, J., et al. (2021). Cryptocurrencies: A guide to getting started global future council on cryptocurrencies. https://www3.weforum.org/docs/WEF_Getting_Started_Cryptocurrency_2021.pdf. (Accessed 19 October 2022).

Carter, E. R. (2016). Estate planning for digital assets: Assigning tax basis and value to digital assets. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2850156

Chen, Q., Goldstein, I., & Jiang, W. (2007). Price informativeness and investment sensitivity to stock price. *Review of Financial Studies, 20*(3), 619–650.

Chevalier, J., & Ellison, G. (1999). Are some mutual fund managers better than others? Cross-sectional patterns in behavior and performance. *The Journal of Finance, 54*(3), 875–899.

Chomczyk, A. (2020). Cryptocurrencies and crypto assets regulation in the Iberoamerican region, Theimpactlawyers.com. https://theimpactlawyers.com/articles/cryptocurrencies-and-cryptoassets-regulation-in-the-iberoamerican-region. (Accessed 19 October 2022).

Chu, J., Chan, S., & Zhang, Y. (2023). An analysis of the return–volume relationship in decentralised finance (DeFi). *International Review of Economics & Finance, 85*, 236–254.

Clark, P. K. (1973). A subordinated stochastic process model with finite variance for speculative prices. *Econometrica: Journal of the Econometric Society*, 135–155.

CoinMarketCap. (2022). Cryptocurrency prices, charts and market capitalisations, CoinMarketCap. https://coinmarketcap.com/. (Accessed 19 October 2022).

Conlon, T., Corbet, S., & McGee, R. J. (2024). The bitcoin volume-volatility relationship: A high-frequency analysis of futures and spot exchanges. *International Review of Financial Analysis, 91*, Article 103013.

Conlon, T., & McGee, R. J. (2020). Betting on Bitcoin: Does gambling volume on the blockchain explain Bitcoin price changes? *Economics Letters, 191*, Article 108727.

Conway, H., & Grattan, S. (2017). The 'new' new property: Dealing with digital assets on death. In H. Conway, & R. Hickey (Eds.), *Modern studies in property law* (9 (1st ed., pp. 99–115). Hart Publishing https://www.bloomsburyprofessional.com/uk/modern-studies-in-property-law-9781782257547/.

Cox, D. R. (1972). Regression models and life-tables. *Journal of the Royal Statistical Society: Series B, 34*(2), 187–220.

Crypto.com. (2024). Crypto market sizing report 2023. https://crypto.com/research/2023-crypto-market-sizing-report. (Accessed 12 June 2024).

Darolles, S., Le Fol, G., & Mero, G. (2017). Mixture of distribution hypothesis: Analyzing daily liquidity frictions and information flows. *Journal of Econometrics, 201*(2), 367–383.

Das, N. (2022). 56% of consumers globally more likely to transact with merchants accepting cryptos. https://www.outlookindia.com/. https://www.outlookindia.com/business/56-of-consumers-globally-more-likely-to-transact-with-merchants-accepting-cryptos-study-news-218927/.

Deville, L., & Riva, F. (2007). Liquidity and arbitrage in options markets: A survival analysis approach. *Review of Finance, 11*(3), 497–525.

Diewert, W. E., Heravi, S., & Silver, M. (2009). Hedonic imputation versus time dummy hedonic indexes. In W. E. Diewert, J. Greenlees, & C. R. Hulten (Eds.), *Price index concepts and measurement* (pp. 161–196). University of Chicago Press.

Dusuki, A. W., & Bouheraoua, S. (2011). The framework of maqasid al-shari'ah and its implication for Islamic finance. *Islam and Civilisational Renewal, 2*(2), 316–336. https://doi.org/10.52282/icr.v2i2.651

El Alaoui, M., Bouri, E., & Roubaud, D. (2019). Bitcoin price–volume: A multifractal cross-correlation approach. *Finance Research Letters, 31*, 374–381. https://doi.org/10.1016/j.frl.2018.12.011

El-Ashkar, A. A. F. (1995). Towards an Islamic stock exchange in a transitional stage. *Islamic Economic Studies, 3*(1), 79–112.

Engle, R. F., & Gallo, G. M. (2006). A multiple indicators model for volatility using intra-daily data. *Journal of Econometrics, 131*(1–2), 3–27.

Evrensel, A. Y. (2008). Banking crisis and financial structure: A survival-time analysis. *International Review of Economics & Finance, 17*(4), 589–602.

Farmer, A. J., & Tyszka, C. E. (2014). Virtual currency estate planning, bit by bit. *ACTEC Law Journal, 40*(2), 3. Available at: https://scholarlycommons.law.hofstra.edu/actec lj/vol40/iss2/3?utm_source=scholarlycommons.law.hofstra.edu%2Facteclj%2Fvol40%2Fiss2%2F3&utm_medium=PDF&utm_campaign=PDFCoverPages. (Accessed 19 October 2022).

Fintech News Malaysia. (2022). *Malaysia fintech report 2021*.

Gemici, E., & Polat, M. (2019). Relationship between price and volume in the Bitcoin market. *The Journal of Risk Finance, 20*(5), 435–444.

Genders, R., & Steen, A. (2017). Financial and estate planning in the age of digital assets: A challenge for advisors and administrators. *Financial Planning Research Journal, 1*(1), 75–80.

George, T. J., Kaul, G., & Nimalendran, M. (1991). Estimation of the bid–ask spread and its components: A new approach. *Review of Financial Studies, 4*(4), 623–656.

Ghimire, S., & Selvaraj, H. (2018). A survey on Bitcoin cryptocurrency and its mining. In *2018 26th international conference on systems engineering (ICSEng)*. IEEE.

Gietzmann, M., Marra, A., & Pettinicchio, A. (2016). Comment letter frequency and CFO turnover: A dynamic survival analysis. *Journal of Accounting, Auditing and Finance, 31*(1), 79–99.

Gilden, A. (2019). The social afterlife. https://papers.ssrn.com/abstract=3448790. (Accessed 19 October 2022).

Goforth, C. R. (2020). Using cybersecurity failures to critique the SEC's approach to crypto regulation. *SDL Rev., 65*, 433.

Grammatikos, T., & Saunders, A. (1986). Futures price variability: A test of maturity and volume effects. *Journal of Business*, 319–330.

Hacibedel, B., & Perez Saiz, H. (2023). Assessing macrofinancial risks from crypto assets. *IMF Working Paper No. 2023/214*. https://doi.org/10.5089/9798400257117.001. https://ssrn.com/abstract=4592236

Hasan, R., Hassan, M. K., & Aliyu, S. (2020). Fintech and Islamic finance: Literature review and research agenda. *International Journal of Islamic Economics and Finance (IJIEF), 3*(1), 75–94.

Hassan, M. K., & Aliyu, S. (2018). A contemporary survey of Islamic banking literature. *Journal of Financial Stability, 34*, 12–43.

Hassan, M. K., Aliyu, S., & Hussain, M. (2022). A contemporary review of Islamic finance and accounting literature. *Singapore Economic Review, 67*(1), 7–44.

Hassan, M. K., Aliyu, S., Paltrinieri, A., & Khan, A. (2019). A review of Islamic investment literature. *Economic Papers: A Journal of Applied Economics and Policy, 38*(4), 345–380.

Heilweil, R. (2022). Inheriting Bitcoin is harder than it sounds. *Vox*. Available at: https://www.vox.com/recode/22971265/bitcoin-wills-estate-planning-cryptocurrency-nfts-death. (Accessed 19 October 2022).

Holt, J., Nicholson, J., & Smeddinck, J. D. (2021). From personal data to digital legacy: Exploring conflicts in the sharing, security and privacy of post-mortem data. In *Proceedings of the web conference 2021*. New York: ACM.
Holt, J., Smeddinck, J. D., Nicholson, J., Vlachokyriakos, V., & Durrant, A. C. (2024). Post-mortem information management: Exploring contextual factors in appropriate personal data access after death. *Human-Computer Interaction*, 1–36.
Houben, R., & Snyers, A. (2018). *Cryptocurrencies and blockchain. Legal Context and Implications for financial crime, money Laundering and tax evasion*. Brussels: European Parliament.
Howden, E. (2015). The crypto-currency conundrum: Regulating an uncertain future. *Emory International Law Review, 29*(4), 741–798. Available at: https://scholarlycommons.law.emory.edu/eilr/vol29/iss4/3/. (Accessed 19 October 2022).
Iwasaki, I., Kočenda, E., & Shida, Y. (2021). Institutions, financial development, and small business survival: Evidence from European emerging markets. *Small Business Economics*, 1–23.
Jarrow, R. A. (1992). Market manipulation, bubbles, corners, and short squeezes. *Journal of Financial and Quantitative Analysis, 27*(3), 311–336.
Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica, 47*(2), 263–291, 03.
Kalbfleisch, J. D., & Prentice, R. L. (2002). *The statistical analysis of failure time data* (2nd ed.). New York: Wiley.
Kamali, M. H. (1996). Islamic commercial law: An analysis of futures. *American Journal of Islam and Society, 13*(2), 197–212.
Kaplan, E. L., & Meier, P. (1958). Nonparametric estimation from incomplete observations. *Journal of the American Statistical Association, 53*(282), 457–481.
Karpoff, J. M. (1987). The relation between price changes and trading volume: A survey. *Journal of Financial and Quantitative Analysis, 22*(1), 109–126.
Katuk, N. (2019). The application of blockchain for halal product assurance: A systematic review of the current developments and future directions. *International Journal of Advanced Trends in Computer Science and Engineering, 8*(5), 1893–1902. https://doi.org/10.30534/ijatcse/2019/13852019
Kim, K., & Kauffman, R. J. (2024). On the effects of information asymmetry in digital currency trading. *Electronic Commerce Research and Applications*, Article 101366.
Kinateder, H., & Papavassiliou, V. G. (2021). Calendar effects in bitcoin returns and volatility. *Finance Research Letters, 38*, Article 101420.
Kirillova, E. A., et al. (2020). The legal status of tokens and their inheritance. *Jurídicas CUC, 16*(1). https://doi.org/10.17981/juridcuc.16.1.2020.12
Klasiček, D., & Šimleša Vučemilović, S. (2019). Certain issues concerning contracts on support for life and contracts on support until death. *EU and Member States: Legal and Economic Issues (ECLIC)*, 747–777. https://doi.org/10.25234/eclic/9030
Koenker, R., & Bassett, G., Jr. (1978). Regression quantiles. *Econometrica: Journal of the Econometric Society, 46*(1), 33–50.
Krause, S. K., Natarajan, H., & Gradstein, H. L. (2017). *Distributed ledger technology (DLT) and blockchain (English)*.
Lane, W. R., Looney, S. W., & Wansley, J. W. (1986). An application of the Cox proportional hazards model to bank failure. *Journal of Banking & Finance, 10*(4), 511–531.
Law Library of Congress. (2021). *Regulation of Cryptocurrency Around the World: November 2021 Update*. Available at: https://tile.loc.gov/storage-services/service/ll/llglrd/2021687419/2021687419.pdf.
Lee, H. S., & Kim, T. Y. (2014). Dynamic prediction of hedge fund survival in crisis-prone financial markets. *Journal of Banking & Finance, 39*, 57–67.
Liu, X. (2012). *Survival analysis: Models and applications*. John Wiley & Sons.
Liu, Y., & Tsyvinski, A. (2021). Risks and returns of cryptocurrency. *Review of Financial Studies, 34*(6), 2689–2727.
Lopez, O., & Livni, E. (2021). *In global first, El Salvador adopts bitcoin as a currency*. New York Times, September 7. Available at: https://www.nytimes.com/2021/09/07/world/americas/el-salvador-bitcoin.html. (Accessed 19 October 2022).
Louwers, T. J., Messina, F. M., & Richard, M. D. (1999). The auditor's going-concern disclosure as a self-fulfilling prophecy: A discrete-time survival analysis. *Decision Sciences, 30*(3), 805–824.
Mali, P., & Prakash, A. (2020). Death in the era of perpetual digital afterlife: Digital assets, posthumous legacy, ownership and its legal implications. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3832404
Mawdudi, S. A. A. (2011). *First principles of islamic economics*. Markfield, UK: Islamic Foundation.
McKinnon, L. (2011). Planning for the succession of digital assets. *Computer Law & Security Report, 27*(4), 362–367. https://doi.org/10.1016/j.clsr.2011.03.002
Micheal, C., et al. (2016). Blockchain technology: Beyond bitcoin. *Applied Innovation Review*, 6–19. June(2).
Mola, S. (2023). *SEC cryptocurrency enforcement*. Washington DC., USA: Cornerstone Research. https://www.cornerstone.com/insights/reports/sec-cryptocurrency-enforcement/.
Moorefield-Lang, H., & Lang, J. (2020). Keeping your digital legacy safe. *Library Technology Reports, 56*(5), 29–31. Available at: https://journals.ala.org/index.php/ltr/article/view/7388. (Accessed 19 October 2022).
Muneeza, A., Bin-Nashwan, S. A., Moshin, M. I. A., Mohamed, I., & Al-Saadi, A. (2022). Zakat payment from cryptocurrencies and crypto assets. *International Journal of Islamic and Middle Eastern Finance and Management* (ahead-of-print).
Nimalendran, M., Pathak, P., Petryk, M., & Qiu, L. (2024). Informational efficiency of cryptocurrency markets. *Journal of Financial and Quantitative Analysis*. https://doi.org/10.1017/S0022109024000310
Noonan, A. K. (2015). Bitcoin or bust: Can one really trust one's digital assets. *Est. Plan. & Cmty. Prop. LJ, 7*, 583.
Opschoor, A., & Lucas, A. (2021). Observation-driven models for realized variances and overnight returns applied to value-at-risk and expected shortfall forecasting. *International Journal of Forecasting, 37*(2), 622–633.
Palamalai, S., Kumar, K. K., & Maity, B. (2021). Testing the random walk hypothesis for leading cryptocurrencies. *Borsa Istanbul Review, 21*(3), 256–268.
Pappas, V., Ongena, S., Izzeldin, M., & Fuertes, A. M. (2017). A survival analysis of Islamic and conventional banks. *Journal of Financial Services Research, 51*(2), 221–256.
Pasztor, J. (2020). The increasing importance of digital assets in estate planning. *Journal of Financial Service Professionals, 74*(5), 18–20.
Paulger, M. (2022). In the crypt: The importance of planning for the distribution of cryptocurrency assets after death. *Estate Planning & Community Property Law Journal, 14*(2), 621–669. Available at: https://epj.us/article/36484-mariah-paulger-in-the-crypt-the-importance-of-planning-for-distribution-of-cryptocurrency-assets-after-death. (Accessed 19 October 2022).
Pr, N. (2022). In major and positive breakthrough. *Islamic coin gains fatwa from leading global muslim scholars, PR Newswire*. Available at: https://www.prnewswire.com/ae/news-releases/in-major-breakthrough-islamic-coin-gains-fatwa-from-leading-global-muslim-scholars-844608565.html. (Accessed 19 October 2022).
Qureshi, M. (2022). What happens to your cryptocurrency and NFTs when you die? Preplan or lose it forever. https://indianexpress.com/article/technology/crypto/what-happens-to-our-cryptocurrency-and-nfts-when-you-die-preplan-or-lose-it-forever-7883455/. (Accessed 19 October 2022).
Rabe-Hesketh, S., & Skrondal, A. (2012). *Multilevel and longitudinal modelling using Stata*. STATA Press.
Raza, S. A., Ahmed, M., & Aloui, C. (2022a). On the asymmetrical connectedness between cryptocurrencies and foreign exchange markets: Evidence from the nonparametric quantile on quantile approach. *Research in International Business and Finance, 61*, 101627.
Raza, S. A., Yarovaya, L., Guesmi, K., & Shah, N. (2022b). Google trends and cryptocurrencies: A nonparametric causality-in-quantiles analysis. *International Journal of Emerging Markets* (ahead-of-print).
Rosele, M. I., Muneem, A., Che Seman, A. B., Haji Abdullah, L. B., Binti Abdul Rahman, N. N., Bin Abd Sukor, M. E., & Bin Ali, A. K. (2022). The concept of wealth (māl) in the Sharī ̄ah and its relation to digital assets. *Sage Open*. https://doi.org/10.1177/21582440221102424
Royston, P., & Lambert, P. C. (2011). *Flexible parametric survival analysis using stata: Beyond the Cox model*. College Station, TX: Stata Press.
Royston, P., & Parmar, M. K. (2002). Flexible parametric proportional-hazards and proportional-odds models for censored survival data, with application to prognostic modelling and estimation of treatment effects. *Statistics in Medicine, 21*(15), 2175–2197.
Rubbaniy, G., Tee, K., Iren, P., & Abdennadher, S. (2022). Investors' mood and herd investing: A quantile-on-quantile regression explanation from crypto market. *Finance Research Letters, 47*, Article 102585.
Sahoo, P. K., Sethi, D., & Acharya, D. (2019). Is bitcoin a near stock? Linear and non-linear causal evidence from a price-volume relationship. *International Journal of Managerial Finance*.
Saleh, A. J., Alazzam, F. A. F., Rabbo Aldrou, K. K. A., & Zavalna, Z. (2020). Legal aspects of the management of cryptocurrency assets in the national security system. *Journal of Security and Sustainability Issues, 10*(1), 235–247. https://doi.org/10.9770/jssi.2020.10.1(17)
Santaolalla, C. (2024). Bitcoin versus central bank digital cryptocurrencies: Last call for freedom. *Cuadernos de Derecho Transnacional, 16*(1), 578–602.
Seres, I. A., Shlomovits, O., & Tiwari, P. R. (2020). CryptoWills: How to bequeath cryptoassets. In *2020 IEEE European symposium on security and privacy workshops (EuroS&PW)*. IEEE.
Shen, D., Tong, Z., & Goodell, J. W. (2024). Do online message boards convey cryptocurrency-specific information? *International Review of Financial Analysis, 91*, Article 102950.
Sheridan, P. (2020). Inheriting digital assets: Does the revised uniform fiduciary access to digital assets act fall short? *Ohio St. Tech. LJ, 16*, 363.
Sigalos, M. (2022). Crypto scammers took a record $14 billion in 2021. *CNBC*. Available at: https://www.cnbc.com/2022/01/06/crypto-scammers-took-a-record-14-billion-in-2021-chainalysis.html. (Accessed 19 October 2022).
Sigaux, J. D. (2024). Trading ahead of treasury auctions. *Journal of Banking & Finance, 158*, Article 107032.
Sim, N., & Zhou, H. (2015). Oil prices, US stock return, and the dependence between their quantiles. *Journal of Banking & Finance, 55*, 1–8.
Singh, R. G., Shrivastava, A., & Ruj, S. (2022). A digital asset inheritance model to convey online persona posthumously. *International Journal of Information Security, 21*(5), 983–1003. https://doi.org/10.1007/s10207-022-00593-8
StataCorp. (2023). *Stata survival analysis: Reference manual release 18*. Stata Press.
Sy, E. (2016). The revised uniform fiduciary access to digital assets act: Has the law caught up with technology? *Touro L. Rev., 32*(3), 647–677.
Sylvester, B. (2021). An overview of the regulation and management of cryptocurrency in South African inter vivos and testamentary trusts. http://etd.uwc.ac.za/xmlui/handle/11394/8140. (Accessed 19 October 2022).
Szetela, B., Mentel, G., Bilan, Y., & Mentel, U. (2021). The relationship between trend and volume on the Bitcoin market. *Eurasian Economic Review, 11*, 25–42.
Szwajdler, P. (2023). Digital assets and inheritance law: How do we create fundamental principles of a digital succession system? *International Journal of Law and Information Technology, 31*(2), 144–168.
Tauchen, G. E., & Pitts, M. (1983). The price variability-volume relationship on speculative markets. *Econometrica: Journal of the Econometric Society*, 485–505.

United States Securities and Exchange Commission. Statement on the Approval of Spot Bitcoin Exchange-Traded Products. https://www.sec.gov/news/statement/gensler-statement-spot-bitcoin-011023/.
United States Securities and Exchange Commission. Crypto assets and cyber enforcement actions. https://www.sec.gov/spotlight/cybersecurity-enforcementactions/.
Urquhart, A. (2017). Price clustering in bitcoin. *Economics Letters, 159*, 145–148.
Veerasingam, N., & Teoh, A. P. (2022). Modelling cryptocurrency investment decision: Evidence from islamic emerging market. *Journal of Islamic Marketing* (ahead-of-print).
Wahab, A. N., Maamor, S., Zainol, Z., Hashim, S., & Kamal, K. A. M. (2021). Developing best practices of islamic estate planning: A construction based on the perspectives of individuals and estate planning providers. *ISRA International Journal of Islamic Finance, 13*(2), 211–228.
Walker, M. D. (2017). *The new uniform digital assets law: Estate planning and administration in the information age* (Vol. 52, pp. 51–78). Real Prop: Tr. & Est. LJ.
Whalen, G. (1991). A proportional hazards model of bank failure : An examination of its usefulness as an early warning tool. *Economic Review - Federal Reserve Bank of Cleveland, 27*(1), 21–31.
Wheelock, D. C., & Wilson, P. W. (2000). Why do banks disappear? The determinants of U.S. Bank failures and acquisitions. *The Review of Economics and Statistics, 82*(1), 127–138.
Yamani, E. (2023). Return–volume nexus in financial markets: A survey of research. *Research in International Business and Finance, 65*, Article 101910.
Ying, C. C. (1966). Stock market prices and volumes of sales. *Econometrica: Journal of the Econometric Society, 34*(3), 676–685.
York, R., & Light, R. (2017). Directional asymmetry in sociological analyses. *Socius, 3*, Article 2378023117697180.
Załucki, M. (2020). Digital content left online after the death of a user. On the research that needs to be conducted. *Studii juridice şi administrative, 22*(1), 53–66. Available at: https://www.ceeol.com/search/article-detail?id=933593. (Accessed 19 October 2022).
Zuleika, A., & Desinthya, N. P. (2013). Islamic inheritance law (faraid) and its economic implication. *Tazkia Islamic Finance, 8*(1), 97, 11.