3RD GLOBAL CRYPTOASSET BENCHMARKING STUDY

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Judge Business School

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TABLE OF CONTENTS

FOREWORDS

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The rapid pace of innovation and increased investment in the cryptoasset industry is increasing the need for information analysing these developments. With the publication of the first edition of the Global Cryptoasset Benchmarking Study three years ago, the CCAF set out to progressively track and take the pulse of this nascent industry by transparently collecting, analysing and disseminating knowledge about cryptoassets. Similarly, the 3rd Global Cryptoasset Benchmarking Study seeks to shed light on the market dynamics of the cryptoasset industry since late 2018.

The report collates data from entities operating in four main segments of the industry: exchange, payments, custody, and mining. A total of 280 entities from over 50 countries across various regions responded to the surveys. This benchmarking report is compiled using data from one of the most comprehensive and robust databases currently available in the cryptoasset industry.

The research findings suggest that the industry has entered a growth stage despite the notable headwinds the cryptoasset markets had encountered since 2018. Additionally, regulators' collaborative dialogue and regulatory interventions in the industry appear to be supporting its growth by providing regulatory clarity and harmonisation on the treatment of cryptoassets and related activities. This is an important development that has had immediate effects. For instance, the publication of updated AML and CFT standards by the Financial Action Task Force (FATF) in June 2019 encouraged compliance by industry participants, with an increased share of the surveyed service providers performing KYC & AML checks on their customers.

Nevertheless, our analysis has identified several hurdles – ranging from regulatory compliance, IT security, and insurance – which need to be addressed for the industry to grow to scale.

Our hope is that the findings captured within this study will offer insight into the evolution of the industry and inform the decisions that industry stakeholders will face as the space matures. As with all of our research projects, we appreciate that our ability to produce high quality research is highly dependent on the cooperation of industry players and we extend our thanks to all the entities that have contributed towards the publishing of this report. Finally, I want to gratefully acknowledge the financial support of Invesco as a long-standing supporter of CCAF's research and whose support made this study possible.

Dr. Robert Wardrop
Director
Cambridge Centre for Alternative Finance

Despite the uncertainty and economic rollercoaster ride that 2020 has brought us with the introduction of the global Covid-19 pandemic, we have learned that even in trying times, businesses and markets have reached a critical point where operations can sustain even a majority of their employees working remotely. Even as the pandemic continues forward, finance still moves, and specifically alternative finance has its place in a post-pandemic world and the research and analysis of trends in emerging still press forward.

2020 brings us the Cambridge Centre for Alternative Finance (CCAF) third edition of its Global Cryptoasset Benchmarking Study. In this study the CCAF gathered data points from approximately 280 entities including representation from 59 countries across four main market segments: exchanges, payments, custody, and mining. While most of the data was collected prior to the pandemic, the aggregated learnings and insights from the report remain relevant in current times.

This year's cryptoasset benchmarking study comes at a particularly appropriate time for Invesco as we completed a successful asset tokenization proof of concept (POC) this year that explores various facets of the token lifecycle including the creation and custody chain of real asset backed tokens and how they may be distributed and exchanged in practice in the real world. The results of the POC validate key findings uncovered in the study in the areas of industry growth, service providers, regulatory standards, and future outlook of cryptoassets. Our own journey in token economics provided us with experience with third party providers of token creation, digital token exchanges, token custodianship, and navigating the complex legal and regulatory requirements for such an endeavor.

As we read through the study, a few highlights stood out in confirmation of our own experiences. One notable observation was the growth patterns of full-time equivalent (FTE) employees within the cryptoasset industry and at the firm level. The industry saw overall slowdown in growth in employment; whereas individual firms saw growth in FTEs indicating that while overall opportunities are shrinking, the existing players are gaining traction and prominence within their area of expertise. This is something we have witnessed ourselves firsthand through the disappearance or consolidation of industry consortiums as the cryptoasset industry sees increased participation from institutional investors and traditional players in the financial sector.

Invesco is proud to provide sponsorship to enable the Cambridge Centre of Alternative Finance to continue their research in alternative finance industry including this cryptoasset benchmarking report. We'd like to thank all of the contributors in the research team who made this report possible through collecting and analyzing data. These ongoing reports provide valuable insights for benchmarking in emerging financial markets and trends and scenarios that we monitor to enable our own growth and the growth of alternative finance models in general around the globe.

Dave Dowsett
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We would also like to extend our gratitude to our research partners from the different regions. Without the help of these industry associations, our survey dissemination would not have been possible. These research partners were: Association pour le Developpement des Actifs Numeriques (ADAN), Asociación Chilena de Criptotecnologías, Asociación FinTech Paraguay, Asociación FinTech Uruguay, Associação Brasileira de Criptoeconomia (ABCripto), Association of Cryptocurrency Enterprises and Startups Singapore (ACCESS Singapore), Bitcoin Argentina, Blockchain Nigeria User Group, Blockchain Ukraine Association, Coin Center, Colombia Fintech, Crypto Valley Association, Fintech Mexico, Global Digital Finance (GDF), German Blockchain Association, MinerUpdate, National Association of Blockchain and Cryptotechnologies, SA Crypto, Thai Fintech Association, The Bitcoin Association of Hong Kong.

We greatly appreciate the help of the following media organisations, whose role was instrumental to successfully disseminate our surveys and research: 8btc, ChainNews, CoinDesk, MinerUpdate and the CryptoTool podcast.

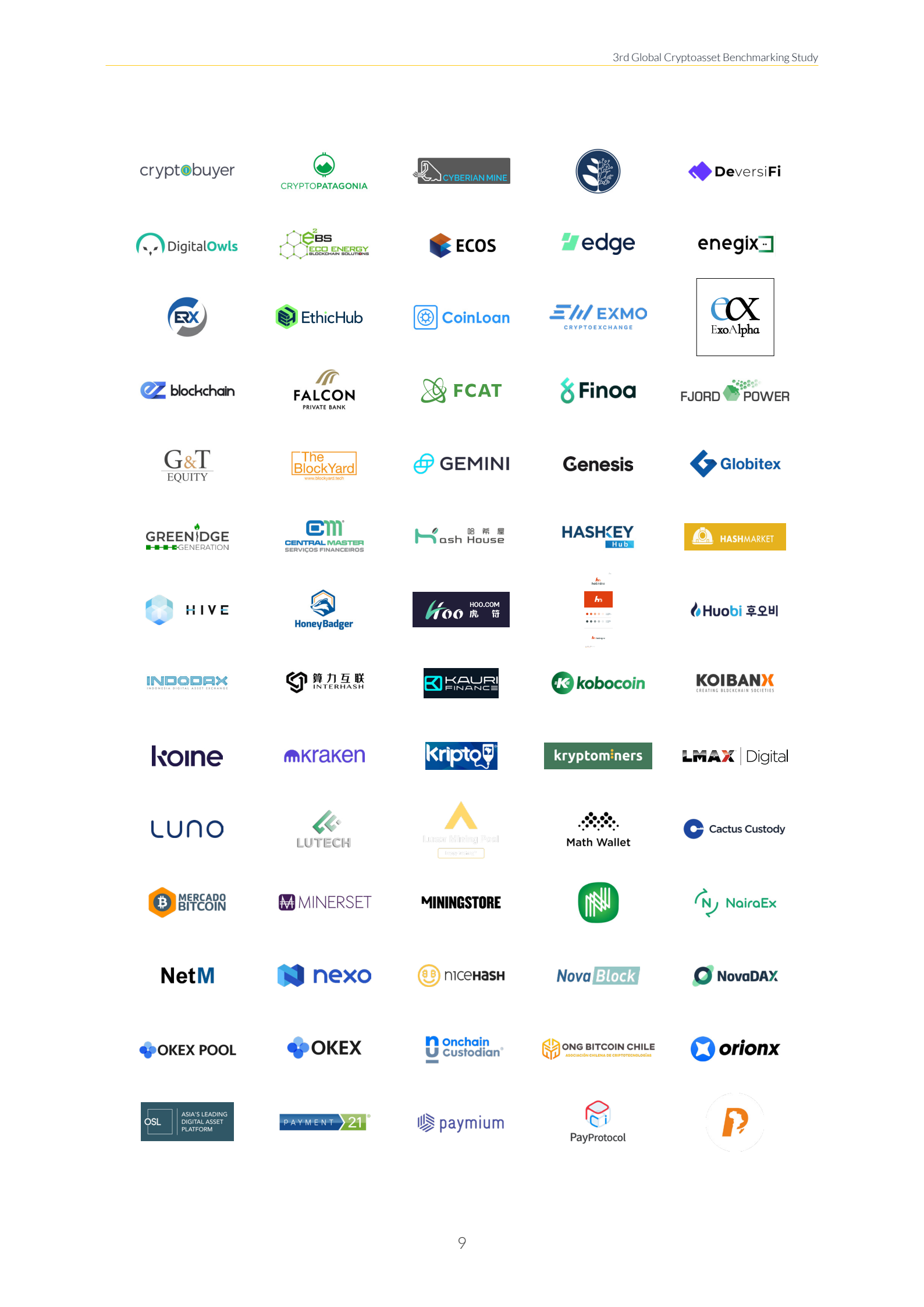
We are also grateful to CryptoCompare for supplementing our survey data with additional data that underpin their annual Exchange Benchmarking Report. We acknowledge their contribution wherever applicable throughout the report.

We would also like to thank the entire CCAF team, especially Robert Wardrop, Raghavendra Rau, Hunter Sims and Herman Smith, for their support. Special thanks go to Louise Smith for her fantastic design work, as well as Kate Belger, Yvona Duncan, and Neil Jessiman for their hard work behind the scenes.

In addition, we wish to thank Philippa Coney and Charles Goldsmith from the Cambridge Judge Business School for their assistance in producing and publishing the report.

Finally, we would like to express our utmost gratitude to all survey respondents from across the globe who participated in the surveys. Their contribution is core to the realisation of this study.

Note: some survey respondents prefer not to publicly disclose their participation.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EXECUTIVE SUMMARY

Over the past three years, the Cambridge Centre for Alternative Finance (CCAF) at the University of Cambridge Judge Business School, has tracked and analysed the development of the global cryptoasset industry. Since the publication of the 2nd Global Cryptoasset Benchmarking Study in December 2018, the industry has undergone significant changes: the 2017-2018 initial coin offering (ICO) bubble has sparked closer scrutiny from regulators resulting in greater efforts with regards to regulatory compliance, while new professional infrastructure and services have emerged to serve the increased interest from institutional investors. Mining analysts, for their part, have suggested that financial engineering is underway in the mining sector.

This report reviews some of these market trends and provides insights into the state of the cryptoasset industry. For the 3rd edition of its Global Cryptoasset Benchmarking Study, the CCAF gathered data from 280 entities from 59 countries and across four main market segments, namely exchange, payments, custody, and mining. The sample consists of 175 service providers, 75 mining companies and 30 individual miners. Data was collected between March and May 2020.

The key findings from this global cryptoasset benchmarking study are as follows:

Analysing growth indicators of the cryptoasset industry

Full-time equivalent (FTE) employee growth slowed considerably following the late-2017 market frenzy. Respondents across all market segments, reported year-on-year growth of 21% in 2019, down from 57% in 2018.

Industry-wide, the growth in FTE employment declined by 36 percentage points between 2017 and 2019, whereas the median firm reported a 75-percentage point downward change in employment growth. The difference in the industry-level and the firm-level employment growth figures reflects the rise of large firms within each industry group that dominates in the aggregate change in employment and suggests that a few large players are dominating the industry.

However, not all firms are equal: individual firm employment data shows that a notable proportion of companies (26%) have sustained an annualised growth in employment level above 10% over the past three years. Using established definition and criteria, which sets the size threshold of a firm at the beginning of the growth period at 10 FTE employees, these companies qualify as "high-growth companies".[1]

A deep dive into mining: from its environmental impact and the financialisation of the sector to centralisation concerns

The survey findings estimate that on average 39% of proof-of-work mining is powered by renewable energy, primarily hydroelectric energy. Understanding the energy source of mining is important because electricity costs account for the majority of hashers' operational expenditures - albeit with some variability across world regions - and hashers have long competed on accessing the cheapest energy source.

Faced with increased competition and tight profit margins, miners with access to sophisticated financial products, such as hashrate or cryptoasset derivatives, have begun using them to hedge their risks (between 12% to 14% of all miners). This is paving the way for the financialisation of mining.

1 Eurostat Glossary (2014) *Glossary: High-growth enterprise*. European Commission. Available from: https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:High-growth_enterprise [Last accessed: 20 August 2020].

Significant differences arise when comparing the cost structure of American and Chinese hashers: capital expenditures - primarily constituted of mining equipment purchase - take up to 56% of American hashers' costs, compared to 31% for Chinese ones. This suggests that Chinese hashers have a competitive edge in the acquisition of mining machines explained mostly by the concentration of hardware manufacturers in China, leading to a shorter supply chain, easier business conduct (e.g. language, working culture, local connections), and absence of international shipping fees and import tariffs. Aligned with this, the study found that 52% of ASIC manufacturers total sales go to Chinese hashers in 2019.

28% of surveyed hashers report receiving support from governments, primarily in the form of locally-focused support, such as electricity subsidy for users within a region. Nearly two-fifths of those receiving local governmental support are based in China.

Off the chain story: understanding service providers' internal flows

Aligned with 2018 findings, new survey data shows that off-chain transactions, both in terms of volumes and numbers, continue to be dominated by fiat-cryptoasset trades (and vice-versa), meaning that users primarily interact with 'gateway' service providers, such as exchanges, to enter and leave the cryptoasset ecosystem.

Usage seems to vary with the geographic location of the service provider. For instance, exchanges based out of APAC record the highest share of cryptoasset-cryptoasset trades (40%) and most transactions initiated at these exchanges are directed to the open-market (i.e. exchange's order-book). This suggests that APAC exchanges are primarily used for trading purposes.

Stablecoins are becoming increasingly available. The share of service providers supporting Tether grew from 4% to 32% between 2018 and 2020, compared to 11% to 55% support growth for non-Tether stablecoins. This is aligned with the rising value of transactions denominated in stablecoins.

Demographics of service providers' customer base

An updated estimate of the number of cryptoasset users indicates a total of up to 101 million unique users across 191 million accounts opened at service providers as of Q3 2020. In 2018, the 2nd Global Cryptoasset Benchmarking Study estimated the number of identity-verified cryptoasset users at about 35 million globally.

While firms continue to serve users from their region of operations, North American, Middle Eastern and African companies appear to have a more geographically diversified clientele. Service providers in both regions report that 42% of their customers are from other regions - primarily in Europe for MEA firms and Latin America for North American ones.

Service providers operationally headquartered in North America and Europe indicate that business and institutional clients make up 30% of their customers. This figure is much lower for APAC and Latin American firms at 16% and 10% respectively.

The composition of business and institutional clientele differs from region to region. While North American and European firms primarily serve cryptoasset hedge funds and traditional institutional investors, Middle Eastern and African service providers that cater to non-retail clients focus on online merchants (50%). Meanwhile, a notable share of APAC service providers deals with miners (41%), in part explained by the high level of mining activities in the region, especially in China.

Regulatory and compliance standards across the industry and geographies

Just over two out of five surveyed firms are licensed or in the process of obtaining a license; these firms are primarily located in Europe. However, the remaining 58% should not be perceived as the share of entities conducting unregulated activities or evading regulations: some surveyed service providers are engaged in activities that do not yet warrant any authorisation process (e.g. non-custodial functions) or are operating in jurisdiction(s) where no regulatory framework or guidance has been put forth.

Compliance with KYC/AML obligations is heterogeneous across regions. Nearly all customer accounts at European and North American service providers have been KYC'ed, whereas this is the case for only one out of two accounts at MEA-based service providers.

The share of cryptoasset-only companies that did not conduct any KYC checks at all dropped from 48% to 13% between 2018 and 2020, most likely resulting from the progressive harmonisation of KYC/AML standards across jurisdictions, such as initiated by the Financial Action Task Force (FATF). The inclusion of firms exclusively supporting cryptoassets featured in FATF's updated standards and recommendations is believed to have spurred greater compliance among this group of firms. However, this should not be interpreted as these companies becoming fully KYC compliant as some KYC checks are only applied to a subset of consumers.

54% of surveyed custodial service providers indicated that they performed an externally-led audit of their cryptoasset reserves over the past 12 months. This is a 24-percentage points decline compared to our 2018 sample. Firms that have undergone an independent audit are most likely to be operating out of Europe or the APAC region.

The development of best industry practices for IT security, security audits, and insurance coverage plans

Regardless of their location or size, the vast majority of surveyed cryptoasset service providers keep cryptoasset funds in cold storage (90%). To a lesser extent, they make use of multi-signature approaches to secure their cold (81%) and hot (70%) storage systems.

Nevertheless, enhanced IT security measures do not automatically come alongside robust insurance plans: 46% of service providers report not being insured against any risks. Those who do have insurance plans are primarily insured against cybercrimes, professional errors, hazards, and loss or theft of private keys.

The median non-custodial service provider usually spends a greater share of its resources, both financial and human, on IT security, between 11% to 20% compared to 6% to 10% for custodians. This is partially explained by the fact that non-custodial systems are generally associated with greater development costs and timeline.

Future outlook: striking the balance between integration and innovation?

A decoupling of duties, such as between custody, clearing and settlement responsibilities, appears to be underway and may lead to greater resemblance with traditional financial market infrastructure. For instance, 45% of respondents indicate using a third-party, primarily crypto-native custodians, as part of their cold storage system.

However, further intertwining with the traditional financial system and greater institutional adoption are conditional on enhanced compliance with international standards, such as those laid out by the FATF. Survey data found that cryptoasset service providers legally incorporated in a jurisdiction member of FATF are more likely to serve traditional institutional investors.

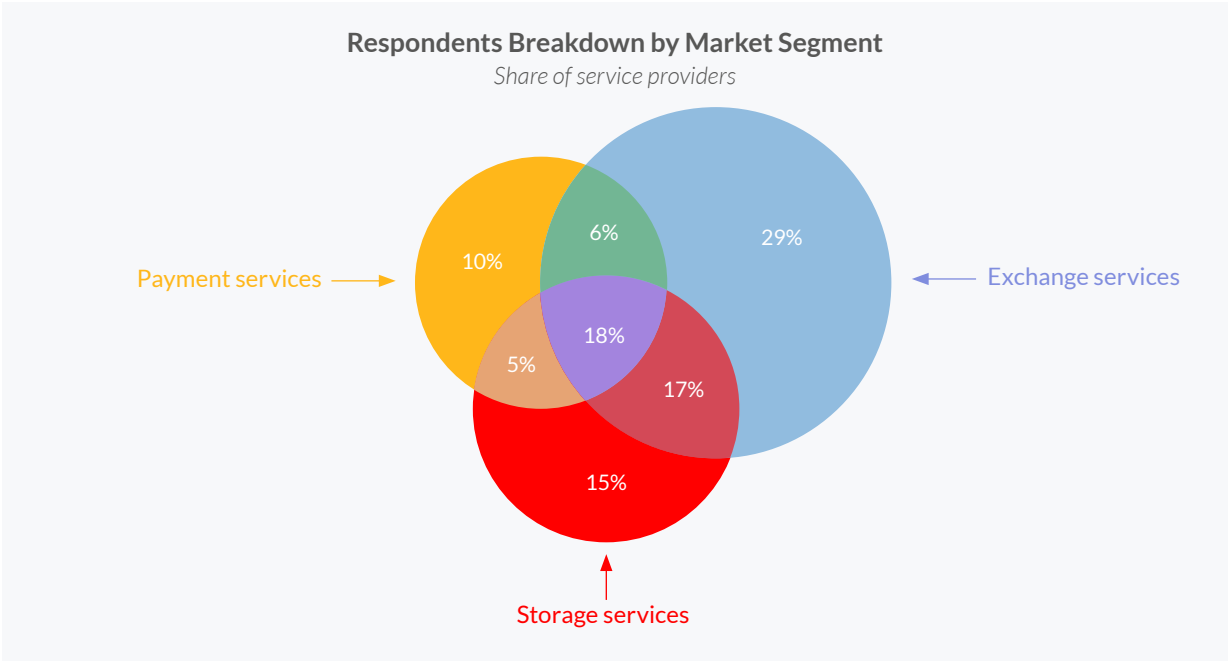
More risky and experimental innovations, such as in the realm of decentralised finance ("DeFi"), might also come to fruition in the near future. Service providers, particularly large ones, expect that future developments in the DeFi space will have considerable impact on their business operations and model in the next 12 months.

METHODOLOGY

For the third edition of the Global Cryptoasset Benchmarking Study, four market segments were surveyed: (i) mining, (ii) payment, (iii) custody, and (iv) exchange. Two separate surveys were constructed and distributed to respondents between March and May 2020, via secure web-based questionnaires.

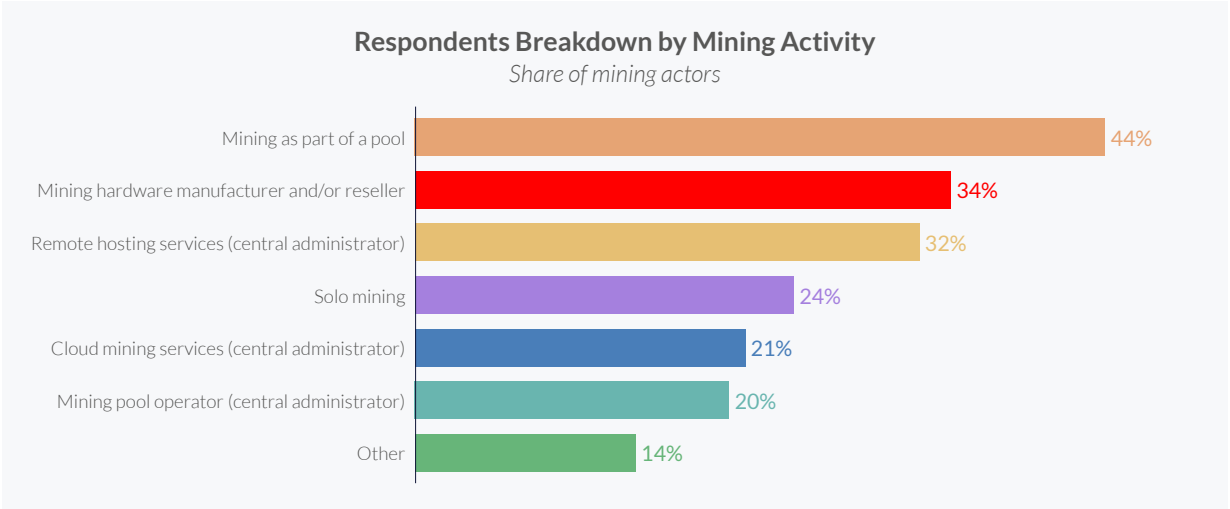
1. The Cryptoasset Service Providers Survey was sent to entities active in one or more of the payments, custody and exchange segments. The breakdown of respondents per market segment is shown in **Figure 1**.

Figure 1: The exchange market segment is the most represented in the survey sample with more than two in three surveyed respondents offering exchange services



2. The Cryptoasset Mining Survey was sent to individuals and organisations involved in the mining industry, such as hashers, hardware manufacturers, and pool operators. The breakdown of mining respondents is shown in **Figure 2**.

Figure 2: Nearly one in two respondents mine as part of a pool



The surveys were globally distributed to ensure a representative sample of geographic dispersion across market segments. Both surveys were made available in English, Spanish, Portuguese, Chinese, Japanese, Russian, and Korean. In addition, the Cryptoasset Mining Survey was translated into Arabic. Respondents were able to choose their preferred language for the web-based questionnaire.

Over 500 invitations to complete the surveys were disseminated by email to known industry contacts and to other participants whose email addresses were obtained through desktop research. Members of relevant industry groups on different messaging platforms, such as Telegram and WeChat, were sent invitation links to complete the surveys. Information and open invitations to complete the surveys were posted on social media platforms, including Twitter, LinkedIn, Reddit, and BitcoinTalk. News outlets (e.g. Coindesk, 8btc, ChainNews) assisted with distribution of the survey. Finally, the research team worked and partnered with 26 national cryptoasset associations to ensure local and national distribution of the surveys, thereby increasing wider global participation.

This study also saw the contribution of a third-party data provider: CryptoCompare provided the CCAF with selected data underpinning their Annual Exchange Benchmarking Report to supplement data collected via our own online surveys.[2]

All collected data was encrypted, safely stored and made accessible only to the CCAF research team responsible for the production of this study. The privacy of all individual and company respondents was ensured by anonymising all the data gathered from the surveys. In addition, the data was only analysed in aggregate, using a range of categories that include industry segment, organisation size, supported assets, custody types, and region.

Data was collected from 280 entities globally across 59 countries

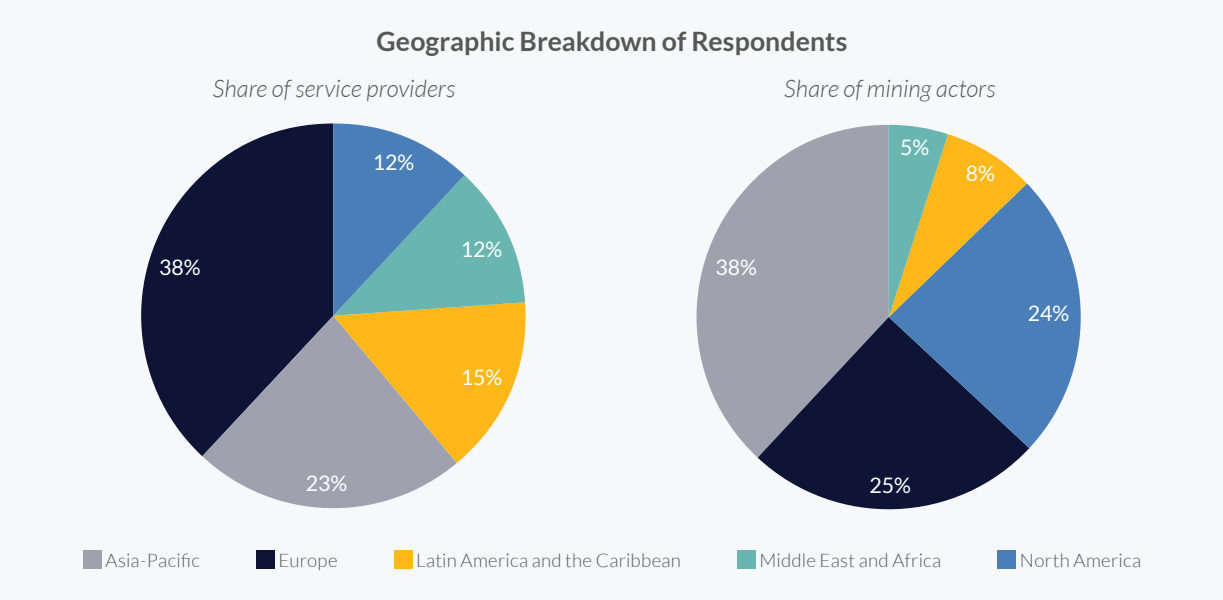
In some instances, the survey data was supplemented by desktop research. This included web scraping using manual techniques as well as Python scripts which were then verified and augmented through a manual search process. Data from company websites, research reports, media outlets, and other public sources was used to gather additional complementary data. If survey responses required clarification, follow-up phone calls were made, or emails were sent to respondents. Where required, and if feasible, additional checks were made by comparing survey results with other publicly available data and responses on prior surveys. All responses were anonymised before the data was processed and analysed.

280 entities across 59 countries and five continents contributed to the surveys. 175 firms participated in the Cryptoasset Service Providers Survey and 105 entities (75 organisations and 30 individuals) completed the Cryptoasset Mining Survey.

Figure 3 provides a breakdown of survey participants by geographic region. European countries make up more than a third of the Service Provider Survey sample. Compared to the previous study, respondents from the Middle East and Africa (MEA) now make up 12% of global respondents, doubling the number from last year. Latin America and the Caribbean (LAC) has also seen an increase from respondents, up from 9% to 15% this year. This change in geographical distribution of respondents helps to provide a more balanced dataset globally.

2 CryptoCompare Research (2020) Exchange Benchmark Report - July 2020. Available from: https://www.cryptocompare.com/media/37072188/cryptocompare-exchange-benchmark-july-2020.pdf [Last accessed: 24 August 2020].

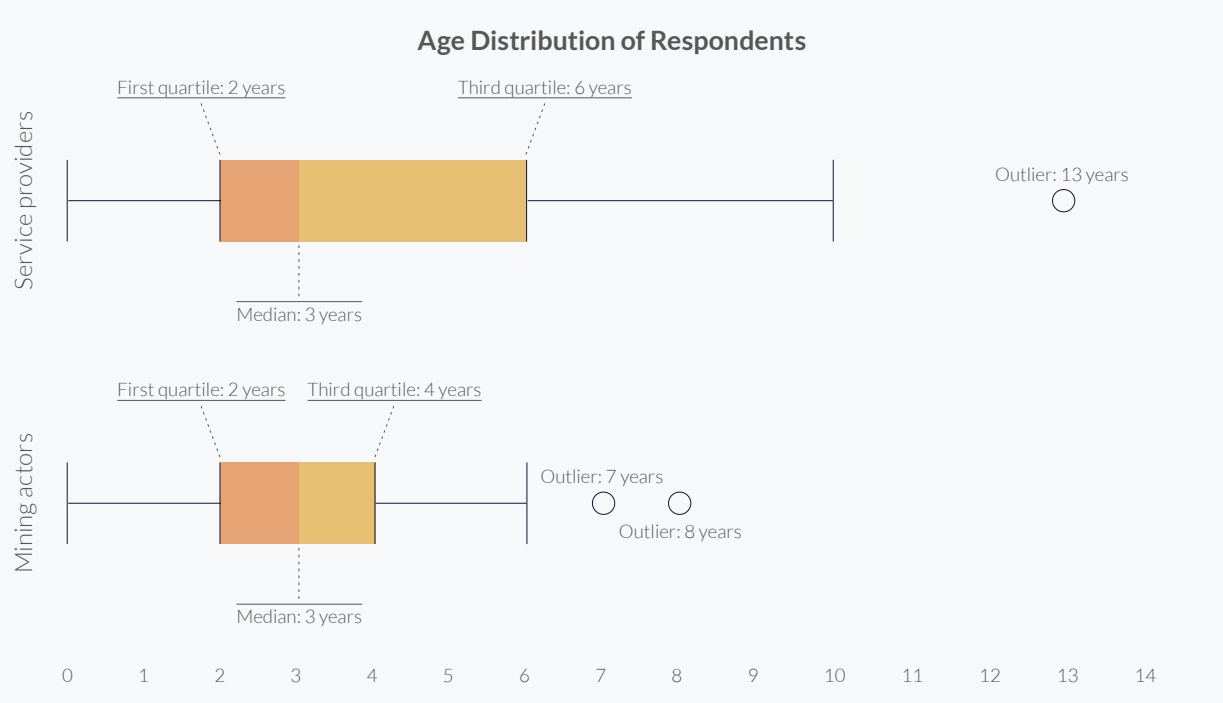
Figure 3: APAC and European respondents constitute the majority of surveyed entities



Asia-Pacific (APAC) respondents still dominate the Mining Survey sample. The proportions of respondents from Europe and North America remain approximately the same as 2018, with a 3% increase from the MEA region and a 4% decrease from LAC. The three most represented countries in our mining sample were China (24%), USA (16%), and Russia (8%).

The distribution of respondents in terms of age is relatively similar across both samples (**Figure 4**). Half of surveyed firms have been in operation for up to 3 years. The other half of surveyed service providers have been operating for between 3 and 10 years, compared to 3 to 8 years for the second half of surveyed mining actors. Further, we observed a significant difference in age distribution across regions. In MEA, the majority of firms are young (less than 2 years old), whereas in Europe and North America almost a fifth of firms are almost as old as the industry itself (7+ years old).

Figure 4: For both samples, the median firm has been operating for three years



SECTION 1: INDUSTRY GROWTH INDICATORS

EMPLOYMENT FIGURES

The growth of the cryptoasset ecosystem has conventionally triggered a corresponding surge in job opportunities. However, throughout 2018, employment growth decelerated as the effects of the late-2017 market frenzy abated. The mining industry was particularly impacted by the slowdown: with a 37 percentage points (pp)[3] decline in the segment aggregated employment level, compared to 36 pp for service providers (**Table 1**).

The difference in the industry-level and the firm-level year-on-year (YoY) growth figures reflects the rise of large firms within each industry group that dominate in the aggregate. Larger companies appear to be less affected than individual firms, which may suggest that a few large players dominate the industry.

Table 1: Global patterns of employment levels at the industry- and firm-level

	YoY 2017-2018		YoY 2018-2019	
	Industry aggregate	Firm-level (median)[4]	Industry aggregate	Firm-level (median)
All market segments	57%	88%	21%	13%
Service providers	55%	100%	19%	0%
Mining	65%	60%	28%	0%

Cryptoasset industries in the different regions have not been impacted equally by this slowdown. Employment growth in Europe decreased by 14 pp, from 32% between 2017-2018 to 18% between 2018-2019. This is roughly half as much as in Latin America (from 45% to 6%) and MEA (from 69% to 35%). Figures from the APAC and North American cryptoasset industries reveal a sharp decline in employment growth - from 73% to 21% for APAC and from 134% to 33% for North American, amounting to a fall of 52 and 111 pp respectively (**Table 2**).

Firm-level figures point to other interesting patterns. In contrast to industry-wide figures, firm-level data shows that individual firms in North America and Europe, alongside MEA companies, have been the most impacted with a 110 and 55 pp negative change in employment growth. This difference between the experience at the aggregate industry employment and the experience of the median firm is another potential indication that large companies are growing ever larger as a share of the industry.

Table 2: Employment growth is uneven across region, both at the industry and firm levels

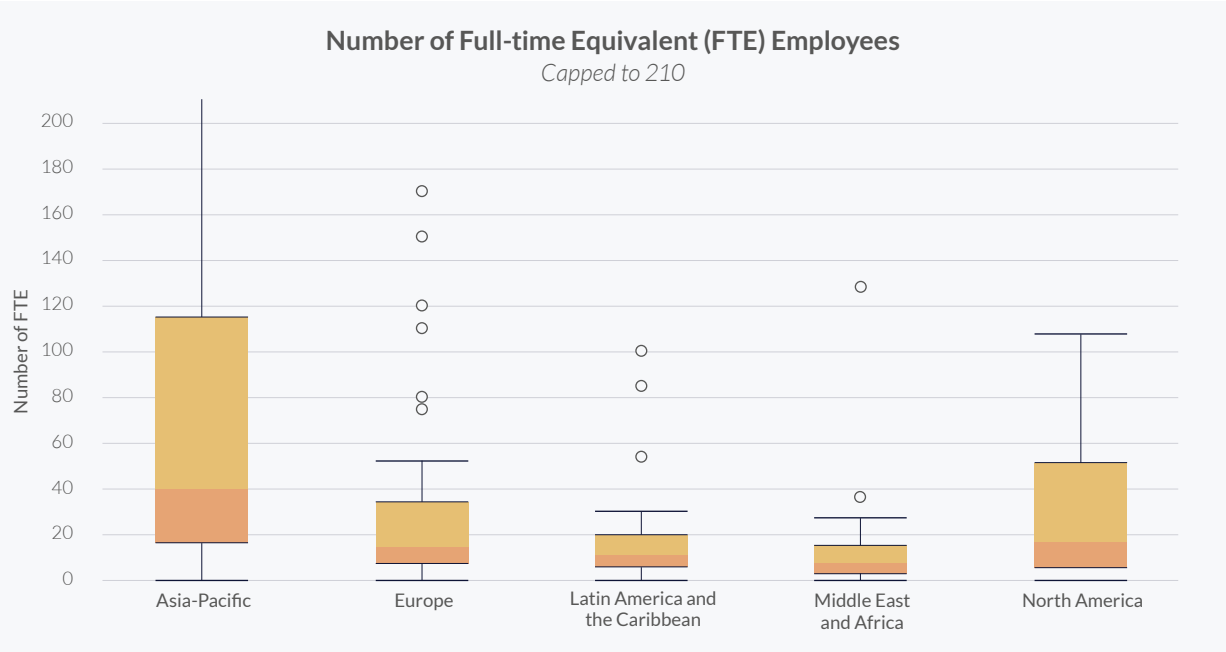
	YoY 2017-2018		YoY 2018-2019	
	Industry-level	Firm-level (median)	Industry-level	Firm-level (median)
APAC	73%	78%	21%	41%
Europe	32%	88%	18%	33%
LAC	45%	43%	6%	15%
MEA	69%	83%	35%	0%
North America	134%	100%	33%	-10%

3 "Percentage points (pp)" is the standard unit to express the difference between two percentages. For instance, at the aggregate level year-on-year growth was 57% between 2017-2018 and 21% between 2018-2019: this is a decline of 57%-21%=36 percentage points (pp) decrease, but a 36/57 = 63% decrease in year-on-year growth .

4 Firm-level data is usually long-tailed in most industries (i.e. composed of many small firms and a few very large ones), which results in significant discrepancy between the mean and the median. From a firm-level perspective, using the median rather than the mean is therefore more representative of the sample.

Despite being one of the two most impacted regions by this decline, FTE figures for 2019 show that the median APAC firm reports a larger workforce size, with a median of 40 FTE employees, than the median companies from other regions. We also note greater variability in staff numbers for APAC companies, which suggest that the regional industry is greatly diversified, with a mix of small and large entities.

Figure 5: Larger firms tend to operate from APAC and North America



HIGH-GROWTH ENTERPRISES

The share of high-growth companies in an industry is often used as an indicator to assess the development stage of the sector. A high-growth enterprise may be determined by its workforce size or profits generated. From an employee figure perspective, an enterprise qualifies as "high-growth" if the average annualised growth in number of full-time employees (FTE) is greater than 10% p.a. over a three-year period and having at least 10 employees at the beginning of the growth.[5]

According to our study sample and using established criteria, high-growth companies accounted for more than one out of every four enterprises active in the cryptoasset ecosystem in 2019. This figure is slightly above the share of high-growth firms in other industries. By comparison, in 2017, the European Commission reported that high-growth firms represented respectively 17% and 13% of European companies in the Information and Communication, and Professional, Scientific, and Technical Activities sectors.[6]

The median YoY employment growth rate for high-growth firms was 53% for the period 2017-2018 and 43% for 2018-2019

The share of high-growth firms as a proportion of the number of surveyed firms that provided FTE figures for three consecutive years, is almost equal across the service providers and mining actors with 27% of surveyed service providers qualifying as high-growth firms compared to 25% of surveyed mining actors.[7] From a geographic standpoint, the majority of these firms are in APAC, where 39% of surveyed

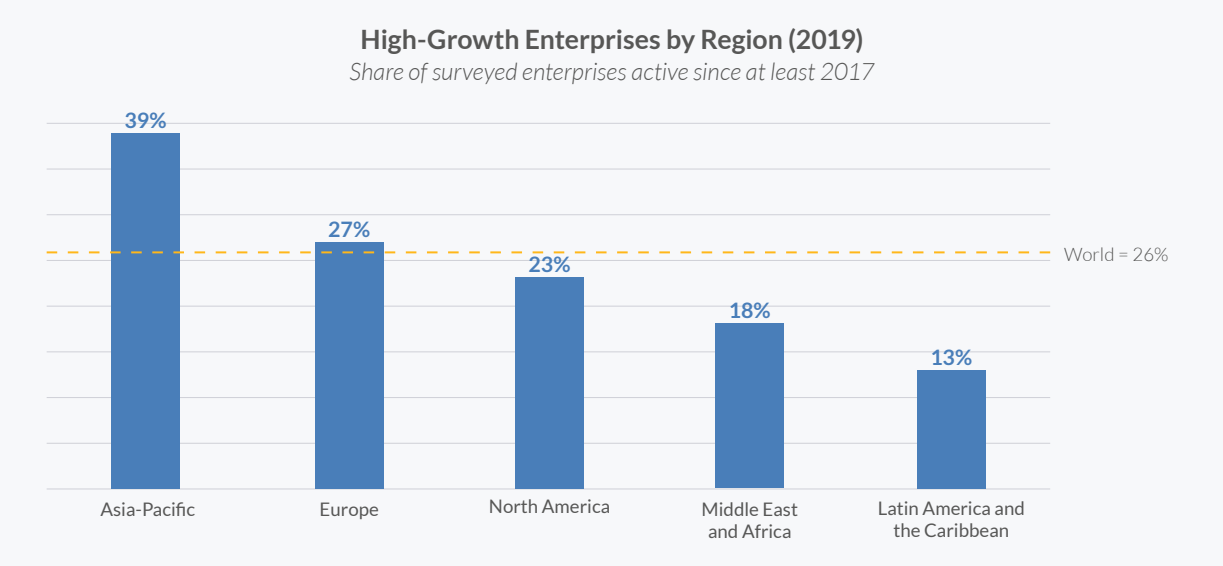
5 Eurostat Glossary (2014) *Glossary: High-growth enterprise*. European Commission. Available from: https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:High-growth_enterprise [Last accessed: 20 August 2020].

6 Eurostat (2019) *1 in 10 enterprises in the EU classified as high-growth companies*. European Commission. Available from: https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20191210-1 [Last accessed: 20 August 2020].

7 Based on the total of respondents that provided FTE figures for three consecutive years, from 2016 to 2019.

enterprises active since at least 2017 can be defined as high-growth firms (**Figure 6**). The lowest share of high-growth enterprises was found in LAC, where only 13% of surveyed firms in that region met the criteria.

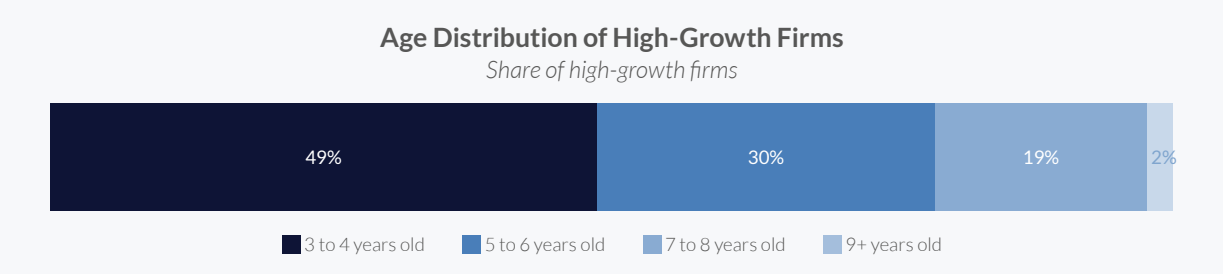
Figure 6: In 2019, APAC recorded the highest share of high-growth enterprises



Higher growth firms account for a larger part of employment in the industry relative to small growth firms. In 2019, more than two in three employees of surveyed enterprises that have been active since at least 2017 were employed by a high-growth company. These firms, on average, more than doubled their workforce over the three-year period. In 2017-2019, high-growth cryptoasset firms experienced on average a positive growth in the number of employees from approximately 84 employees in 2017 to 200 employees in 2019. This minority of high growth firms appear to account for higher employment levels across the industry.

A commonly shared view is that high-growth firms are typically young (but at least three years old). Although survey data shows that 3-4 years-old firms represent 49% of high-growth enterprises, the median high-growth firm in the cryptoasset industry is 6 years old (**Figure 7**).

Figure 7: High growth is primarily a young firm phenomenon

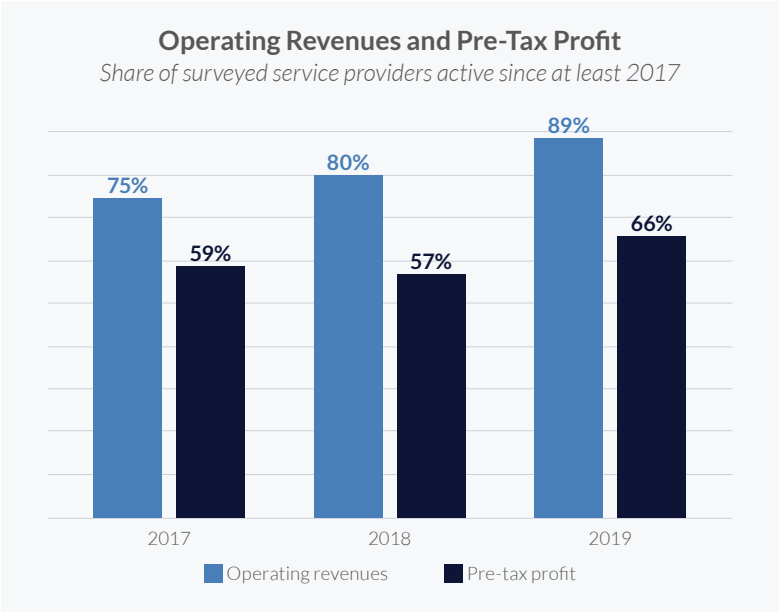


FINANCIAL PERFORMANCE OF SERVICE PROVIDERS

To perform a longitudinal assessment of the financial performance of service providers over the years, we collected data on the operating revenues and pre-tax profits. Majority of the surveyed entities that have been active since 2017, indicate that they have generated operating revenues over the past three years (**Figure 8**).

Despite the growth in the number of firms reporting operating revenues between 2017 and 2019, from 10% to 16%, the number of firms that realised pre-tax profit stagnated between 2017 and 2018. 2018 corresponds to the year when the market experienced a sharp drop in prices and total market capitalisation, which may have had a debilitating effect on some service providers and their ability to generate profits.

Figure 8: Surveyed service providers report increased profitability in 2019 in comparison to the preceding years



Unsurprisingly, the older the company, the more likely it is to be profitable. 80% of firms aged 7 years old or older report having earned profits in 2019, compared to 60% for the 3-4 years old age group and 64% for firms that are 5-6 years old.

SECTION 2: MINING, THE BACKBONE OF THE INDUSTRY

With mining operations reaching industrial scale, the ecosystem has morphed into a complex network of interdependent actors,[8] often opaque and hard to understand for external observers and the general public. In particular, the crucial role of miners in the functioning and the security of proof-of-work (PoW) systems, such as Bitcoin, is often underappreciated and overlooked. This section intends to address this complexity by delving into the role of hashers, pool operators, and hardware manufacturers.

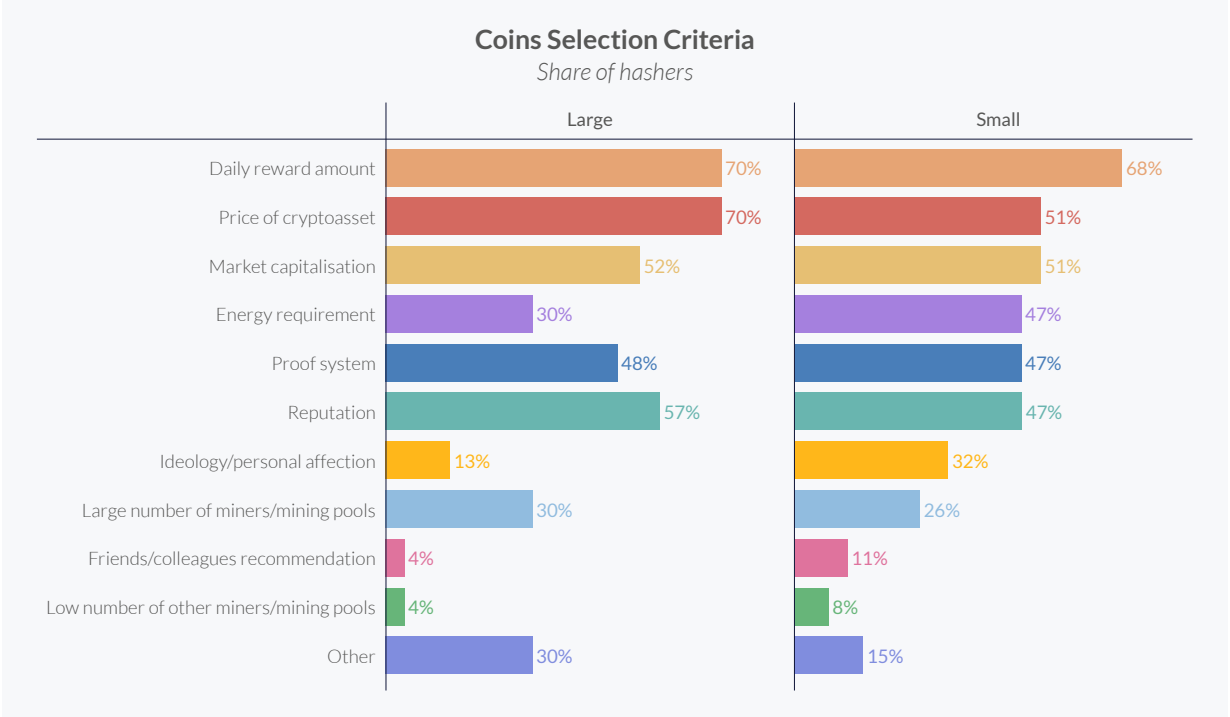
HASHING AS A BUSINESS

Hashers' *raison d'être* is the existence of PoW, a consensus mechanism to produce a commonly-agreed history of transactions without relying on a central coordinating authority.[9] There are other consensus mechanisms that exist, such as proof-of-stake, but given PoW's predominance at the time of writing this report, this section exclusively focuses on PoW mining.

COIN SELECTION

The entry cost into cryptocurrency mining has been on the rise since 2013, partly attributable to increasing computational difficulties that necessitate the utilisation of specific-purpose hardware.

Figure 9: Financial parameters primarily guide hashers' choice of coins to mine



8 For an introduction to the mining industry please see Rauchs et al. (2018) *2nd Global Cryptoasset Benchmarking Study*. Cambridge Centre for Alternative Finance. Available from: https://www.jbs.cam.ac.uk/wp-content/uploads/2020/08/2019-09-ccaf-2nd-global-cryptoasset-benchmarking.pdf [Last accessed: 24 August 2020].

9 In proof-of-work cryptocurrencies, "hashers" provide computing power and are commonly known as "miners". For further discussion on the role of hashers, see Rauchs et al. (2018) *2nd Global Cryptoasset Benchmarking Study*. Cambridge Centre for Alternative Finance. Available from: https://www.jbs.cam.ac.uk/wp-content/uploads/2020/08/2019-09-ccaf-2nd-global-cryptoasset-benchmarking.pdf [Last accessed: 24 August 2020].

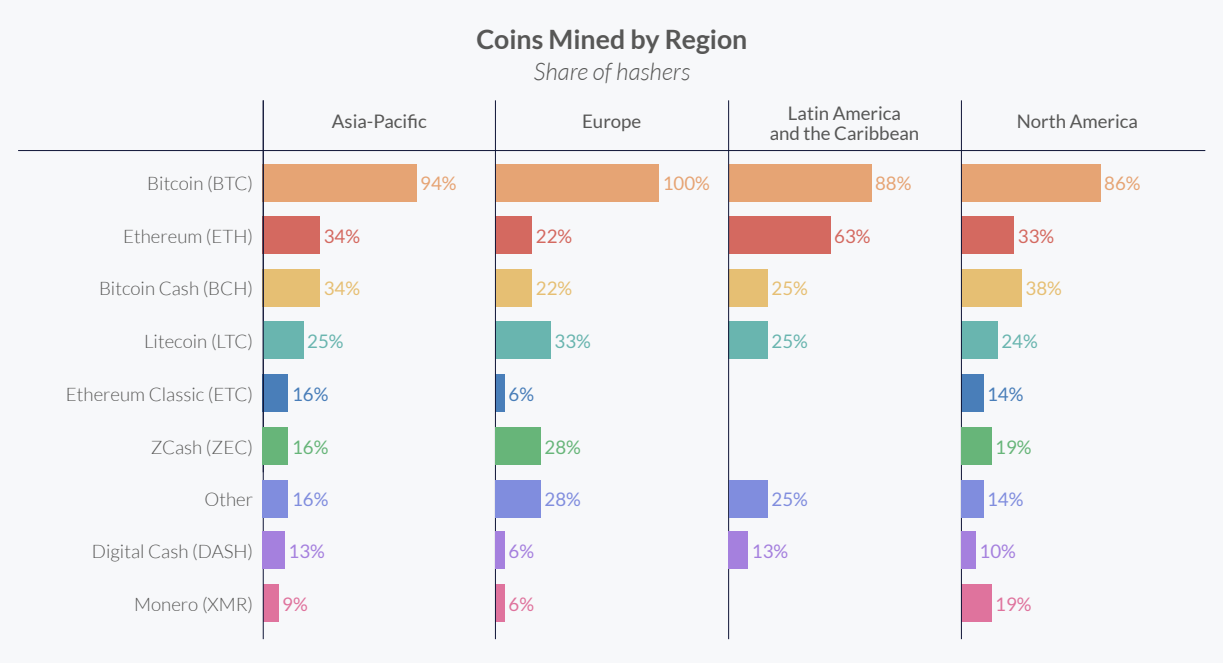
Hashers must therefore carefully select the coin(s) to mine against a set od criteria to break even. For the majority of hashers that are driven by profit motives and returns, coin selection is generally guided by financial criteria, such as daily reward amount or cryptoasset prices (**Figure 9**).

Conversely, the remaining portion of hobbyist hashers, believed to be mostly located in Europe and North America,[10] are likely to be driven by more subjective criteria, such as ideology and personal affection.

Interestingly, energy requirement seems to be a much more determining factor for small hashers than large ones. This difference is also reflected at the regional level: hashers operating out of Europe (56%) and LAC (63%) more often base their coin choice on this criteria than those from APAC (37%) or North America (35%). This might be an indication that hashers, and particularly large ones, from APAC and North America are more confident in their ability to secure stable access to energy sources.

Bitcoin is the most popular coin mined, with 89% of surveyed hashers indicating that they mine it, followed more distantly by Ethereum (35%) and Bitcoin Cash (30%). Interestingly, while Bitcoin mining is predominant across all regions, other coins seem more popular in certain areas than others (**Figure 10**). For instance, Ethereum mining appears to be particularly popular among Latin American hashers, whereas Bitcoin Cash is more popular in APAC and North America. The mining of privacy coins in Western regions also differs from the global average: 28% and 19% of European and North American hashers report mining ZCash, and as many North American hashers also engaged in Monero mining.

Figure 10: Beside global consensus on Bitcoin, the popularity of other PoW coins varies across world regions



COST OF HASHING

Hashers' costs comprise capital expenditures (e.g. purchase of mining equipment, infrastructure development and allied costs), which represent on average 45% of hashers' total costs. The remaining 55% fund operational expenditures (e.g. electricity bills, maintenance, workforce), of which 75% is utilised towards the payment of utilities. This figure varies slightly based on the type of coins mined. For instance, for hashers exclusively focusing on cryptocurrencies that employ the SHA-256 mining algorithm,

10 Genesis Mining (2020) *State of Crypto Mining 2020*. Genesis Mining. Available from: https://www.genesis-mining.com/state-of-mining2020?download=confirm [Last accessed: 20 August 2020].

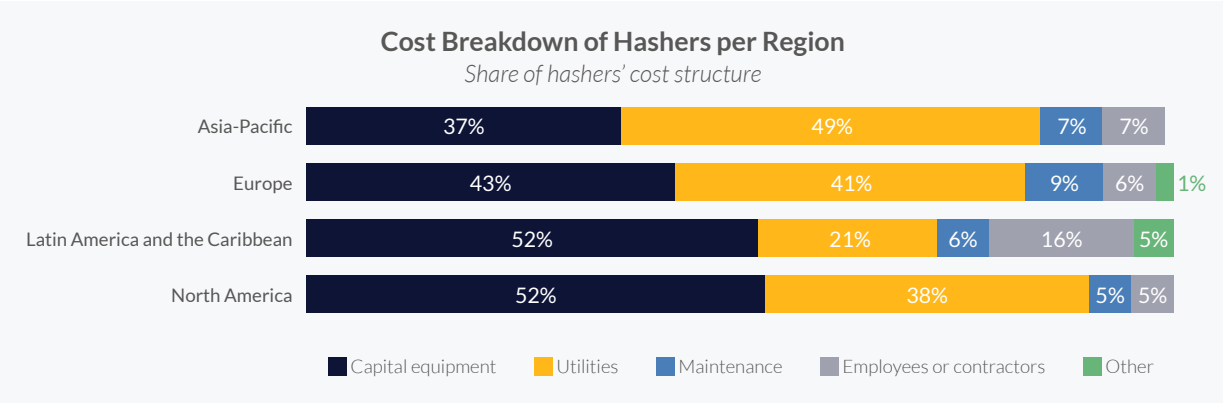
utility costs correspond to 79% of their operational expenditures. This is in part explained by diverging production costs of the different PoW coins.

Utility costs represent on average 79% of SHA-256 hashers' operational expenditures

Differences also arise at the regional level (**Figure 11**): hashers operating in LAC reported the lowest share of utilities cost as part of their total cost structure. The clustering of respondents at the bottom part of the distribution for North and Latin American hashers suggests that a select few hashers in these regions are able to drastically minimise their utilities costs.

Importantly, Latin American hashers registered the highest share of capital expenditures - although we note a relative variability across them - possibly explained by a lack of robust supply chains to ship equipment to the region. In contrast, easy reach of hardware manufacturers is reflected by a lower share of capital expenditures as part of their total costs for APAC miners (37%).

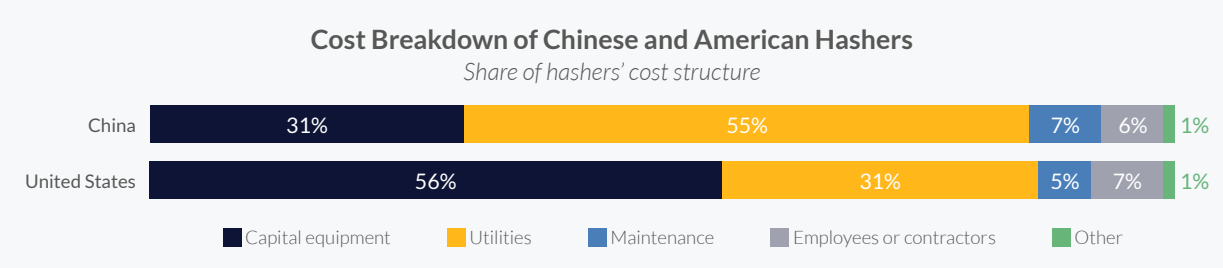
Figure 11: Most of North and Latin American hashers' costs go to capital equipment



A focus on the two most represented countries in our study sample offers additional insights. Cost structure data from Chinese and American hashers seems to confirm that Chinese hashers have a competitive edge in the acquisition of mining machines (**Figure 12**). The concentration of hardware manufacturers in China implies well-connected and shorter supply chains to Chinese hashers, simplified business conduct (e.g. language, working culture), and absence of additional overseas shipping fees.[11]

Unexpectedly, the share of labour and maintenance costs do not seem to differ significantly between the two mining regions, despite common belief that cheaper workforce in China would necessarily lead to labour contributing less to their overall expenditures. Cost of labour is indeed cheaper in China, but Chinese hashers tend to rely on a larger workforce size to run their operations. In contrast, most North American facilities have deployed sophisticated ASIC management software that reduces the need for technicians.

Figure 12: Chinese hashers allocate more than half of their total expenditures to utilities



11 For instance, since the introduction of new tariffs on Chinese imports, US hashers have to pay 25% tariffs on ASICs shipped to the USA.

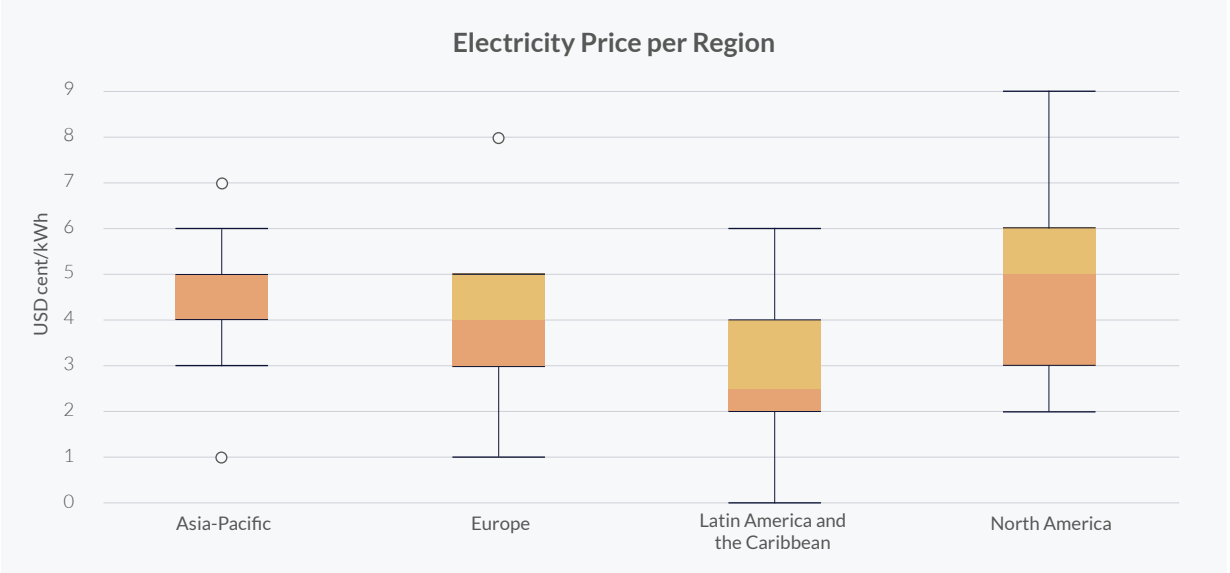
ELECTRICITY PRICE

Utilities, primarily composed of electricity costs, take the lion's share of hashers' operational expenditures. Contrary to the popular assumptions found in academic papers and mainstream media[12], the vast majority of hashers no longer pay residential electricity prices, but often access preferential/industrial pricing by entering contractual agreements with power generators. The median electricity price is comparatively higher in North America - albeit significantly variable across hashers from the region - and APAC at USD 0.05/kWh, whereas Latin American hashers report the lowest median electricity price (USD 0.025/kWh) of all regions (**Figure 13**).

Globally, electricity price paid by miners averages USD 0.046 per kWh[13]

There is a notion that electricity surplus in some APAC areas, such as the province of Sichuan in China, gives hashers who relocate their operations there during the rainy season a competitive advantage in minimising their running costs. However, survey data demonstrates that this seasonal advantage appears to be offset by less affordable electricity prices throughout the rest of the year when hashers migrate back to other provinces, such as Xinjiang or Inner Mongolia in China.

Figure 13: The median Asian and North American hasher pay the same electricity price



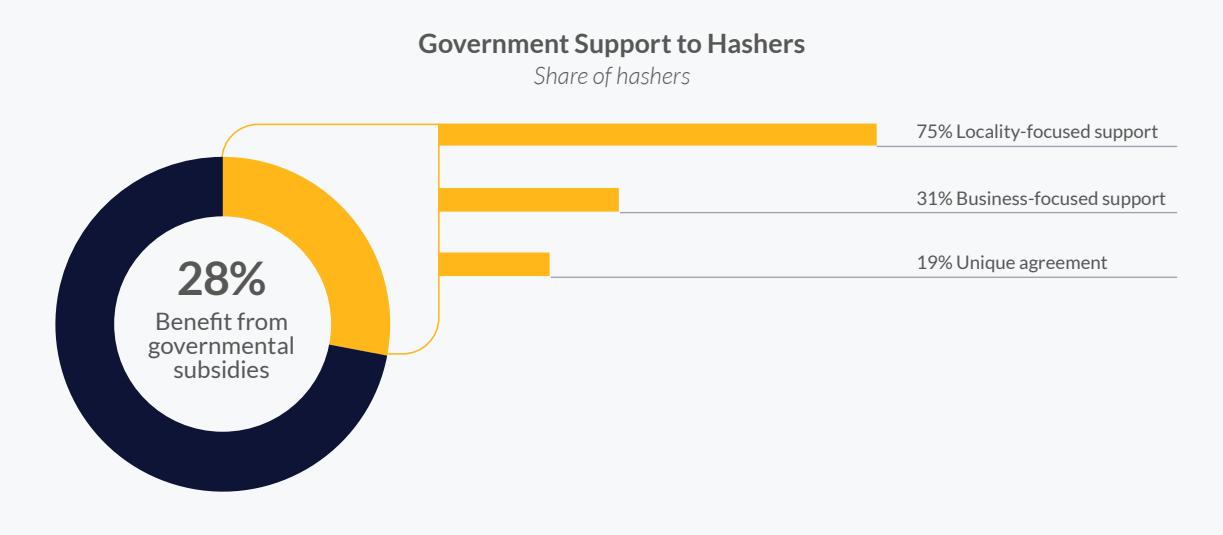
GOVERNMENT SUPPORT

Hashers' operational costs may be reduced through government support, which may take the form of subsidies or tax exemptions. Government interventions through subsidies and tax exemptions are, however, still relatively uncommon in most regions. Only 23% of the surveyed hashers report receiving support from governments (**Figure 14**). This aid primarily takes the form of locally-focused support, such as electricity price subsidy for users within a region. 38% of surveyed hashers who receive government support operate in China, followed by Kazakh (19%) and Canadian (12%) hashers.

12 See for instance, Malfuzi, A. et al. (2020) *Economic viability of bitcoin mining using a renewable-based SOFC power system to supply the electrical power demand*. Energy. Available from: https://doi.org/10.1016/j.energy.2020.117843 [Last Accessed: 20 August 2020]; Benetton, B., Compiani, G. and Morse, A. (2019) Crypto Mining: Local Evidence from China and the US. University of Berkeley. Available from: https://faculty.haas.berkeley.edu/morse/research/papers/BenettonCompianiMorse_CryptoMining.pdf https://doi.org/10.1016/j.energy.2020.117843 [Last accessed: 21 August 2020].

13 The weighted average was calculated by combining survey data on electricity price and the estimated monthly share of total Bitcoin hashrate per country for the period September 2019 to April 2020, according to the CBECI mining map. See *Cambridge Bitcoin Electricity Consumption Index*. Cambridge Centre for Alternative Finance. Available from: https://cbeci.org/mining_map [Last accessed: 21 August 2020].

Figure 14: A select few hashers benefit from governmental subsidies



Mining activities have attracted greater regulatory scrutiny

CCAF's regulatory landscape of cryptoasset activities study released in April 2019 revealed that very few jurisdictions have included or explicitly mentioned mining in their regulatory guidance on cryptoasset activities. Mining has, however, sparked greater regulatory attention recently, and in some instances led to the development of bespoke legal frameworks for mining activities, such as in Kazakhstan.[14] In other jurisdictions, enforcement actions have provided further clarity on the regulatory treatment of mining-related products. For instance, in a ruling dated April 2020, the Texan regulator indicated that a cloud mining platform breached US securities law by offering unlicensed securities.[15]

Miners from the same region greatly diverge in their opinion on their immediate regulatory environment. This heterogeneity in opinion suggests either that miners have limited awareness of existing regulation, or that regulation is confusing and inconsistent. Nonetheless, regulatory changes seem unlikely to induce a change in the geographic location of operations as reported by surveyed miners; only 23% indicated having opened a new mining facility following a change in local regulation.

14 For an overview of regulatory developments in 2020, see TokenInsight (2020) 2020 Q2 Cryptocurrency Mining Industry Report. Available from: https://tokeninsight.com/report/1189?lang=en&title=2020-Q2-Cryptocurrency-Mining-Industry-Report [Last accessed: 21 August 2020].

15 'Texas State Securities Board vs Ultra BTC Mining LLC' (2020) *Emergency Cease and Desist Order*. Texas State Securities Board. Available from: https://www.ssb.texas.gov/sites/default/files/ENF_20_CDO_1801.pdf [Last accessed: 21 August 2020].

WHERE ARE WE ON POW'S ENERGY CONSUMPTION?

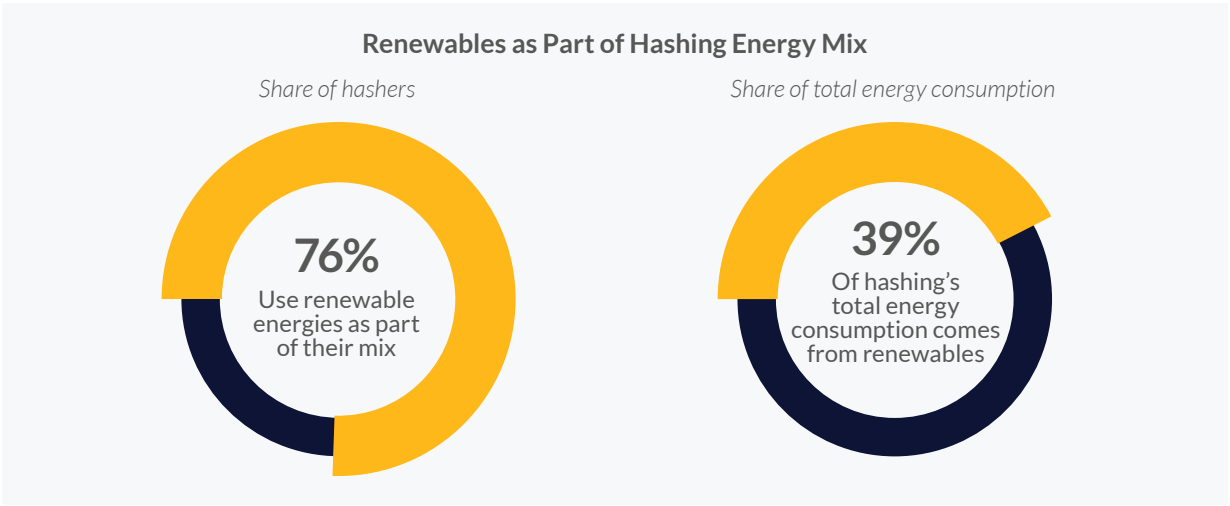
Despite increasing transparency and research on the environmental impact of PoW mining,[16] the topic is still typically misrepresented in most sources and on both sides of the debate. Similar to 2018, this year's survey data shows that a significant majority of hashers (76%) use renewable energies as part of their energy mix (**Figure 15**). However, the share of renewables in hashers' total energy consumption remains at 39%.

Hydropower is listed as the number one source of energy, with 62% of surveyed hashers indicating that their mining operations are powered by hydroelectric energy (**Figure 16**). Other types of clean energies (e.g. wind and solar) rank further down, behind coal and natural gas, which respectively account for 38% and 36% of respondents' power sources.

39% of surveyed miners' total energy consumption comes from renewables

The data does not allow us to infer what share of natural gas usage corresponds to stranded gas, i.e. represents energy that would otherwise be wasted or unused. Stranded gas either takes the form of gas that would be flared at oil or gas wells due to limited pipeline capacity or gas coming from non-exploited wells due to logistical or economic reasons. Despite reported challenging logistics, certain areas in the USA have witnessed the installation of a few mining sites powered by stranded gas, such as in Texas or North Dakota.

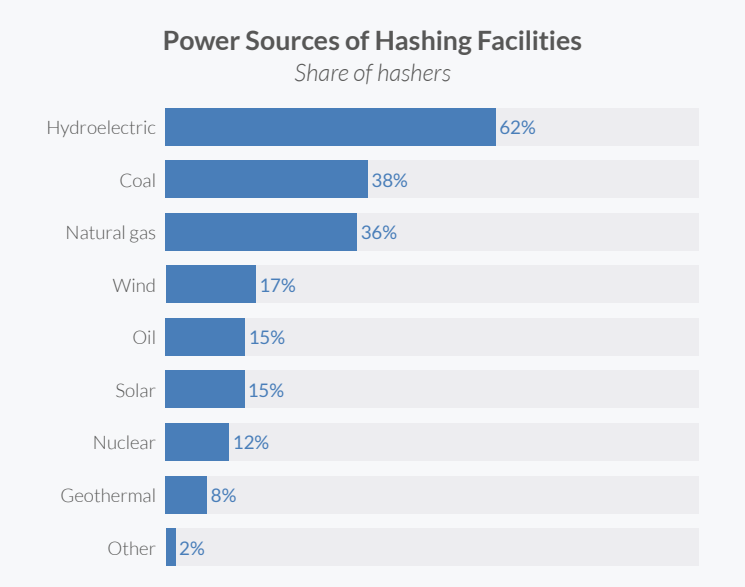
Figure 15: PoW mining is primarily powered by non-renewable energy sources



The spread shape of regional distributions for the share of renewables suggests that there is extreme variability across miners from the same region, particularly in APAC, Europe, and North America. The median percentage of renewables in Europe and North America is relatively high at about 70% and 66% respectively, while the median is much lower in APAC, at 25%.

16 Stoll C., Klaaßen U. and Gallersdörfer, U. (2019) *The Carbon Footprint of Bitcoin.* Joule. Available from: https://www.cell.com/joule/pdf/S2542-4351(19)30255-7.pdf [Last accessed: 21 August 2020], Bendikson, C. and Gibbons, S. (2019) *The Bitcoin Mining Network - Trends, Composition, Average Creation Cost, Electricity Consumption & Sources.* CoinShares Research. Available from: https://coinshares.com/assets/resources/Research/bitcoin-mining-network-december-2019.pdf [Last accessed: 21 August 2020], and *Cambridge Bitcoin Electricity Consumption Index.* Cambridge Centre for Alternative Finance. Available from: https://cbeci.org/mining_map [Last accessed: 21 August 2020].

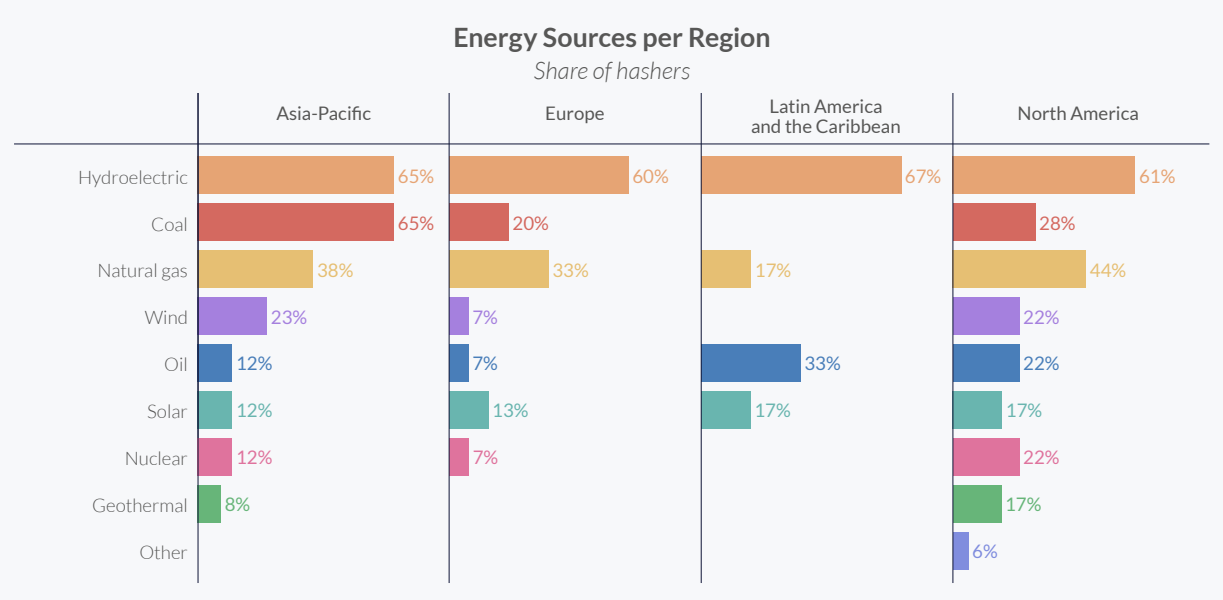
Figure 16: Hydroelectricity, coal, and natural gas are the most reported power sources



Regional breakdown of energy sources reveals that APAC hashers equally rely on coal and hydropower (**Figure 17**). Coal-based mining is principally adopted in regions such as the Chinese provinces of Xinjiang and Inner Mongolia, and in Kazakhstan, whereas hydroelectric energy is mainly generated in South-Western regions of China (Sichuan and Yunnan).

China's oversupply of hydroelectric energy during the rainy season has often been used as evidence in claims that a vast majority of mining is powered by environment-friendly power sources. While it is true that the Chinese government's strategy to ensure energy self-sufficiency has led to the development of massive hydropower capacity,[17] [18] the same strategy has driven public investments in the construction of large-scale coal mines. Like hydroelectric power plants, these coal power plants often generate surpluses. It should not come as a surprise then that a significant share of hashers in the region equally report using both hydropower and coal energy to power their operations.

Figure 17: North American hashers appear to use a wider range of energy sources[19]



17 Hydropower accounts for approximately a quarter of the total power capacity in China. See, Youmei (2020) *Hydropower and Sustainable Development in China*. Department of Economic and Social Affairs. Available from: https://www.un.org/esa/sustdev/sdissues/energy/op/hydro_luyoumei.pdf [Last accessed: 21 August 2020].

18 Consumption of hydropower for mining operations has sometimes been encouraged by Chinese government officials, including most recently by the Municipal Economic and Information Bureau and the Municipal Development and Reform Commission of Ya'an District. See, Zamundzinski, A. (2020) *Chinese Officials Support Renewable Energy-Powered Cryptocurrency Mining*. Cointelegraph. Available from: https://cointelegraph.com/news/chinese-officials-support-renewable-energy-powered-cryptocurrency-mining [Last accessed: 21 August 2020].

19 Of note, most North American hashers connect their operations to the grid, which naturally combine a mix of power sources.

In July 2019, CCAF launched a real-time estimate of Bitcoin's electricity consumption, the *Cambridge Bitcoin Electricity Consumption Index (CBECI)*, which was followed by the release in May 2020 of an interactive map of the geographic distribution of Bitcoin hashpower from September 2019 to April 2020.[20] The findings from the map combined with survey data for SHA-256 hashers offer an alternative methodological approach to estimate the energy mix of Bitcoin mining. The results of this top-down calculation are displayed in **Table 3** and indicates that about 29% of Bitcoin mining is powered by renewables.

Table 3: Aggregate share of renewables in Bitcoin mining energy sources

Region	Regional average share of renewables	Regional share of Bitcoin hashpower	Regional weighted share of renewables in Bitcoin mining
Asia-Pacific	26%	77%	20%
Europe	30%	10%	3%
Latin America and the Caribbean	20%	1%	0%
Middle East and Africa	NA	4%	NA
North America	63%	8%	5%
Global		100%	29%

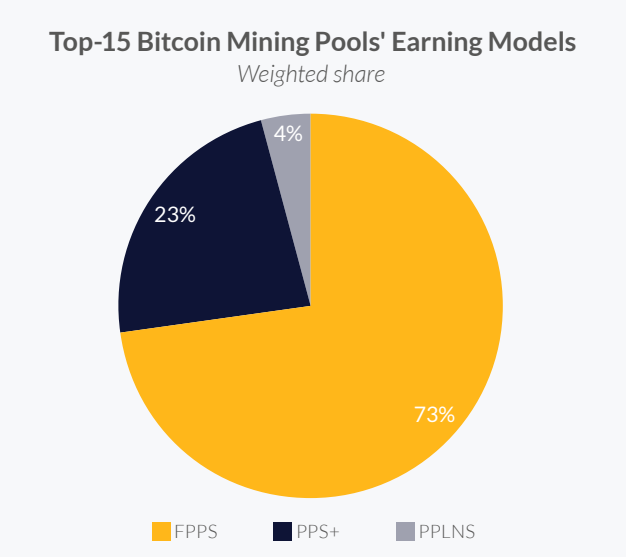
Source: CBECI mining map, survey data. As of April 2020

MINING POOLS

PAYMENT METHODS

Pool operators coordinate the work of thousands of hashers to increase the likelihood of producing a valid PoW. They are also responsible for compensating hashers based on the expected value of their contribution and according to a chosen payment method (see call-out box). There are more than a dozen reward systems for pools to choose from. However, one seems to have prevailed to date: the pay-per-share (PPS) model and its associated subalterns full-pay-per-share (FPPS) and pay-per-share + (PPS+).[21] The study of a separate data set focusing on the top-15 Bitcoin mining pools and their respective share of total hashrate shows that the full-pay-per-share (FPPS) model dominates (**Figure 18**). This distribution may vary for other coins, however, in particular those whose transaction fees are insignificant for miners payouts.

Figure 18: FPPS is the most widely supported across Bitcoin top mining pools



Source: BTC.com, Pools' individual website

20 Data underpinning the map was provided by three pools, BTC.com, Poolin, and ViaBTC, that together represent 37% of Bitcoin's total hashrate.

21 Mining rewards comprise both the block subsidy and transaction fees. While in a PPS model, pools only redistribute the block subsidy, the FPPS and PPS+ schemes also include the distribution of transaction fees.

The reward systems of mining pools

A reward system corresponds to the payment method used by pool operators to split mining rewards among hashers contributing to their pool. One key difference between existing reward systems lies in the valuation of hashers' work. In the PPS model, a hasher is immediately rewarded upon completion of work, even though the pool is not guaranteed to find a block. The amount paid is calculated based on the *expected* value of a hasher's work. As a result, PPS payoffs are deterministic for mining pool participants as the value of the payoff is known in advance.

Conversely, in the pay-per-last-n-share (PPLNS) system, mining pools define a time window and pay out rewards to miners only after the pool has found a block. The *actual* value of the payoff is based on the share of work produced by the hasher during this time window.

Each model comes with its own set of trade-offs; while the regularity of PPS payments reduces the variance or "luck factor" on miners' side, the revenue miners can expect from a PPS pool is slightly lower, in the short term, than in a PPLNS model. In the long run, however, a miner is expected to earn a higher revenue with the PPS model, all else equal. This is because in a PPS setup, pools will continue to pay even under unfavourable circumstances (e.g. orphan blocks, blockwitholding attacks). Conversely, in the PPLNS mode, miners bear the "luck" risk, but usually pay a lower fee to the pool and might receive higher earnings, in the short term, depending on how lucky the pool is in finding blocks.

Most reward systems are constructed to prevent "pool-hopping", whereby hashers regularly switch between pools as their profitability changes. Hopping-proof reward systems (e.g. PPLNS, score-based) disincentivise hashers from doing so by offering better rewards to "loyal hashers". A growing body of academic literature has emerged to study pool-hopping behaviours and hashers' migration patterns between pools.[22] [23] For instance, Belotti et al.'s (2018) analysis has shown that although pool-hopping might be more profitable, the practice is not necessarily widespread among hashers.

Pools are also developing novel techniques to better reward hashers and win their loyalty. For instance, at the time of writing, pools are beginning to offer profit-switching algorithms between PoW coins using the same hashing algorithm (e.g. Bitcoin, Bitcoin Cash, Bitcoin SV, Bitcoin Diamond, all use the SHA-256 algorithm). Instead of performing work for a single coin, this service lets the pool direct hashers' aggregate hashpower to the most profitable coin of those that use the same hashing algorithm. In turn, pools are expected to buy hashrate at a significantly higher price from miners.[24]

This is also interesting in light of updated survey data on the distribution of miners' hashpower contribution to pools, which, per 2019, suggests that hashpower contributed by the most active miners follows a power-law distribution.[25] **Figure 19** shows that the top-1% of active miners are responsible for two-thirds of the pool's total hashpower at the median. If pool-hopping was common practice, pools' overreliance on a small number of customers would pose risk to their operations. Furthermore, the change in the median contribution of hashers across all three groups between 2018 and 2020 data suggests greater concentration at the top.

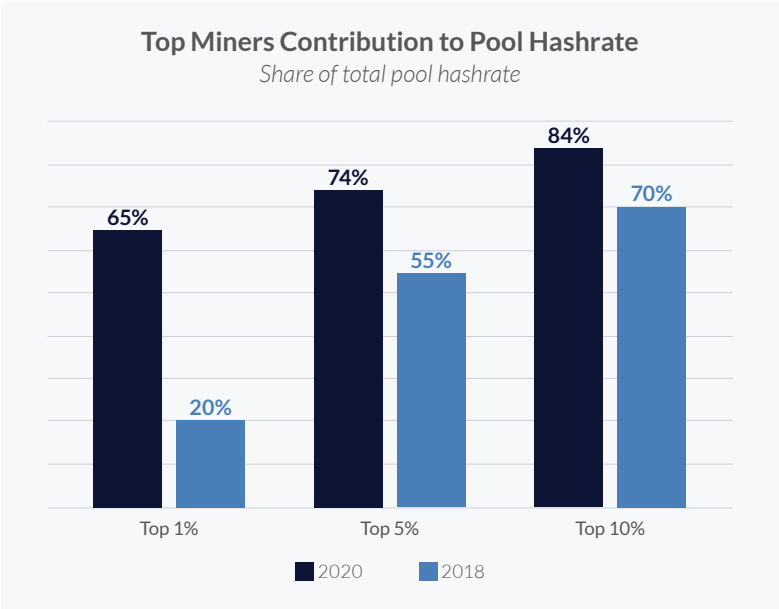
22 Belotti M., Kirati, S. and Secci, S. (2018) *Bitcoin Pool-Hopping Detection*. Proc. of 2018 IEEE 4th International Forum on Research and Technology for Society and Industry. Available from: https://www-phare.lip6.fr/~secci/papers/BeKiSe-RTSI18.pdf [Last accessed: 21 August 2020].

23 Liu, K. and Ohsawa, Y. (2019) *Auction based Rewards Distribution Method in Pool Mining*. Proc. of 2019 IECC International Electronics Communication Conference. Available from: https://dl.acm.org/doi/pdf/10.1145/3343147.3343162 [Last accessed: 21 August 2020].

24 For a detailed explanation of profit-switching see for instance, Luxor Tech (2020) *Introducing Luxor Switch*. Available from: https://medium.com/luxor/introducing-luxor-switch-6c65401d3d71 [Last accessed: 21 August 2020].

25 Active participation is defined as contributing hashpower at least once a week to the pool. The median share of active members is 80%, with noticeable variability across pools as a significant number of them report lower activity figures.

Figure 19: The median hasher in the top-10% of active contributors produces 84% of the pool's total hashrate



A NOTE ON MINING CENTRALISATION AND POOL GOVERNANCE

As discussed in the 2nd Global Cryptoasset Benchmarking Study, centralisation risks are mainly perceived to occur at three levels of the mining value chain: geographic location (and/or ownership) of hashpower, hardware production, and pool operation.[26] Specifically, pool operations have been of great concern given the censorship power that they have had to date over the work performed by hashers. Given this concern, it is important to understand pools' governance model and their role in the mining process.

From a governance standpoint, survey data reveals that no clear-cut model stands out: one third of pools use a mix of approaches in their decision-making process, while another third acknowledged that decision-making is a prerogative of pool administrators.

In their coordination role, mining pools retain great leverage over the work done by miners and leave them with relatively limited bargaining power.[27] If incentivised to, pools could choose to exploit their influence in multiple ways, e.g. to dishonestly mine, blacklist transactions or addresses, or redirect miners' hashpower to support another chain. Similar scenarios could also materialise if a pool was to be attacked and controlled by malicious actors. In response to this centralisation risk, different solutions have been developed to ensure greater decentralisation in the mining process at the pool level (see callout box on stratum v2).

26 See page 95, Rauchs et al. (2018) *2nd Global Cryptoasset Benchmarking Study*. Cambridge Centre for Alternative Finance. Available from: https://www.jbs.cam.ac.uk/wp-content/uploads/2020/08/2019-09-ccaf-2nd-global-cryptoasset-benchmarking.pdf [Last accessed: 24 August 2020].

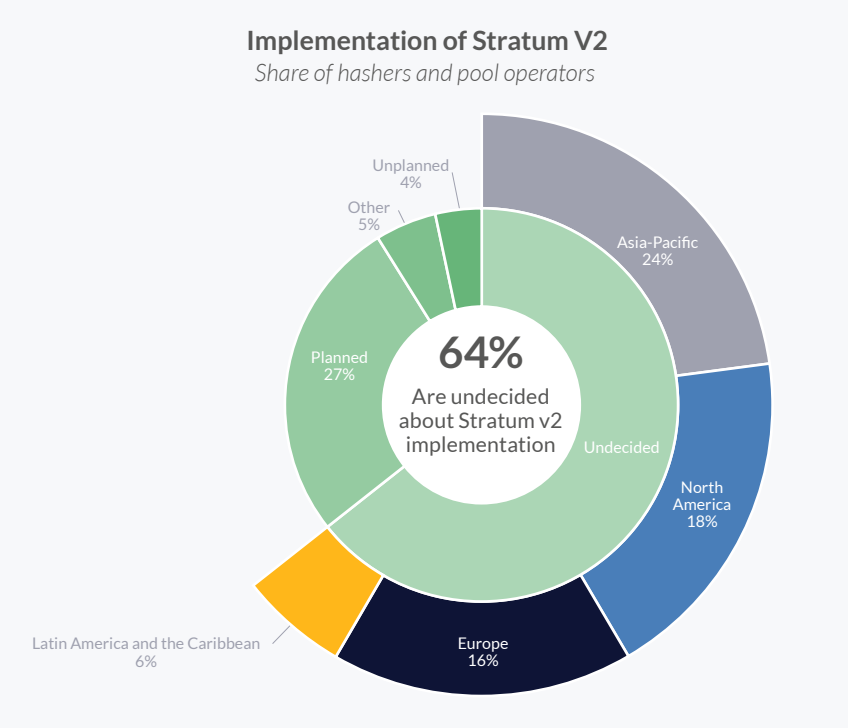
27 In practice however, it is commonly believed that pools' heavy involvement in the mining industry and entire dependence on miners willing to connect to their pool may have disincentivised more than one to behave dishonestly.

Stratum v2: handling control back to hashers?

Hashers participating in pooled mining rely on a protocol stack to communicate with pool services, contribute work, and receive rewards. Since the creation of the first Bitcoin mining pool in 2011, the dominant mining protocol in use has been *stratum*. Concerns raised by multiple developers over centralisation risk and pools' censorship power spurred the research and development of an alternative mining protocol. Several actors have laid the groundwork in putting forth several proposals. One such example is stratum v2. Simply put, stratum v2 introduces an extra-step in the pooled mining process consisting in a negotiation phase between hashers and pools. During the negotiations, hashers have the possibility to choose what they will work on (i.e. transaction set) instead of letting the pool unilaterally decide on their behalf. Ultimately this decouples the block building and propagation to the network phases from payouts to miners.

For this approach to take off, alternatives to the original stratum protocol must be widely supported and implemented by hashers and pools. From our survey data, a large majority of surveyed pools and hashers report being undecided regarding the implementation of Stratum v2. A fourth have reported planning to implement stratum v2, but they have yet to follow through (**Figure 20**).

Figure 20: In APAC, one-fourth of hashers and pools are unsure about stratum v2 implementation



MINING HARDWARE MANUFACTURING

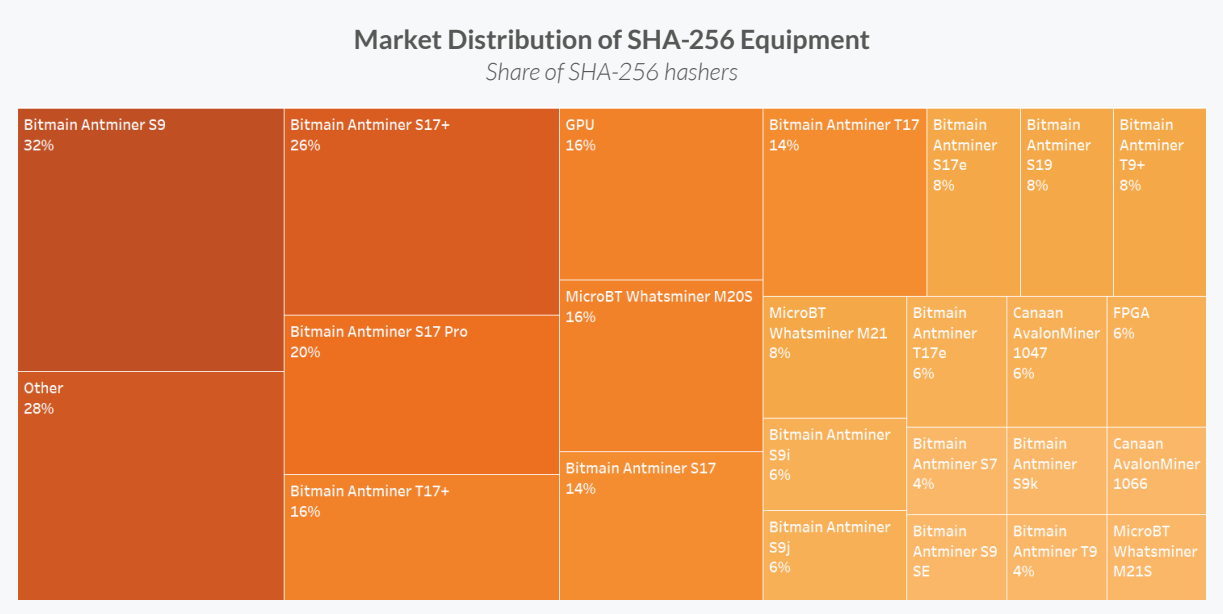
The mining hardware industry is another constituent of the mining industry that is often perceived as a complete black box. Its relatively concentrated and secretive nature may conceal power dynamics and relationships at play. Firstly, it is important to emphasize that manufacturing industries greatly differ based on the type of hardware in use and the coin mined. For instance, the hardware space for Bitcoin mining (and other SHA-256 coins) is dominated by ASIC producers, whereas Ethereum mining has had a long-lasting loyalty to GPU-mining. Undeniably, the former has received most press coverage to date. This subsection primarily focuses on the ASIC manufacturing industry.

The introduction of ASICs in 2013 hastened the professionalisation of the cryptoasset mining ecosystem as a whole. Over the years, ASIC manufacturers have been acknowledged for their role in considerably improving the efficiency of equipment and lengthening the obsolescence period of hardware.[28]

However, the ASIC manufacturing industry is one that is still trying to find its feet. ASIC manufacturers are particularly dependent on their partnership with third-party foundries that supply them with advanced integrated circuits technology necessary to build ASIC chips. Given the concentration of the foundry market, ASIC manufacturers' operations are heavily reliant on a few fabrication plants, and a rise in price, a reduction in the foundry capacity allocation, or simply a deterioration of relationships could be detrimental to manufacturers' business.

In this context, it is interesting to examine how these challenges may have impacted the market distribution of ASIC manufacturers' equipment. There is, however, a severe shortage of reliable information on the topic. In an attempt to gauge the scale of the ASIC primary market, several reports based on publicly disclosed sales information attributed the majority of the market share to a single manufacturer until 2018.[29] After 2018, these reports found that fiercer competition from other manufacturers has led to a shift in dominance and to a more diversified landscape.

Figure 21: The vast majority of SHA-256 hashers report using Bitmain's Antminers



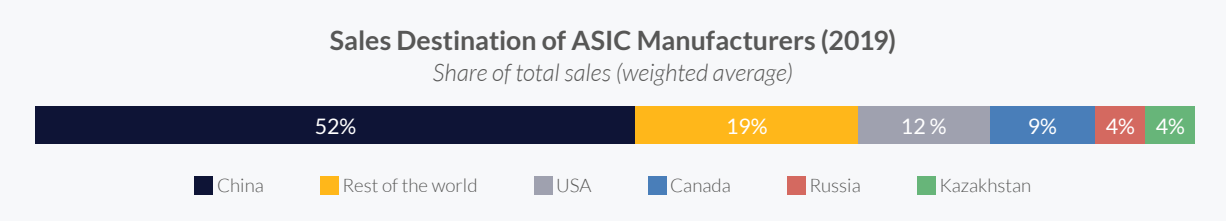
28 See for instance, Elmandjra, Y. and Hsue, D. (2019) *Bitcoin Mining - The Evolution of A Multibillion Dollar Industry*. Ark Invest. Available from: https://research.ark-invest.com/bitcoin-mining-white-paper [Last accessed: 21 August 2020].

29 These reports estimate the market presence of each ASIC manufacturer, either based on the number of machines sold or the amount terahash per second (Th/s) sold. See for instance, BitMEX Research (2020) *Battle For ASIC Supremacy*. BitMEX. Available from: https://blog.bitmex.com/battle-for-asic-supremacy/ [Last accessed: 21 August 2020].

Survey data partially corroborates these findings. For instance, data collected from SHA-256 hashers reveals that, as of April 2020, Bitmain Antminer machines appear to dominate the market (**Figure 21**). In particular, Bitmain S9 model, which was released in May 2016, was reportedly used by 32% of surveyed SHA-256 hashers.[30] Interestingly, alternative techniques using network data to estimate the amount of hashpower provided by certain types of hardware suggested that Antminer S9 machines were responsible for 32% of Bitcoin's hashpower.[31] The next most cited manufacturer was MicroBT, whose Whatsminer M20S model appears to be particularly popular among hashers (16%).

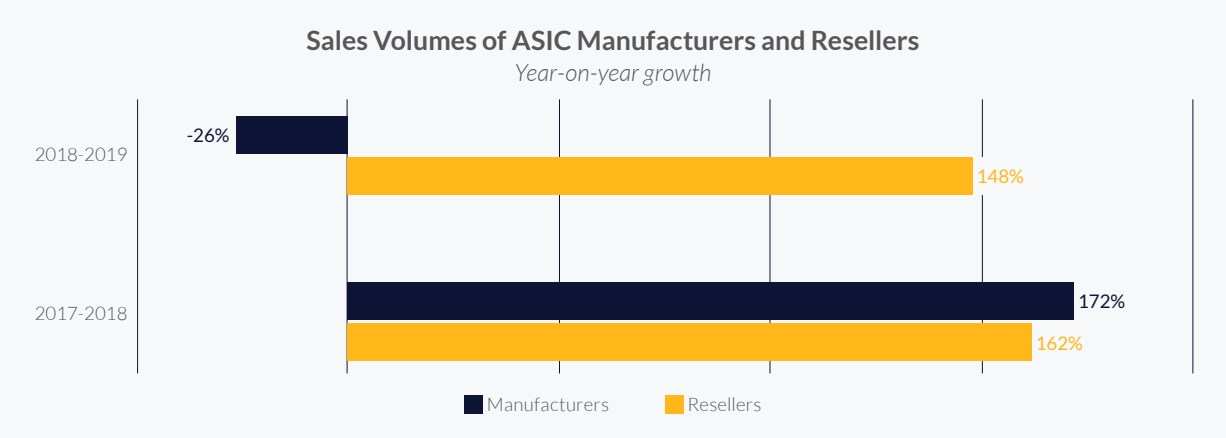
Figure 22 shows that China accounts for a substantial portion of manufacturers' total sales (52%), dwarfing other world regions, including the USA (12%) and Canada (9%). This is consistent with the fact that China is the main hub of mining activities as revealed by pools' data displayed on the CBECI. The CBECI mining map also shows that Kazakhstan and Russia occupy a notable share of mining activities albeit, they each account for only 4% of manufacturers' total sales. Possibly, hashers from these countries may primarily be supplied by equipment sold on the secondary market.

Figure 22: In 2019, one in two ASICs produced is distributed to Chinese hashers



Accurate figures on the ASIC secondary market are even scarcer than information on the primary market. Suspected to be particularly dynamic, the scale of the secondary market is hard to come by as most trades take place over-the-counter often via informal channels (e.g. Telegram groups). Existing data sets on deals happening on the secondary market suggest that the market share of each SHA-256 hardware manufacturer is relatively similar to their market share of primary sales.[32]

Figure 23: Secondary market trades may have help resellers sustain their sales volumes



Source: CCAF survey data, Ebang IPO filings

30 It should be noted however that data was collected prior to the Bitcoin halving of May 2020. Hence, the market share of each model may have significantly changed since then, as some machines became unprofitable and obsolete.

31 Helmy, K. (2020) *The Half-Time Show: The State of Bitcoin Network Security After the Halving*. Coin Metrics. Available from: https://coinmetrics.substack.com/p/coin-metrics-state-of-the-network-fcf [Last accessed: 21 August 2020].

32 Hashrate Index (2020) *SHA-256 Rig Index*. Hashrate Index. Available from: https://www.hashrateindex.com/machines/sha256-rig-index [Last accessed: 21 August 2020].

Data obtained from surveyed manufacturers and resellers (including the sale of second-hand machines) reveals that their volumes have moved in opposite directions after 2018 (**Figure 23**): while both grew significantly between 2017 and 2018 - at +172% and +162% respectively - only resellers sustained this growth between 2018 and 2019, at +148%, albeit at a slower pace. Meanwhile, manufacturers reported a 26% decline in the number of machines sold.

Preferred distribution channels for manufacturers and resellers have been direct sales to mining companies (80%), closely followed by online stores which open equipment purchase to all (67%). These figures are fairly consistent across all manufacturers and resellers, regardless of their geographic location or sale destination. A marginal number of resellers and manufacturers indicate relying on other, often more informal, channels, such as messaging and social media platforms (e.g. Telegram, Twitter).

THE FINANCIALISATION OF MINING

Hashrate: a new commodity for derivatives markets?

Hashrate refers to the amount of computing power used to generate a valid PoW. Mining pools have long been described as a simple aggregator of hashrate. In reality, pools and their operators do more than pooling hashrate from miners. Practically speaking, pools purchase hashrate from hashers, contributing to the *commoditisation* of this computing power. As for any other commodity, the development of a spot market has led to the introduction of derivative contracts. At the time of writing, a small number of companies have started issuing a suite of financial products based on hashrate. Miners may see this development as an hedging opportunity to better manage their risks and improve their cashflow situation.

Increased competition among mining players and tighter profit margins have led them to explore various strategies to hedge risks and generate additional cashflows. In particular, the recent development of new financial instruments targeted at miners, such as hashrate forwards and difficulty futures,[33] has spurred active discussion in the industry and made the headlines in cryptoasset-native outlets.[34]

What is a block subsidy halving?

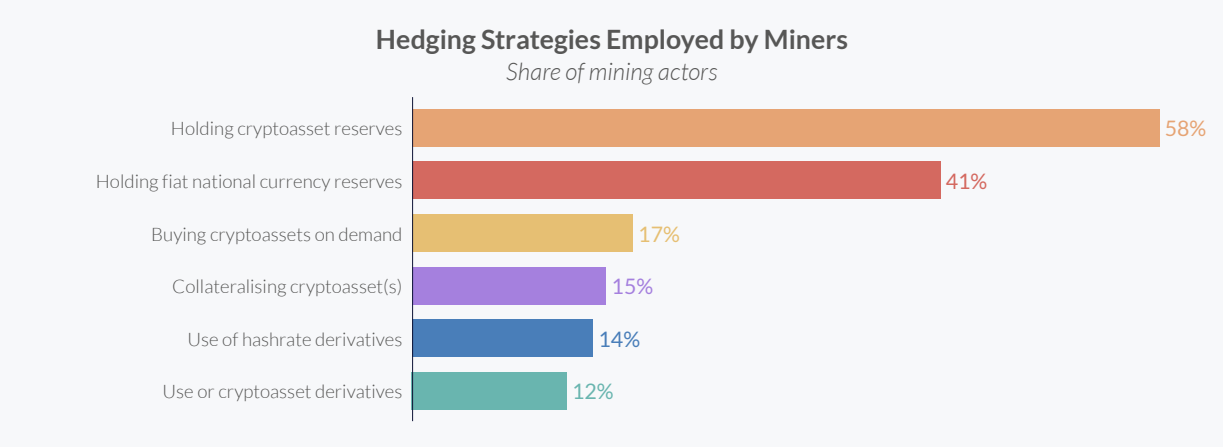
Pioneered by Bitcoin, a "halving" corresponds to a periodic decrease (generally by 50%, hence "halving") of the block subsidy distributed to miners for every newly mined block as determined by the supply issuance schedule. Several PoW coins have adopted these halving events; however, it appears primarily consequential for PoW coins with a high production cost, such as Bitcoin. Block subsidy is the main component of miners' revenues as transaction fees – which constitute the second element of the block reward – remain marginal for the majority of cryptocurrencies other than Bitcoin and Ethereum. As such, the scheduled reduction of block subsidy directly influences miners' profitability.

33 Future contracts trading against Bitcoin's future mining difficulty.

34 See for instance Zhao, W. (2020) *New York Power Plant Sells 30% of Its Bitcoin Mining Hashrate to Institutional Buyers*. Coindesk. Available from: https://www.coindesk.com/new-york-power-plant-greenidge-has-sold-up-to-30-of-its-bitcoin-mining-hash-rate [Last accessed: 20 August 2020].

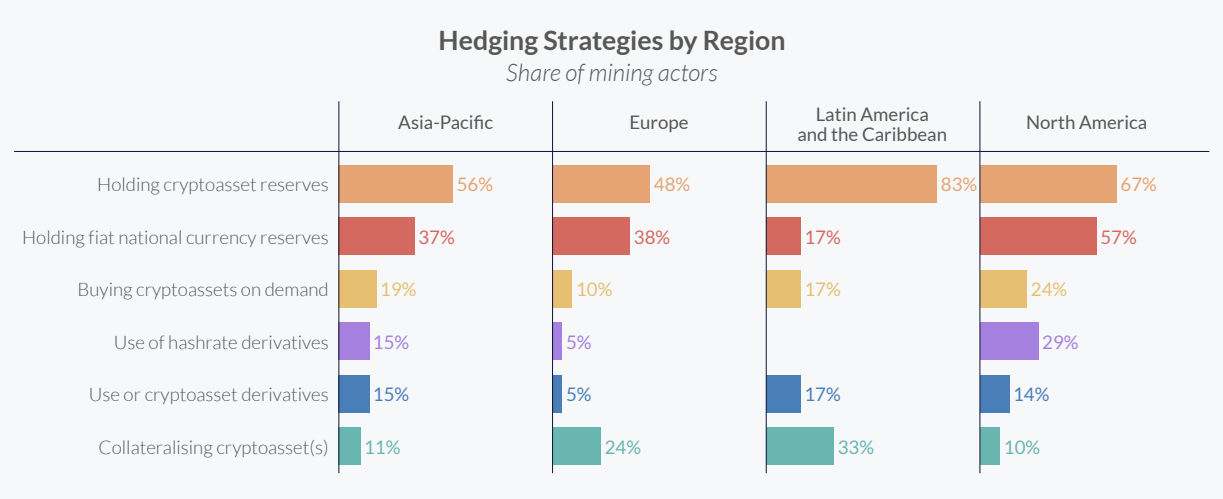
Figure 24, however, shows that miners' hedging strategies remain relatively elementary, and primarily consist of holding cryptoassets (58%) or fiat reserves (41%). Only a handful of miners make use of sophisticated financial instruments, such as cryptoasset (12%) or hashrate (14%) derivatives, or choose to collateralise their coins (15%).[35]

Figure 24: The use of complex financial products is limited to a handful of actors



Geographic distribution reveals that North American mining actors are twice as likely to use hashrate derivatives than APAC actors and six times more likely than European actors (**Figure 25**). However, miners from either APAC or North America are equally likely to enter cryptoasset derivative contracts. Factors, such as availability of these financial products and regulatory clarity, may explain these regional discrepancies.

Figure 25: Holding cryptoasset reserves remain the main strategy used by miners across regions



35 The reader should note, however, that this survey response data predates the decentralised finance ("DeFi") explosion which may have increased the use of collateralisation by miners. For a discussion on decentralised finance, please refer to **Section 7**.

SECTION 3: THE OFF-CHAIN STORY

ON-CHAIN AND OFF-CHAIN STORIES

Most analyses of cryptoasset usage and activity are based on data generated by *on-chain* activity ("on-chain data"). On-chain activity refers to transactions that clear and settle on the corresponding blockchain base layer (e.g. Bitcoin, Ethereum). Tracking tools then turn this raw blockchain data into readable information to produce valuable data insights (e.g. blockchain explorers). Further investigation, such as those performed by blockchain forensic firms, associates wallet addresses with real-world entities to examine on-chain transaction flows between known actors on the network.

On-chain data analysis has been helpful in understanding the share of illicit activity using cryptocurrencies, which is estimated to amount to less than 1.1% of total volumes transacting on 25 chains.[36] On-chain analysis is also useful to deduce the value being moved on-chain between real-world entities, demonstrating for instance that exchanges account for 90% of all funds sent by cryptoasset services.[37]

However, on-chain data only tells us part of the story since it highlights what happens between entities that use the blockchain base layer to settle their transaction, but does not capture transactions between entities using an intermediary to settle their transaction outside of the blockchain layer, for example two traders on an exchange's internal order-book. The latter can only be studied using *off-chain* data.[38]

A typical example of off-chain data is trading volumes or market data reported by individual cryptoasset exchanges, where there have been numerous controversies surrounding faked trade volumes. Another often cited resource for off-chain data has been volumes displayed on peer-to-peer exchanges, such as LocalBitcoins. The information reported on peer-to-peer trading platforms similarly depicts a somewhat skewed picture of cryptocurrency usage: the platform is primarily used to identify reliable brokers, and subsequently a significant share of trade is taking place outside the platform and left unrecorded.

Another unknown in the cryptoasset usage realm is the amount of trades taking place over-the-counter (OTC). These trades cannot purely be captured either by on-chain or existing off-chain data. Previous estimates place OTC trades at two to three times larger than global exchange volumes. More recent anecdotes estimate it at around USD 600 million a day.[39]

In this section, we use data collected from exchanges, which provide a financial market for cryptoassets, and payment service providers, who facilitate the use of cryptoassets for payments of goods and services (for example, merchant services, bill payment service, etc.[40]) to offer a glimpse into the use of cryptoassets off-chain.

36 Chainalysis (2020). *The 2020 State of Crypto Crime*. Chainalysis. Available from: https://go.chainalysis.com/rs/503-FAP-074/images/2020-Crypto-Crime-Report.pdf [Last accessed: 21 August 2020].

37 Chainalysis (2020). *Who's Who On The Blockchains? The Chainalysis Guide to Cryptocurrency Typologies*. Chainalysis. Available from: https://go.chainalysis.com/rs/503-FAP-074/images/Typologies-Report-final.pdf [Last accessed: 21 August 2020].

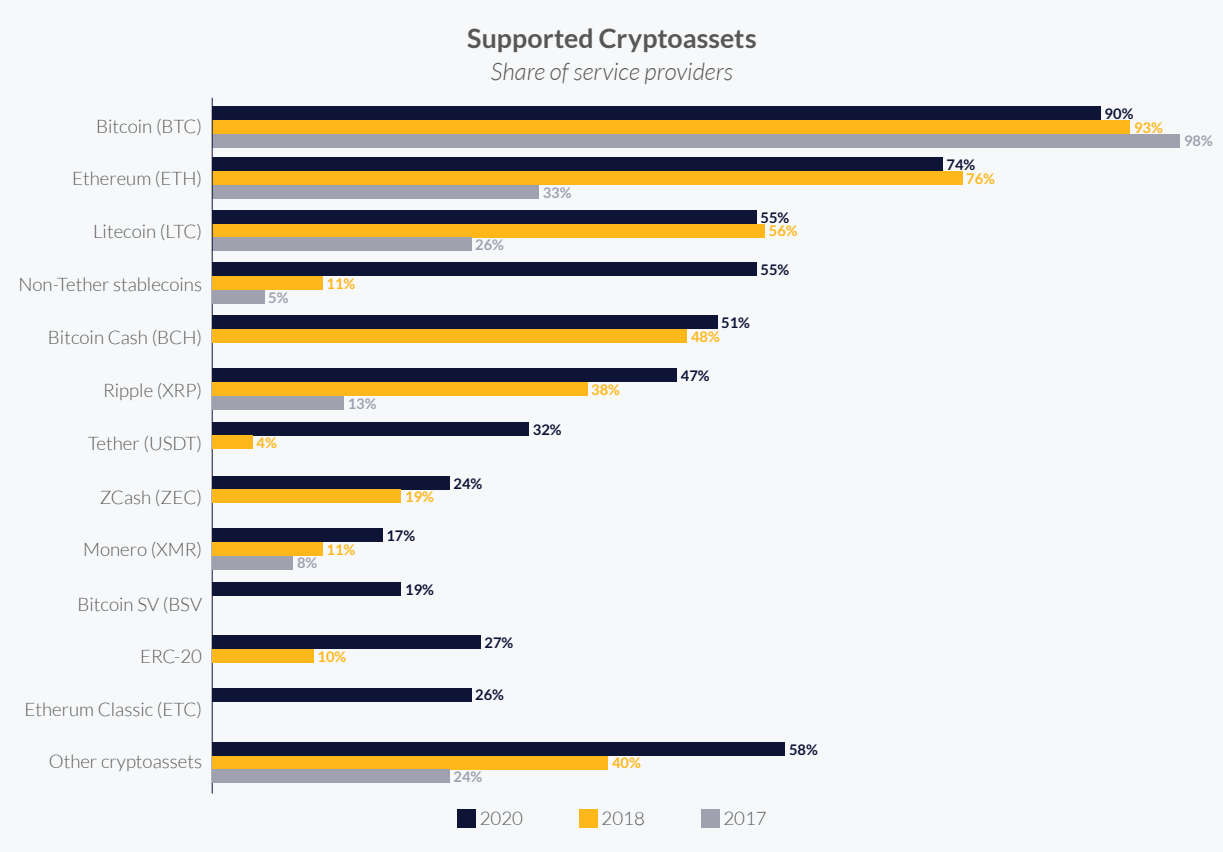
38 In our previous benchmarking study, we made the distinction between two types of off-chain transactions: "trusted" transactions that are recorded by, and reliant upon, service providers for internal clearing and settlement, and "trust-minimised" transactions that are based on payment channels using the blockchain exclusively for settlement (e.g. the Lightning Network).

39 Chaparro, F. (2019) *Inside B2C2: The crypto market making firm that almost closed shop in 2018, and is now growing market share across the globe*. The Block. Available from: https://www.theblockcrypto.com/daily/47750/inside-b2c2-the-crypto-market-making-firm-that-almost-closed-shop-in-2018-and-is-now-growing-market-share-across-the-globe [Last accessed: 24 August 2020].

40 For a full description, see Rauchs et al. (2018) *2nd Global Cryptoasset Benchmarking Study*. Cambridge Centre for Alternative Finance. Available from: https://www.jbs.cam.ac.uk/wp-content/uploads/2020/08/2019-09-ccaf-2nd-global-cryptoasset-benchmarking.pdf [Last accessed: 24 August 2020].

OFF-CHAIN CRYPTOASSETS AND FIAT CURRENCY SUPPORT

Figure 26: Service providers have rallied to support stablecoins



Bitcoin continues to be the most popular cryptoasset on exchanges, payments, and storage service providers, which is unsurprising given its high convertibility into sovereign fiat currencies and other cryptoassets even though its support has declined slightly over time from 98% of service providers in 2017 to 90% in 2020 (**Figure 26**). Ether has seen rapid gains in its availability since 2017 and is now the second most common token, reflecting the extent to which smart contracts and decentralised applications rely on the Ethereum blockchain. The growth in popularity of ERC-20 coins also reflects this shift. Litecoin, Bitcoin Cash, and Ripple are available at about half of service providers. Despite increasingly strict regulations and concerns over their use for dark market activities, privacy coins Zcash and Monero are still becoming increasingly more available, and are supported at 24% and 17% of service providers respectively.

Stablecoins,[41] both asset-backed and algorithmic, are also becoming more available, with Tether support growing from 4% to 32% of service providers and all non-Tether stablecoins growing from 11% to 55%. This increase is not simply from service providers holding stablecoins diversifying their holdings, but rather more service providers offering stablecoins. Among exchanges alone, the number of exchanges offering at least one stablecoin increased from 11% to almost half (48%) of the same. In June 2020 more value was transacted using stablecoins than Bitcoin for the first time.[42]

41 The current generation of stablecoins are digital tokens that offer a fixed conversion rate to a specific asset or commodity reserves (e.g. fiat-collateralised such as Tether, USDC, or the Gemini Dollar).

42 Maddrey, N. (2020) *The Rise of Stablecoins*. Coin Metrics. Available from: https://coinmetrics.substack.com/p/coin-metrics-state-of-the-network-f0a [Last accessed: 24 August 2020].

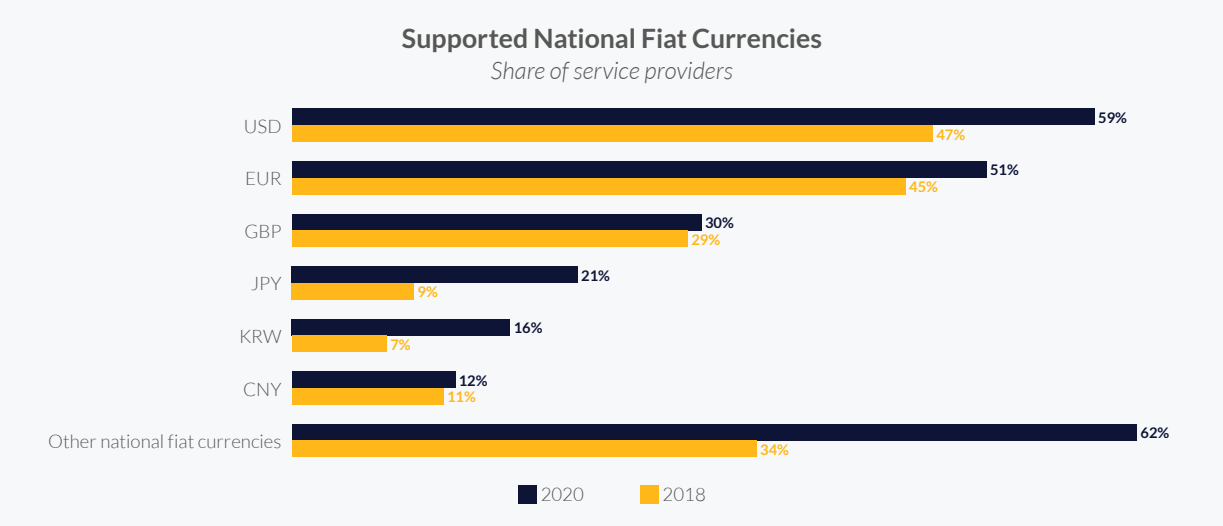
Stablecoin issuers promise a fixed, or windowed, conversion rate between their token and corresponding underlying asset (similar to an exchange rate peg). In response to price deviations from the peg, an investor has an incentive to buy (sell) the token from the issuer at a one-for-one rate and sell (buy) the token in the secondary market when that price trades above (below) parity.

Historically, traders primarily used stablecoins to facilitate quick fiat-denominated transfers between cryptoasset exchanges for arbitrage. Albeit less commonly, stablecoins have also been used as an alternative to highly volatile cryptoassets for temporarily storing wealth.[43] Following the price crash of cryptoassets in March 2020, the tokens saw a surge in demand as investors sought to meet liquidity needs and avoid exposure to the highly volatile markets. This resulted in several stablecoins trading at a premium (trading at a higher price than their peg).[44] However, deviations in stablecoin parities are not one sided; collateral concerns (in the case of reserve-backed stablecoins) or mechanism concerns (in the case of "two-coin" systems) have caused tokens to trade at a discount relative to their peg.

As of August 2020, the largest and most successful stablecoin, Tether, had a market capitalisation of USD 10 billion, representing 80% of the total stablecoin market cap weathering various controversies. For example, in April 2019, Tether Limited officials confirmed that only 74% of Tether was backed by cash and other securities, and not 100% backed as had been understood.[45]

The scalability of these tokens is hindered by the ever-changing regulation in the cryptoasset space: in July 2020 the FATF released a report on stablecoins, emphasising the need for stablecoin issuers to comply with global anti-money laundering (AML) and counter-terrorist financing (CFT) standards.[46] Though monitoring and centralisation may threaten the immediate widespread adoption of stablecoins, such necessary regulatory infrastructure bolsters the legitimacy of both issuers and stablecoins.

Figure 27: All national fiat currencies are becoming more widely available



43 Lyons, R. and Viswanath-Natraj, G. (2019) *What Keeps Stable Coins Stable?*. SSRN Electronic Journal. Available from: https://jbs.cam.ac.uk/wp-content/uploads/2020/08/2020-conference-paper-lyons-viswanath-natraj.pdf [Last accessed: 24 August 2020].

44 Coin Metrics Research (2020). *The Rise of Stablecoins*. Coin Metrics. Available from: https://f.hubspotusercontent00.net/hubfs/5264302/The%20Rise%20of%20Stablecoins.pdf [Last accessed: 24 August 2020].

45 De, N. (2019). *Tether Lawyer Admits Stablecoin Now 74% Backed by Cash and Equivalents*. CoinDesk. https://www.coindesk.com/tether-lawyer-confirms-stablecoin-74-percent-backed-by-cash-and-equivalents [Last accessed: 24 August 2020].

46 FATF (2020) *FATF Report to G20 on So-Called Stablecoins*. Financial Action Task Force. Available from: www.fatf-gafi.org/publications/virtualassets/documents/report-g20-so-called-stablecoins-june-2020.html [Last accessed: 24 August 2020].

The growth in popularity of stablecoins has not prevented providers from increasing their supported fiat currencies (**Figure 27**): US Dollar (USD) support has grown from 47% to 59% of service providers, while the Japanese Yen (JPY) saw the largest increase from 9% to 21%. Non-major sovereign currencies are also increasingly offered, with an increase from one third to two thirds of all providers from 2018 to 2020 offering a national fiat currency that was not USD, Euro (EUR), British pound (GBP), Chinese Yuan (CNY), JPY, or Korean Won (KRW).

The growing regulatory clarity may have helped this increase in support for national fiat currencies, as service providers may have previously avoided fiat currencies to avoid financial regulations. With many regulations now updated to include cryptoasset service providers even if they do not incorporate fiat currency, the gains from not listing a sovereign fiat currency is diminished.

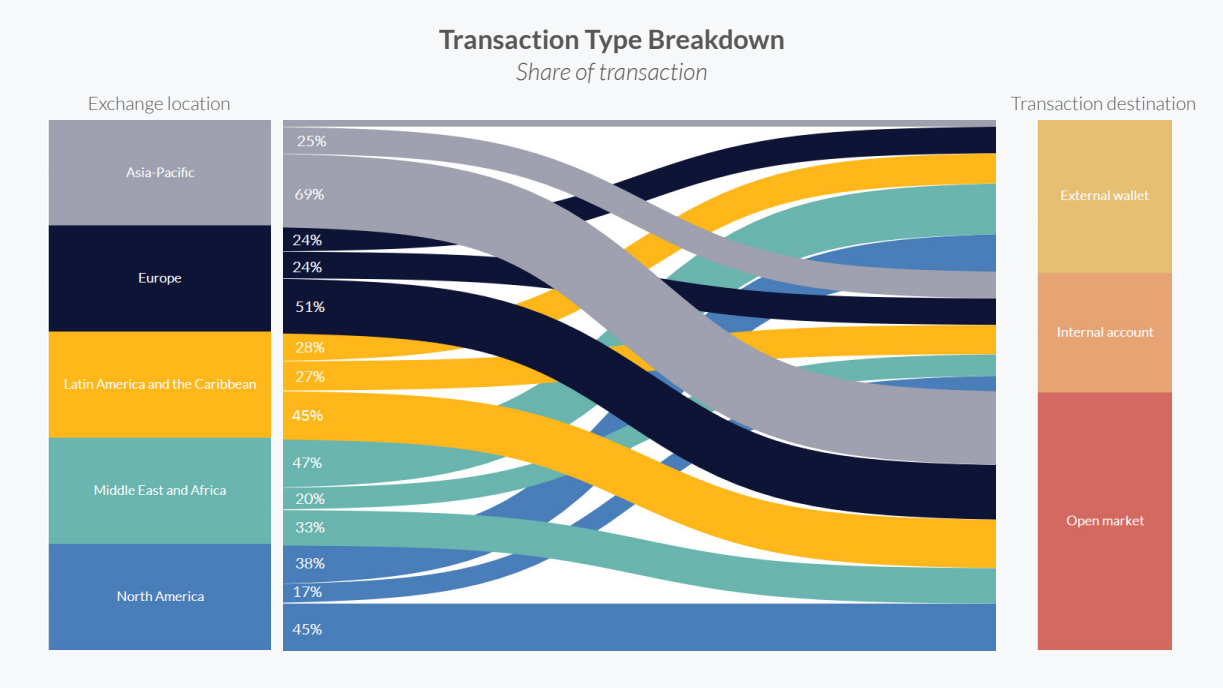
OFF-CHAIN ACTIVITY PROVIDERS

EXCHANGES

A key component in the off-chain story are exchanges. Exchanges' internal flows reveal that these platforms are primarily used as fiat on-off-ramps, i.e. when a user seeks to enter the cryptoasset market by converting its fiat currencies into cryptoassets, or leave and convert cryptoassets into fiat. Fiat-cryptoasset transactions make up most of exchanges' trades, both in terms of trading volumes and transaction numbers, while fiat-fiat trades are a small share of trades.[47]

Once on-boarded onto an exchange platform, users may choose to settle their transactions off-chain (for example, engage in an open market buy/sell order on the exchange's order book, or an internal transfer on the exchange's recordkeeping system to another user account within the exchange). The user may also direct their on-boarded exchange balance to a wallet external to the exchange, a transaction that normally necessitates an on-chain transaction.

Figure 28: APAC, and to a lower extent European exchanges appear to be primarily used for trading purposes



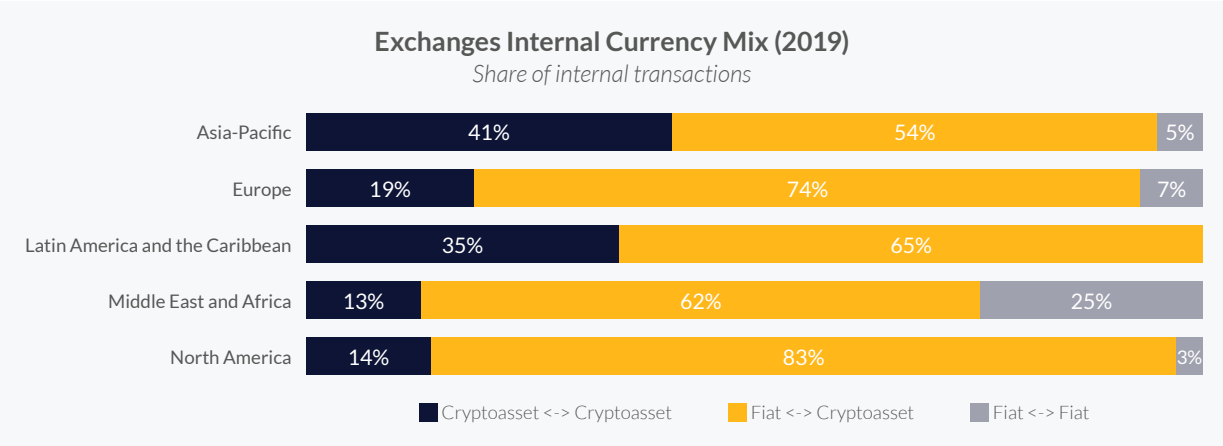
47 So-called stablecoins are classified as "cryptoassets" for the purpose of this section.

Large exchanges have a higher average of transactions on their open market than small exchanges (70% compared to 42%), with users of smaller exchanges almost twice as likely to send transactions to an external wallet (14% on large exchanges and 33% on small exchanges).[48] This is consistent with small exchanges being used more intensively as on-off-ramps, while larger exchanges are used for trading.

The unequal distribution of small and large exchanges also leads to regional patterns in exchanges (**Figure 28**). The presence of large exchanges in APAC means that very little of APAC exchanges' volumes leave their exchange platform, consistent with the observation that half of APAC exchanges are large exchanges.[49] The opposite is true for the predominantly small exchanges in MEA, where up to 47% of transacted volumes is directed to external wallets.

In 2019, over 70% of transaction volume for exchanges headquartered in Europe, LAC, and North America were fiat-cryptoasset transactions (**Figure 29**) compared to 54% of APAC transaction volume. 41% of APAC volume stemmed from cryptoasset-cryptoasset transactions, although the APAC cross-exchange variation for cryptoasset-cryptoasset trades ranges from almost 0% to almost 100%. The LAC region has a similarly large variation in cryptoasset-cryptoasset trade shares across exchanges. MEA platforms stand out for the popularity of fiat-fiat transactions, which account for 25% of trade volumes, considerably higher than other regions. The fiat-fiat transaction population in MEA exchange could reflect the larger geographic distribution, presented in **Section 4**.

Figure 29: In APAC and LAC, cryptoasset-cryptoasset trades take up more than one third of total transaction volumes



A possible contributing factor for the regional differences in cryptoasset-cryptoasset trade volume is that many exchanges are used to onboard users into the cryptoasset ecosystem before they migrate to APAC exchanges for trading purposes. We can provide three pieces of supporting evidence for this assertion:

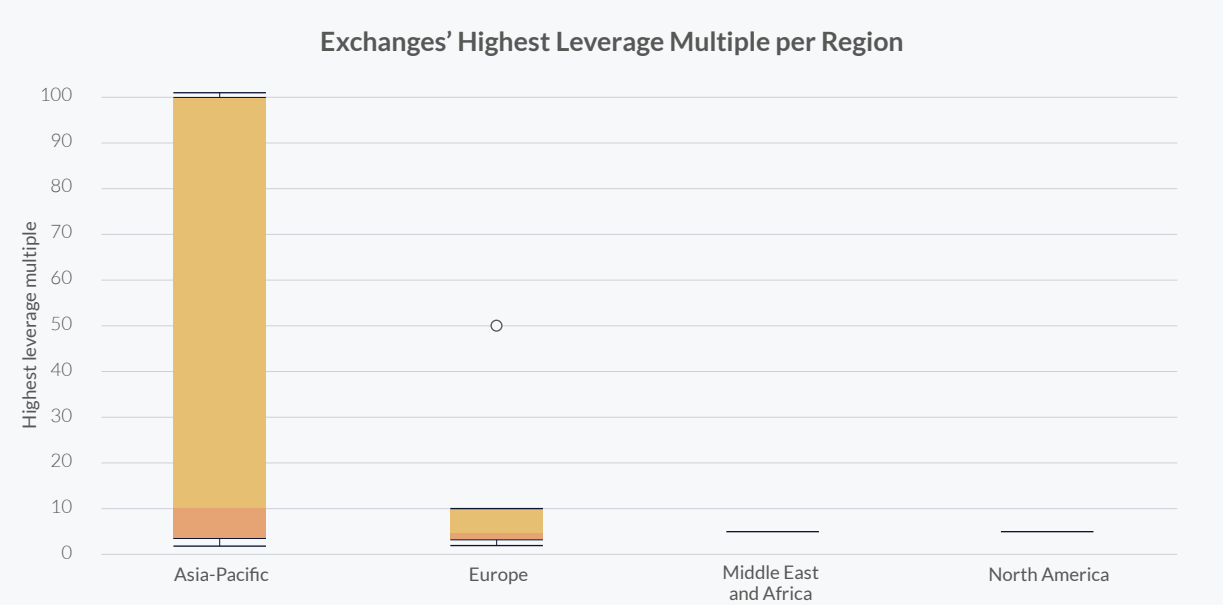
- the majority of APAC exchange transactions are directed to the open market within the exchange (i.e. exchange's internal order-book) consistent with trading behaviour. Additionally, our survey sample reveals 83% of APAC platforms have an internal order book, compared to only 40% for MEA exchanges,
- APAC platforms usually support a wider range of coins. The average APAC exchange supports 40+ coins, compared to 13 in Europe or 10 in North America, and

48 We define a large exchange to be one with more than 40 full-time equivalent employees. In most regions small exchanges are 70% or more of all exchanges, though small exchanges represent 95% of all exchanges in MEA. APAC breaks with the 70% rule of thumb and has approximately the same number of large and small exchanges.

49 The data however does not provide further detail about genuine public trading and proprietary trading.

- APAC exchanges offer considerably greater leverage to users allowing for the chance of greater gain (or loss) for speculative investors.[50] In our survey, 55% of surveyed exchanges offering leverage to users are headquartered in APAC, followed by 30% out of Europe. These APAC exchanges are well known in the industry for their high leverage multiples, with a median at 15x and some outliers offering up to 110x leverage (**Figure 30**).

Figure 30: Margin trading is more widely available on APAC exchanges

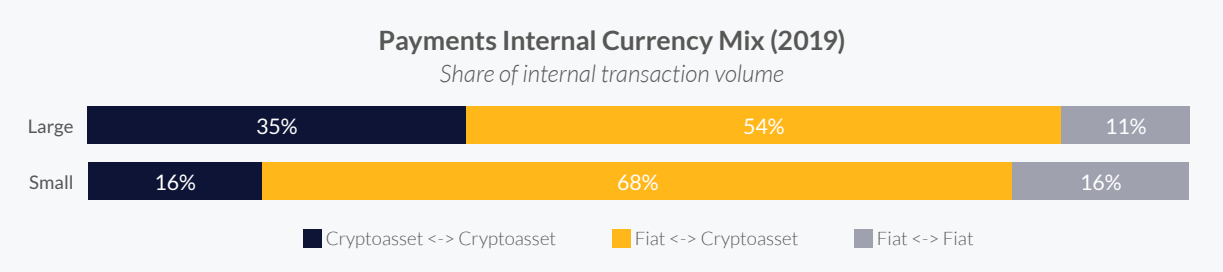


PAYMENT PLATFORMS

The payment service provider landscape continues to be dominated, both in transaction volume and transaction number, by fiat-cryptoasset transactions, which make up nearly two-thirds of all volumes (65%) and transactions (63%). This dominance of fiat-cryptoasset features in both large and small payment service providers, though large providers have over twice the transaction share of cryptoasset-cryptoasset transactions as small providers (35% to 16%) as shown in **Figure 31**.

Further geographic breakdown reveals patterns similar to exchanges, with payment service providers in APAC reporting a greater share of cryptoasset-cryptoasset volumes compared to European, North American, or MEA actors.

Figure 31: Cryptoasset-fiat trades are more frequent on small payments service providers



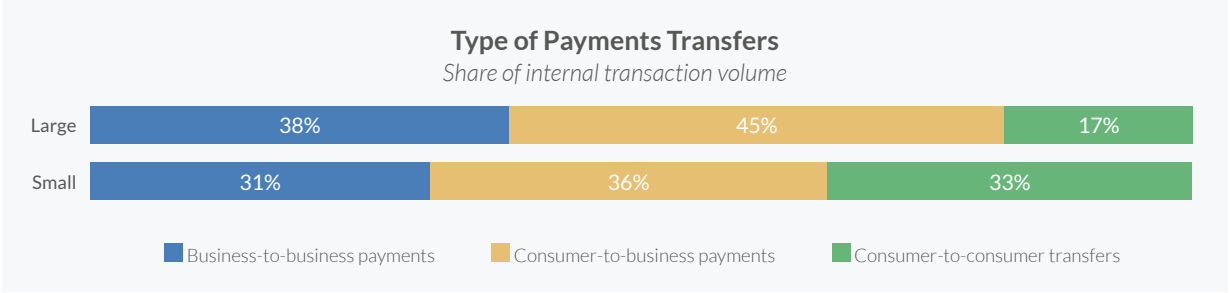
There is a difference in the payment values for domestic and cross-border transactions . Low-value

50 Under a leverage model, the exchange offers a loan to users to use for buying or selling cryptoassets. There are various different models for leverage, for example margin trading.

domestic transactions (below USD 100) account for 44% of all domestic transactions, while high-value domestic transactions (over USD 1,000) are less than one third (31%) of domestic transactions. In contrast, low-value transactions account for only 30% of the total cross-border transactions, whereas higher-value transactions account for 45%. This contradicts anecdotes of individuals using cryptoasset payment service providers to facilitate personal international payments that would otherwise be too small to be economically feasible to transmit internationally via established entities.

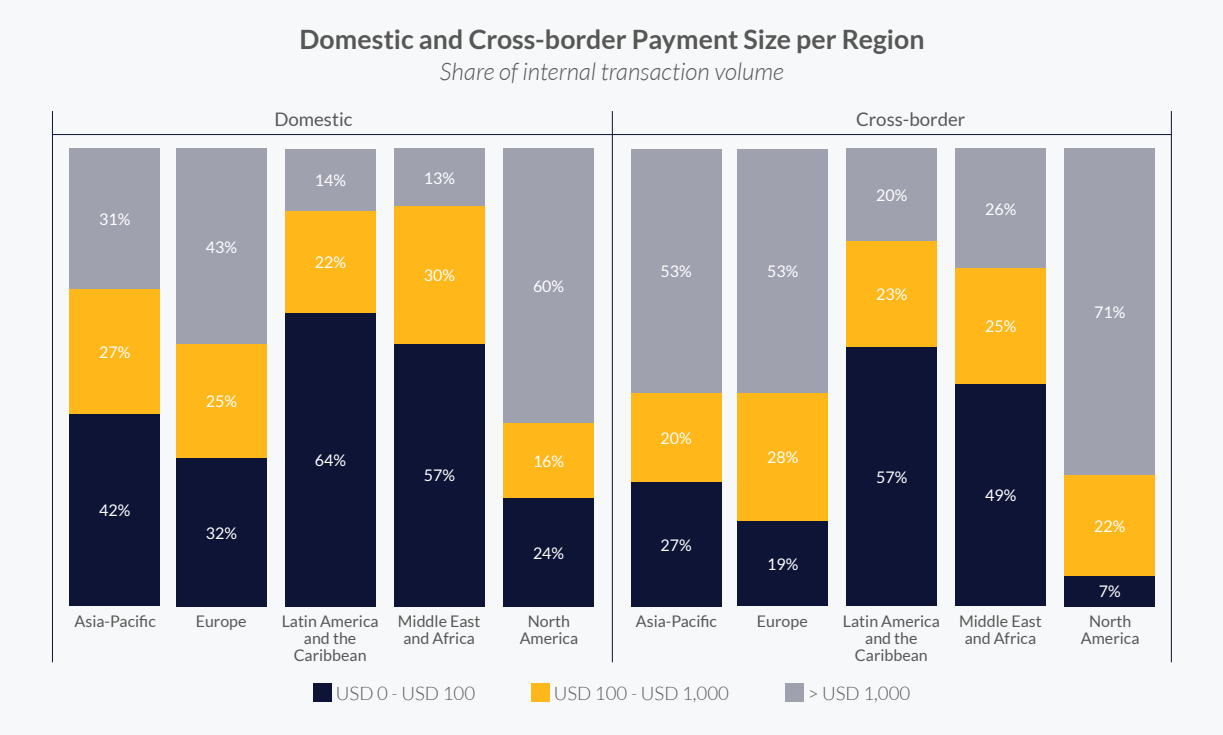
There are also notable differences between large and small payment providers regarding the payment value mix in cross-border transactions but relative uniformity in the value mix for domestic transactions. Large payment providers predominantly offer 65% high-value cross border transactions against 8% low-value cross border transactions, whereas small payment providers offer 41% high-value cross border transactions against 35% low-value cross border transactions. This indicates that these different service providers are respectively serving disparate market niches. An examination of the transaction types confirms this inference: small payment providers' transactions are twice as likely to be peer-to-peer in comparison to large payment providers' transactions (33% to 17%), with both consumer-business (36% to 45%) and business-to-business (31% to 38%) transactions more common across large providers than small providers (**Figure 32**).

Figure 32: Transactions are divided relatively equally across the three payment groups for small payments service providers



For lower and upper middle-income countries, payment service providers mostly facilitate small payments, whether domestic or international, while in high income countries most payments are large. This income-based pattern is repeated at the regional level, with Europe and North America engaging in mostly large payments domestically and internationally, LAC and MEA engaging in mostly small payments domestically and internationally, and APAC mixing, with a higher share of smaller payments domestically and larger payments internationally (**Figure 33**).

Figure 33: Low-value payments account for the largest proportion of transaction volumes in LAC and MEA regions



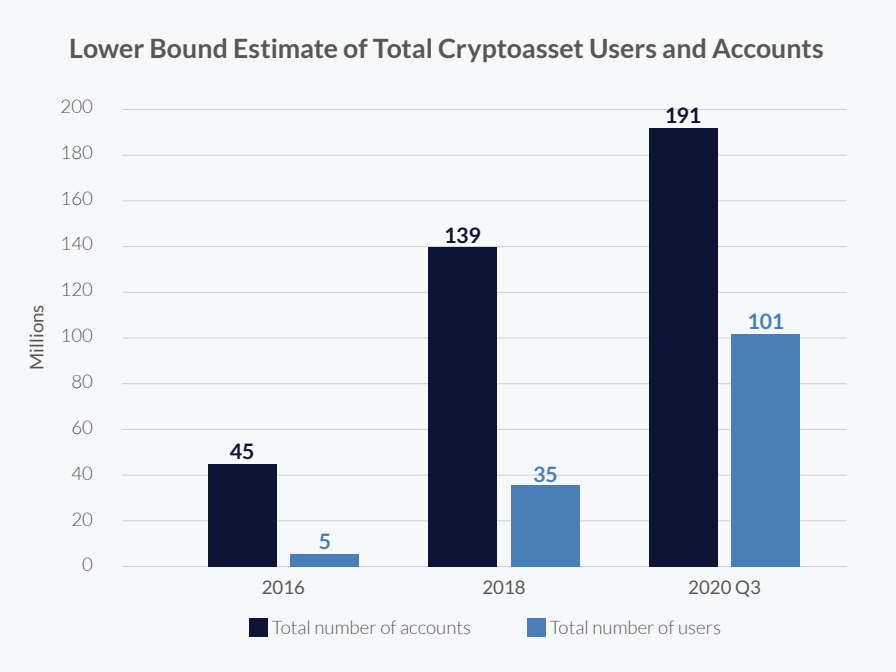
SECTION 4: PROFILING CRYPTOASSET USERS

Descriptive data on cryptoasset holders are crucial for industry participants and regulators alike. Individual service providers often conduct consumer surveys to better tailor their services to their user profile. Meanwhile, in some jurisdictions, regulatory authorities have undertaken similar studies to grasp the size of the cryptoasset market in their jurisdiction and understand consumer attitudes toward cryptoassets to better assess what part of the population is most at risk. This section offers complementary insights into the composition of cryptoasset holders.

USER NUMBER AND ACTIVITY

In 2018, the 2nd Global Cryptoasset Benchmarking Study estimated the number of identity-verified cryptoasset users at about 35 million globally.[51] Applying the same methodology, an update of this estimate indicates a total of up to 101 million unique cryptoasset users across 191 million accounts opened at service providers in Q3 2020 (**Figure 34**).[52] This 189% increase in users may be explained by both a rise in the number of accounts (which increased by 37%), as well as a greater share of accounts being systematically linked to an individual's identity, allowing us to increase our estimate of minimum user numbers associated with accounts on each service provider.

Figure 34: The total number of cryptoasset accounts held at service providers has experienced a fourfold increase over four years



Despite clear limitations to this methodology (*see Section 2 p.33 of the 2nd Global Cryptoasset Benchmarking Study for a more thorough discussion*), there are reasons to believe that this estimate offers a reliable approximate figure of the total number of cryptoasset holders globally. Other recent consumer research also highlights an increase in cryptoasset ownership. A study commissioned by the UK financial regulator estimated an increase of 78% compared to 2019

51 The methodology is detailed p.33 in Rauchs et al. (2018) *2nd Global Cryptoasset Benchmarking Study*. Cambridge Centre for Alternative Finance. Available from: https://www.jbs.cam.ac.uk/wp-content/uploads/2020/08/2019-09-ccaf-2nd-global-cryptoasset-benchmarking.pdf [Last accessed: 24 August 2020].

52 It should be noted that this figure does not include self-hosted wallets.

estimates.[53] Finally, large service providers have concomitantly publicly reported a rise in the entrance of new users, especially in the first quarter of 2020.[54]

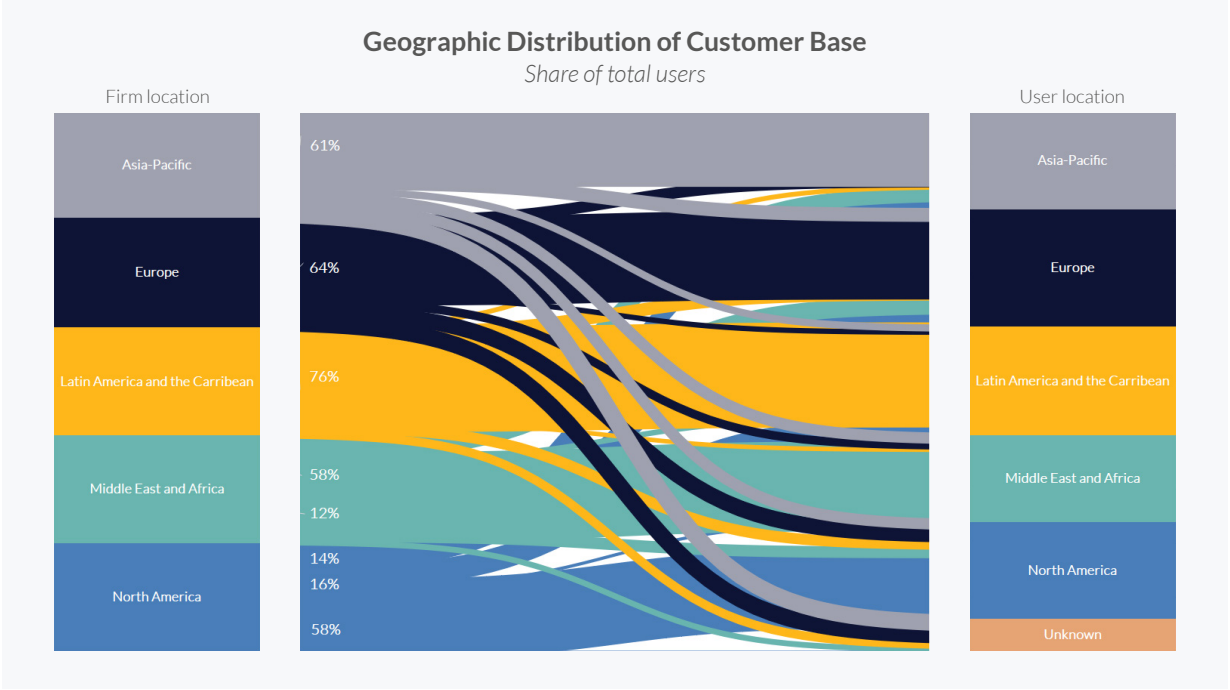
However, consumers vary widely in how they engage with cryptoassets. User activity as reported by service providers is one useful metric to monitor users' interaction with the cryptoasset ecosystem. Service providers operating from North America and Europe generally report higher user activity, with the median firm indicating that 40% of total users are considered active. However, as the spread of the distribution shows, reported figures on user activity vary significantly between actors from the same region. This heterogeneity is particularly pronounced for North American, European, MEA companies.

On average, small service providers experience higher level of user activity

Disparity in user activity may also be explained by inconsistent definitions used by service providers to monitor activity levels. While 54% of service providers define as "active" a user that logs in or interacts with the service at least once a month, 33% do so using a weekly timeframe. Perhaps unsurprisingly, exchanges that voluntarily define user activity using a shorter timeframe (e.g. weekly) also report greater user activity, on average, than those using a monthly-based definition.

USER GEOGRAPHY

Figure 35: Firms continue to majorly serve users from their region of operations



53 English, R., Tomova, G. and Levene, J. (2020) *Research Note: Cryptoasset consumer research*. Financial Conduct Authority (UK). Available from:https://www.fca.org.uk/publications/research/research-note-cryptoasset-consumer-research [Last accessed: 24 August 2020].

54 See for instance, Partz, H. (2019) *Coinbase Added 8 Million New Users in the Past Year*. Cointelegraph. Available from: https://cointelegraph.com/news/coinbase-added-8-million-new-users-in-the-past-year [Last accessed: 24 August 2020], Binance (2020) *Binance 2019: Year in Review*. Binance. Available from: https://www.binance.com/en/blog/418708327988203520/Binance-2019-Year-in-Review [Last accessed: 24 August 2020], and Krekotin, V. (2020) *Sharing Thoughts on Security, OKEx's Jay Hao Says Customers Come First*. Cointelegraph. Available from: https://cointelegraph.com/news/sharing-thoughts-on-security-okexs-jay-hao-says-customers-come-first [Last accessed: 24 August 2020].

Cryptoasset users span the globe, but firms continue to primarily serve customers based in their region of operation (**Figure 35**), in line with our 2018 findings. This is particularly the case for companies headquartered in LAC, but less so for those in MEA and North America. North American firms' presence in other regions seems to confirm the success of the internationalisation strategy adopted by these companies. Finally, the slightly more geographically distributed customer base of MEA companies - APAC, Europe, and North America each take 10% on average of MEA companies' customer base - may reflect the presence of diaspora from MEA into those three regions.

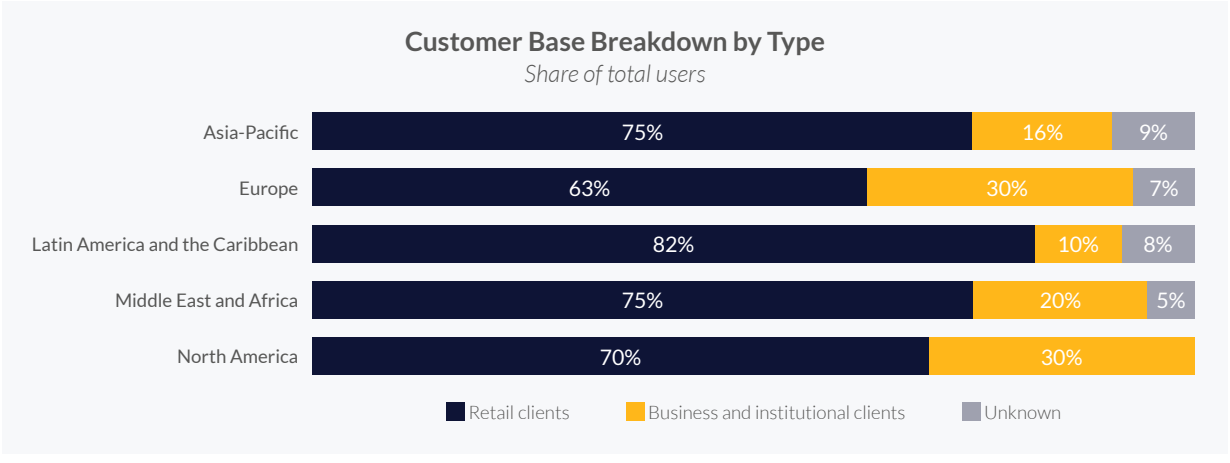
USER TYPES

Several studies have reported a growing interest from institutional investors in cryptoasset markets. For instance, a blind survey of American and European institutional investors conducted by Fidelity Digital Assets reveals that 36% of respondents have invested in cryptoassets and that three in five believe that cryptoassets should form part of their portfolios.[55] Interestingly, a growing share of US institutional investors have exposure to cryptoassets via the derivatives market.

The past four years have indeed seen a rapid increase in the number of financial instruments available to market investors. These instruments, such as perpetual swaps, options and futures, were initially launched by unregulated offshore entities, slowly followed by regulated incumbents. Since 2016, unregulated products have been dominating the market in terms of volume and aggregated open interest, though the share of regulated products has progressively increased. Due to counterparty risk and fiduciary responsibility, institutional engagement is expected to grow in tandem with the expansion of regulated financial products and regulatory clarity.[56]

Despite the considerable development of institutional-grade financial instruments and infrastructure, our data suggests that cryptoasset service providers' customer base is still primarily retail-driven, showing that despite growing institutional interest, the conversion rate (from expression of interest to investment) remains limited. As further explored in **Section 7**, there are several hurdles that the industry needs to overcome to bolster engagement of traditional institutional investors (e.g. asset managers, family offices), such as concerns on market manipulation and price volatility.

Figure 36: Retails take the lion's share of service providers' customer base



55 Bhutoria, R. (2020) *Institutional Digital Asset Survey Report - 2020 Review*. Fidelity Digital Assets. Available from: https://www.fidelitydigitalassets.com/bin-public/060_www_fidelity_com/documents/FDAS/institutional-investors-digital-asset-survey.pdf [Last accessed: 24 August 2020]. *Note:* The survey included cryptoasset hedge funds, which may skew the results since their investment portfolios naturally comprise a greater share of cryptoassets.

56 For a comprehensive overview of the cryptoasset derivatives market, please refer to, Todd, R. (2020) *Institutional Digital Asset Derivatives Markets*. The Block. Available from: https://www.theblockcrypto.com/genesis/65421/institutional-digital-asset-derivative-markets [Last accessed: 24 August 2020].

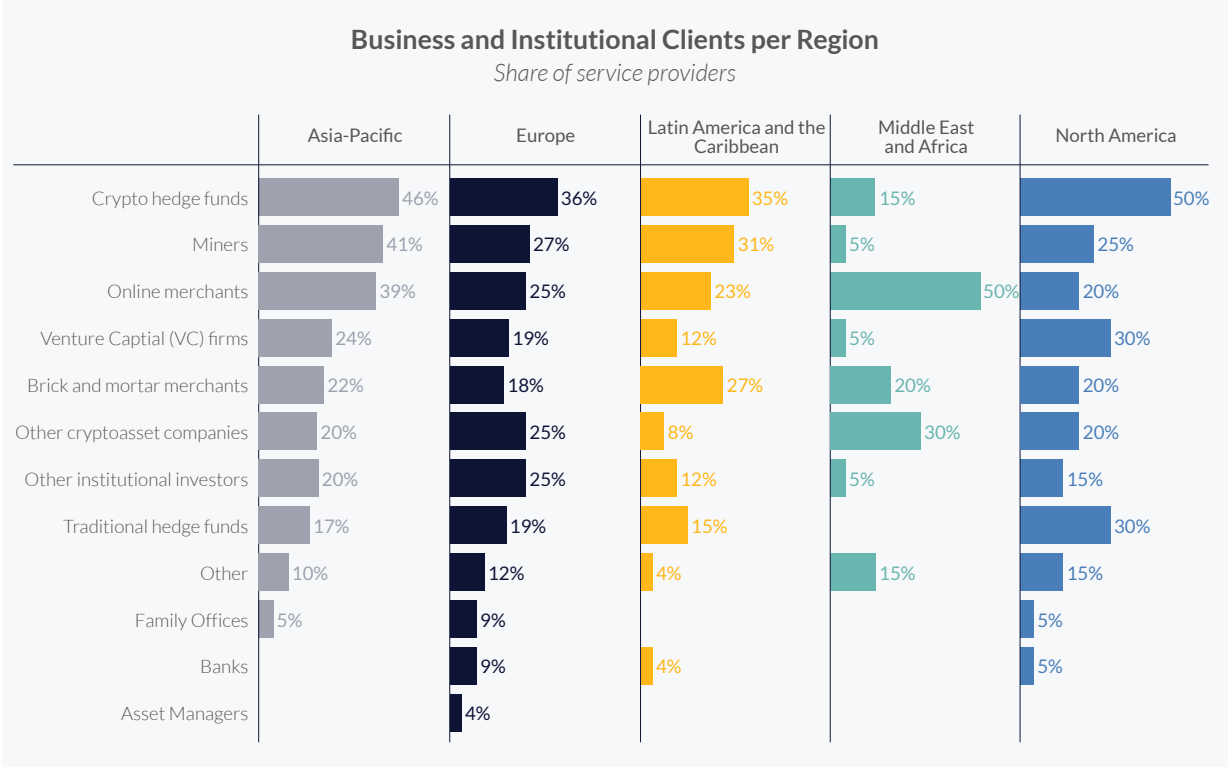
There are noticeable differences between companies from different regions (**Figure 36**). While the majority of firms' customer base is composed of individual clients, North American and European firms report that an average of 30% of their customers are business and institutional clients. In contrast, this figure for APAC, LAC, and MEA is 16%, 10%, and 20% respectively.

There is also significant disparity among service providers *within* North America and Europe, suggesting that these regions have a mix of retail-focused and institutional-focused companies, whereas companies in regions like LAC are primarily targeting retail cryptoasset users.

A deeper analysis of the type of business and institutional clients reveals that, globally, cryptoasset service providers primarily serve cryptoasset hedge funds (37%), online merchants (30%), and miners (27%). Interestingly, company size mix is fairly stable across institutional and businesses clients (60% to 40% respectively for small and large service providers) except for traditional hedge funds, which equally deal with large- and small-scale firms.

Figure 37 reveals noticeable regional differences in the type of business and institutional clients served: beyond cryptoasset hedge funds, North American, APAC, and European companies appear to engage more with traditional investors (hedge funds, venture capitalists, and other institutional investors), whereas LAC and MEA companies primarily focus on online merchants and cryptoasset companies (other than miners).

Figure 37: The composition of business and institutional clientele differ from region to region



A considerable share of APAC companies serves miners (41%), in part explained by the high level of mining activities in the region, especially in China. Miners use their services to liquidate their coin inventory for national fiat currencies and cover fiat-based expenditures. Evidence from the study of miners' hedging strategies (see **Figure 24** in **Section 2**) also reveal that a growing number of miners rely on service providers to collateralise their coins (i.e. through loans) and unlock additional funds.

Alternative sources using on-chain data analysis confirm that mining actors, in particular mining pools, are active users of Asian exchange platforms.[57] For instance, in 2019, 28% of bitcoins flowing into exchanges originated from mining pools, though this distribution is not even, with the vast majority of bitcoins (77%) sent to one of the top 10 exchanges.[58]

57 Chainalysis (2020) *Mining Pool Market Power*. Chainalysis. Available from: https://go.chainalysis.com/2020-markets-case-study-mining-pools.html [Last accessed: 24 August 2020].

58 This analysis excludes bitcoins that were transferred from exchanges.

SECTION 5: REGULATORY AND COMPLIANCE

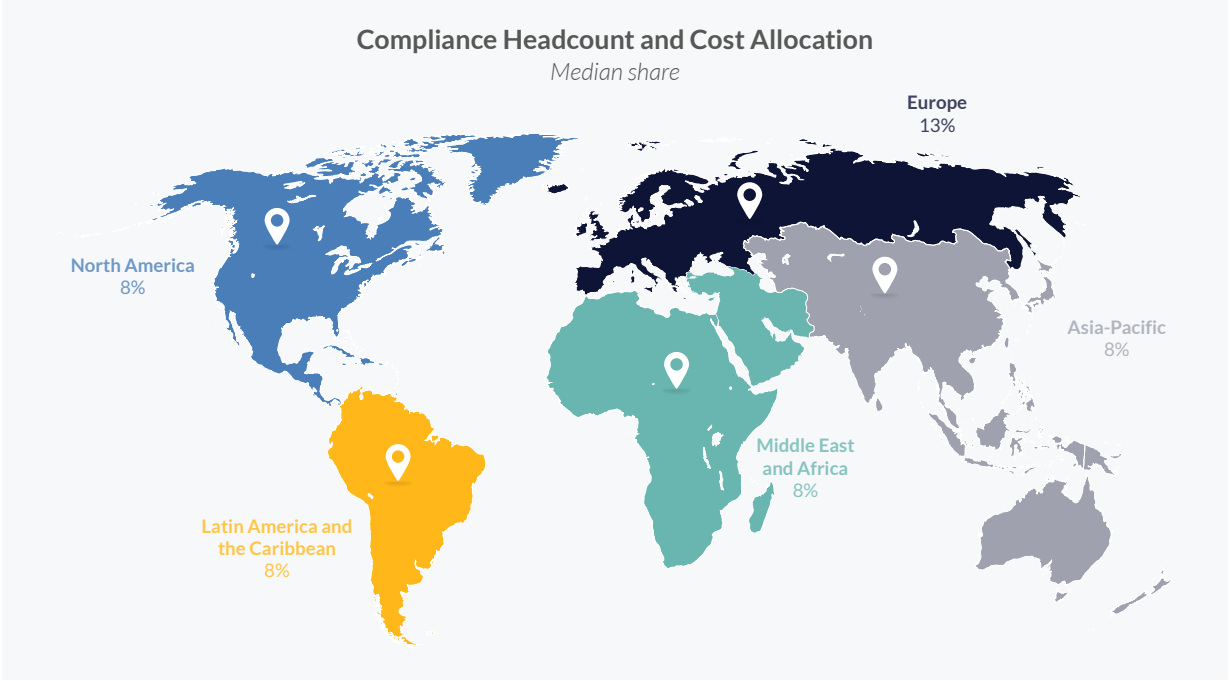
COMPLIANCE BENCHMARKS

The cryptoasset industry has been on the radar of regulators from as early as 2011. The industry has, however, experienced a steady appreciation in the levels of regulatory scrutiny since 2013 when popular darknet market Silk Road was shut down and the market witnessed its largest bubble since the inception of Bitcoin. Since then, authorities have issued guidance, retrofitted their existing regulation, or even developed bespoke regulatory frameworks to bring cryptoasset-related activities within their scope.[59] These changes in the regulatory environment often translate into internal adjustments in how firms go about meeting mandated requirements. Increasing regulatory burden is ranked as the second highest operational risk by firms, regardless of their size and location (see **Appendix**).

RESOURCES ALLOCATED TO COMPLIANCE

Across all surveyed geographic regions, 75% of the respondents reported having an in-house compliance team. The median share of a company's total headcount and costs allocated to compliance is relatively consistent across regions, with the exception of Europe (**Figure 38**). Half of European service providers report compliance headcount and costs equal or greater than 13% (compared to 8% in 2018). The top 25% of European respondents report compliance headcount and cost greater than 18% and up to 40%.

Figure 38: European service providers allocate most resources to compliance



59 For a more detailed analysis of the cryptoasset regulatory landscape, please refer to, Blandin et al. (2019) *The Global Cryptoasset Regulatory Landscape Study*. Cambridge Centre for Alternative Finance. Available from: https://www.jbs.cam.ac.uk/fileadmin/user_upload/research/centres/alternative-finance/downloads/2019-04-ccaf-global-cryptoasset-regulatory-landscape-study.pdf [Last accessed: 24 August 2020].

In 2019, EU member states were expected to transpose the 5th AML Directive, whose scope was broadened to include cryptoasset exchanges and custodial service providers, into their national regulatory frameworks. This has increased the compliance requirements for companies and consequently some European firms have already announced their closure in the face of increased regulatory burden.[60]

While the median firm in the four other regions allocate roughly the same share of human and financial resources to compliance, an analysis of North American firms' distribution shows significant variability amongst firms from the region. This may be a reflection of diversity in regulatory approaches amongst different US states because entities operating in the USA have to navigate a patchwork of state-level regulations, in addition to federal ones. Consequently, companies operating in all US states would have more resources dedicated to compliance to cope with the heterogenous state-level regulations. US companies drawn to crypto-friendly states (e.g. Wyoming) and avoiding states with tighter regulations (e.g. New York City) are likely to have relatively lower compliance cost and headcount overall.

From a regulatory perspective, 2019 was a particularly active year for the US cryptoasset industry, with both federal and state regulators, releasing new statements and guidance. At the federal level, for instance, FinCEN issued a guidance in May 2019 regarding the applicability of the Bank Secrecy Act (BSA) to cryptoasset businesses. According to the guidance, with the exemption of non-custodial wallets, decentralised exchanges that do not settle trades, and certain infrastructure providers (e.g. DApp developers, cloud miners), most cryptoasset businesses qualify as money transmitters and must comply with AML/KYC regulations.[61]

One common element of these new regulatory developments worldwide is the absence of distinction between entities exclusively supporting cryptoassets and those supporting both fiat currencies and cryptoassets. This equal treatment of cryptoasset-only and cryptoasset-and-fiat entities seems to have led to an increase in fiat support among cryptoasset service providers. When comparing 2018 and 2020 samples, we noticed that more than one in three companies that exclusively offered cryptoasset in 2018 now support fiat currencies.

Over 30% of companies that exclusively supported cryptoassets in 2018 have added fiat support since then.

From a data analysis perspective, this development matters because the extension of regulatory authorities' supervisory mandate to the cryptoasset realm had the effect to erase minimal discrepancies in compliance headcount and costs observed in 2018 between cryptoasset-only and cryptoasset-and-fiat companies. While these discrepancies were already limited in 2018, greater homogeneity is observed across both types of firm groups in 2020. For instance, the median compliance headcount is similar for cryptoasset-and-fiat and cryptoasset-only entities, while the median for compliance cost is slightly lower for the latter. We observe greater dispersion in the compliance cost of cryptoasset-and-fiat companies, which may account for regional variability.

AUDIT OF CRYPTOASSET RESERVES

Regulatory frameworks governing traditional financial institutions mandate banks to hold minimum reserve requirements and to perform independent audits. Similarly, cryptoasset reserve audits are good industry practices to provide assurance that a firm maintains equivalent reserves of its customers' funds, and play a pivotal role in upholding stakeholders' confidence. They ensure firms are operating transparently and adhering to set performance, security, and compliance standards. The audits could either be on-chain proof-of-reserves or more traditional audits performed by independent third parties.

60 See for instance, BitKassa Team (2020) *BitKassa closing down*. BitKassa. Available form: https://www.bitkassa.nl/en/bitkassa-closing-down [Last accessed: 24 August 2020].

61 Similarly, in 2020, Canadian regulators issued a notice indicating that any entity dealing in "virtual currency" will be considered as a money service business (MSB) and must register with the regulators.

Proof-of-reserves and proof-of-solvency

Cryptographic features of public blockchains enable new forms of public accountability, sometimes referred to as "proof-of-reserves".[62] There are several techniques to perform proof-of-reserves audits available to custodial service providers, but in its simplest form, proof-of-reserves audit entail signing a transaction with the entirety of their on-chain customer funds and publishing a signed message emanating from the associated address where funds are held.

Combined with the disclosure of the total customer liabilities of a service provider (i.e. how much a service provider owes to its users), proof-of-reserves would help prove that a custodial service provider has sufficient cryptoassets in reserve to meet (at a minimum) its liabilities.

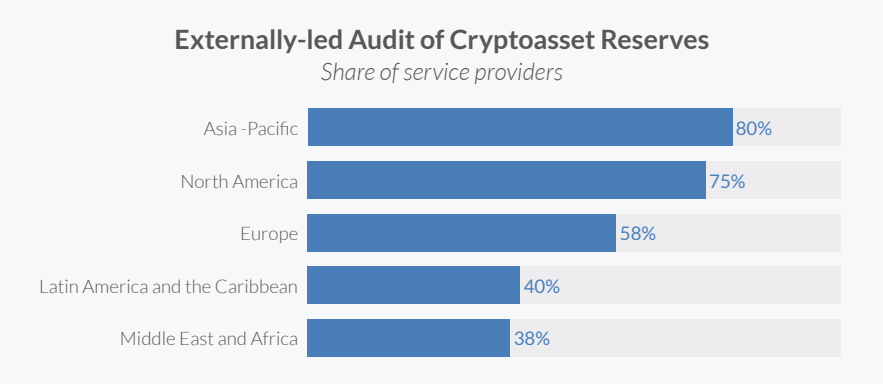
Although this approach has its own limitations (e.g. unaccounted or omitted liabilities, impracticality), regular on-chain audits combined with more traditional externally-led audits might play a pivotal role in enhancing trust and transparency in the conduct of operations by custodial service providers.

The need to perform independent cryptoasset reserves audits is more imperative in the absence of a widespread practice of public proof-of-reserves programmes. 59% of firms indicate that they had their cryptoasset reserves audited by an independent comptroller over the past 12 months, primarily based out of Europe (35%) and APAC (31%).

Two out of five service providers did not conduct an independent audit of their cryptoasset reserves in the past 12 months

Surprisingly, a 2018-2020 comparison of custodial service providers performing externally-led cryptoasset reserve audits indicates that only 54% of custodial service providers had their reserves audited in the past 12 months. This is a 24 percentage points decline from 2018, which may suggest that firms feel a decrease in scrutiny relative to 2018 when it was revealed that the stablecoin Tether did not have 100% reserves as previously thought. Additionally, large firms are nearly twice likely to have undergone independent audit relative to small firms. Similarly, 22% more of companies incorporated in a FATF country conduct externally-led audits than those incorporated in a jurisdiction that is not part of the inter-governmental body.

Figure 39: Independent cryptoasset reserves audits are more prevalent among APAC and North America companies



62 Bitcoin Improvement Proposal 127 "Simple Proof-of-Reserves Transactions" (2019). Available from: https://github.com/bitcoin/bips/blob/master/bip-0127.mediawiki [Last accessed: 24 August 2020].

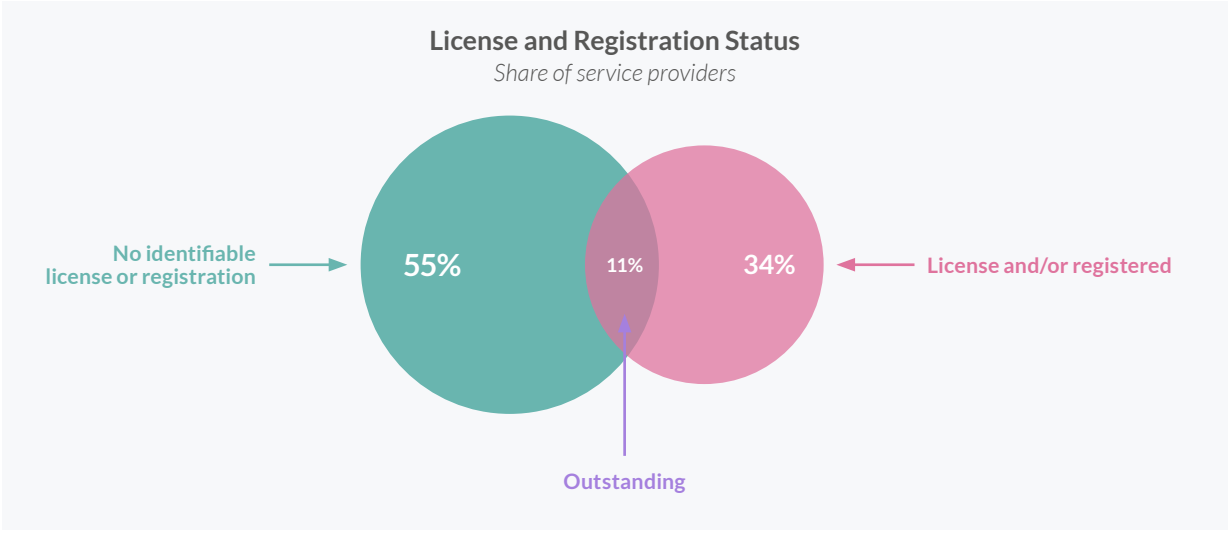
User's legal compliance

As the industry matures, individual cryptoasset holders also come under scrutiny by regulatory and government bodies, in particular tax authorities. A significant majority of surveyed service providers (67%) indicate that they provide users with compliance documentation, such as tax receipts. However, this might not be sufficient to ensure users accurately report liabilities to authorities. Inconsistencies in transaction reporting, absence of uniformity in tax forms issued by various service providers, or lack thereof, may render cryptoasset holders' compliance processes more difficult.

AUTHORISATION OF SERVICE PROVIDERS

Relevant authorisation regimes, involving either a licensing or registration process, for cryptoasset service providers are jurisdiction-specific and depend on the type of services provided, as well as the type of assets supported. 37% of the surveyed service providers are licensed or regulated, whereas 11% have an outstanding application (3% are both license holders and prospective applicants) as shown in **Figure 40**.[63] The research team has been unable to identify any license or registration (granted or outstanding) for 55% of survey respondents. It should, however, be noted that some service providers are engaged in activities that may not warrant or exempt licensing/registration processes (e.g. hardware wallet manufacturing, non-custodial wallet software provision).

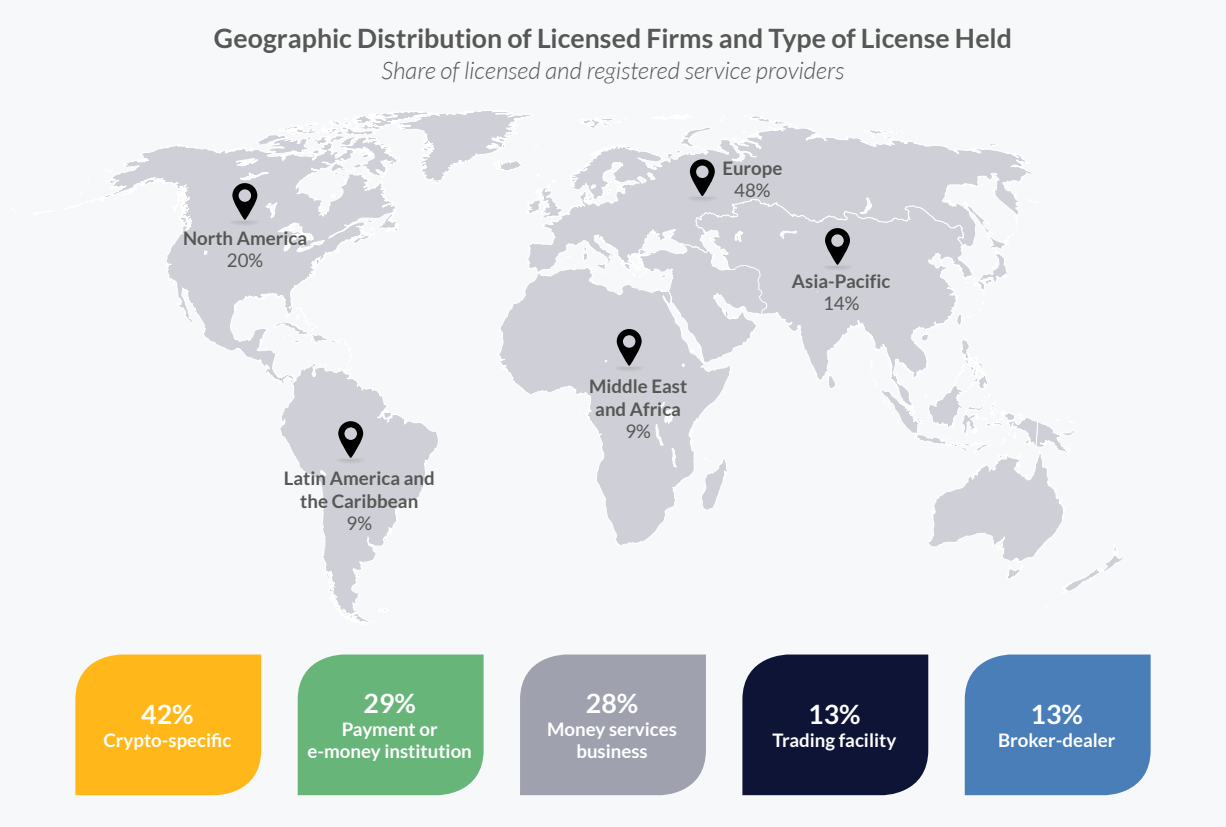
Figure 40: Just over two out of five firms are licensed or in the process of obtaining a license



The median number of licenses/registrations held by a single firm is one, but some companies hold as many as five. As shown in **Figure 41**, license holders primarily hold a crypto-specific license (42%), followed by payment or e-money licenses (29%), and money business licenses (28%). The existence of a crypto-specific licensing regime arises either from the introduction of a bespoke regulatory framework, which specifically regulates cryptoasset-related activities as a standalone activity (e.g. Gibraltar's DLT Provider licensing regime), or from the retrofitting of an existing law or regulation to include activities dealing with cryptoassets (e.g. Japan's amendment of its Payment Service Act). Several other types of license exist, including, *inter alia*, qualified custodian (5%) and banking (3%).

63 The figures presented in this section only consider national and federal licenses and registrations.

Figure 41: Firms may seek alternative licenses when no crypto-specific licensing regime exists



Note: This chart is based on public data collected by CCAF in combination of data provided by CryptoCompare

Registration or license seekers typically have one outstanding application and primarily pursue a crypto-specific (58%) or payment institution (21%) license.

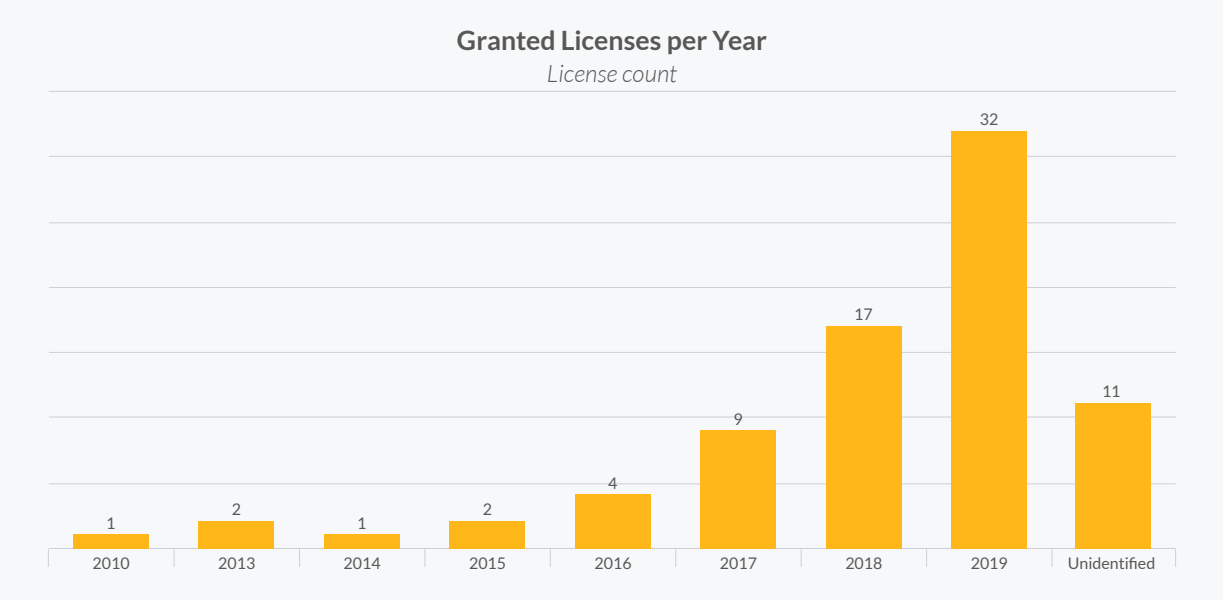
Of the licensed and registered entities, licenses and registration were primarily issued by British (23%) and American (23%) regulatory authorities. Switzerland and Estonia rank both at the third place (17%) of most cited jurisdictions for license and registration. Interestingly, only a small share of licenses held were issued by jurisdictions with a bespoke regulatory regime, such as Gibraltar (4%). Entities with an outstanding application were primarily seeking approval from the US (26%) and Singaporean (26%) authorities. The other main jurisdictions for outstanding applications were Hong Kong, the UK, South Korea, Japan, Switzerland, and Thailand.

72% of license holders or prospective applicants obtained or are seeking a license/registration from their home country (i.e. operational HQ)

With 48% and 58% of firms being registered/licensed, European and North American firms are roughly twice more likely to be regulated than companies from LAC or APAC, which both report that 23% of firms are registered or license holders. Meanwhile, slightly less than one in three companies operationally headquartered in the MEA region holds a license or a registration.

Of all identified licenses and registrations, 36% were granted in 2019 after the rise of regulatory scrutiny following the boom of 2017-2018 (**Figure 42**). As the cryptoasset regulatory landscape continues to evolve and the number of pending applications continues to grow, more firms are expected to be licensed and registered in the coming years.

Figure 42: The number of issued licenses almost doubled between 2018 and 2019



Note: This chart is based on public data collected by CCAF in combination of data provided by CryptoCompare

AML AND KYC PROCEDURES

The cryptoasset industry is progressively integrating with the global financial system and, by the same token, required to abide by the same standards. Around the world, AML/KYC standards are being harmonised to regulate an industry that is global by its very nature. The charge has first been led by the FATF to ensure consistency in AML/KYC requirements across its member states.

These updated requirements seem to have spurred industry actors to enhance their due diligence measures: in 2020, the vast majority (77%) of surveyed service providers perform AML/KYC checks for every single account, with only 20% using specific criteria (e.g. withdrawal/deposit thresholds, frequency of activity, location of account's owner). This figure is lower for platforms with an exclusive focus on cryptoassets (**Figure 43**): while 82% of entities supporting both fiat and cryptoassets verify user's identity for every account, only 48% of cryptoasset-only platforms do so, and 39% use other criteria.

Only a small minority of service providers (3%) do not perform KYC checks at all

However, it should be noted that user identity verification is usually a multi-tier process. Often, the stringency of the verification process increases with the amount a user is willing to deposit, withdraw, or trade, but also based on the type of assets for platforms supporting both fiat and cryptoassets. By registering and undergoing an identity check of all surveyed respondents, the CCAF research team found that 72% of them performed KYC checks when dealing with fiat, but only 46% did so when customers exclusively used cryptoassets.

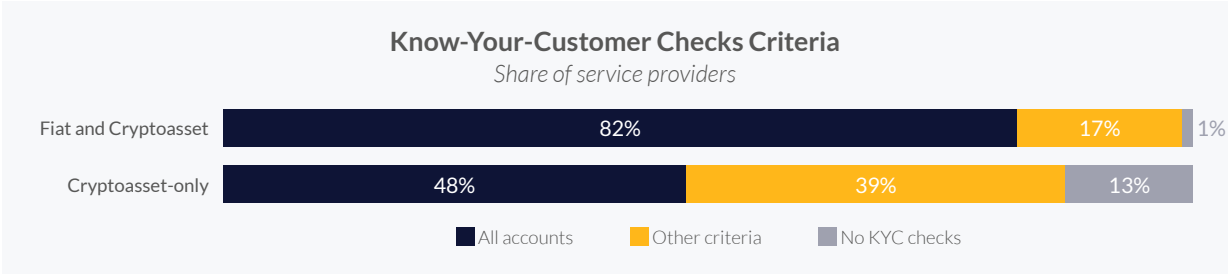
It is also relevant to note that, regardless of their size, location, or assets they support, nearly 90% of surveyed service providers have a policy in place about which parties can access sensitive customer information, such as identification documents and bank account information.

FATF Recommendation 16: Travel Rule

The FATF is an inter-governmental body that coordinates member countries' efforts on AML and counter-terrorism financing (CFT). It issues non-binding recommendations to its members, which it monitors and reviews on a regular basis.

In June 2019, FATF released an interpretive guidance (revised FATF standards) including virtual assets and virtual asset service providers (VASPs), which sets out several requirements and recommendations that apply to VASPs, such as licensing, registration, and Customer Due Diligence (CDD) requirements. Recommendation 16, also referred to as the "travel rule", has proven to be particularly challenging for VASPs to implement technically. The travel rule requires VASPs to obtain, hold and transmit accurate (verified) originator information, information about intended beneficiary, and securely transmit required customer information. From a technical standpoint, the travel rule necessitates the establishment of common technical standards (e.g. messaging) to streamline and standardise information transmission from the originator to its beneficiaries, as well as the development of technological solutions for VASPs to comply with the travel rule globally.

Figure 43: The share of cryptoasset-only companies that do not conduct any KYC checks dropped from 48% to 13% between 2018 and 2020

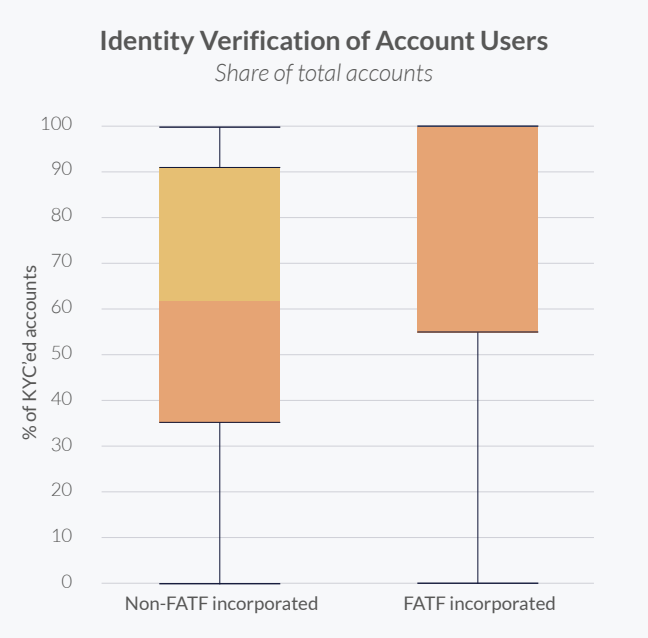


The share of accounts' owners whose identity was verified differs from region to region: it is consistently high across European and North American firms, approaching 100%, whilst service providers in other regions report lower and more disparate numbers. The median figure is particularly low in MEA-based companies, with approximately 50% of account owners having their identity verified.

The median firm in Europe, North America, or Middle East and Africa reported that 8% of its KYC checks led to account closure

Companies incorporated in a FATF member country more frequently conduct KYC checks on all accounts, than entities legally headquartered in non-FATF countries (**Figure 44**). Furthermore, at the median only 3% of KYC checks lead to the closure or refusal to open an account for companies incorporated in non-FATF countries, against 8% for FATF-incorporated entities. These trends might be read as a testament to the importance and influence of commonly established global standards.

Figure 44: At the median, the identity of all account holders has been checked for companies incorporated in FATF countries



REGULATION IMPACT: REDEFINING GEOGRAPHIES

As the previous subsection has extensively shown, regulatory changes have had a direct impact on companies' internal compliance standards. The impact of regulation may also be observed from a geographical standpoint by reshaping the geographic boundaries of the cryptoasset ecosystem.

REGULATORY ARBITRAGE

In the context of cryptoassets, regulatory arbitrage often occurs when companies choose to settle in jurisdiction(s) offering greater regulatory certainty due to the existence of a bespoke regulatory framework to supervise cryptoasset activities.[64] In this context, the concept of "regulatory arbitrage" slightly departs from its traditional meaning. It is understood as *seeking maximum regulatory certainty and the most benign environment*, rather than to *exploit legal and regulatory loopholes (i.e. absence of regulation)* as is often discussed in other industries. Another form of regulatory arbitrage is the exploitation of different tax rules; a practice which is not specific to cryptoasset businesses but also observed in traditional finance and other industries.

Nearly one in three companies sought regulatory approval from outside its main jurisdiction of operations. Another approach to investigate geographic relocation of entities to amenable jurisdictions is to compare respondents' operational headquarters with their country of incorporation. On this front, of surveyed entities, 22% have been incorporated in a country different from where their operational headquarters are based, and up to 15% in a different region. For these companies, top countries for incorporation include Switzerland, British Virgin Islands, the UK, and the Republic of Seychelles.

64 It is also worth noting that jurisdictions that adopted a bespoke regulatory framework are often those known for their relatively flexible business regulations, see Blandin et al. (2019) *The Global Cryptoasset Regulatory Landscape Study*. Cambridge Centre for Alternative Finance. Available from: https://www.jbs.cam.ac.uk/fileadmin/user_upload/research/centres/alternative-finance/downloads/2019-04-ccaf-global-cryptoasset-regulatory-landscape-study.pdf [Last accessed: 24 August 2020].

Supervisory duty: whose responsibility?

While numerous regulators take varied approaches to govern service providers in the industry, several jurisdictional issues arise when attributing organisation's liabilities. Recently, the organisational structure of large cryptoasset companies have come to resemble those of large corporations from other industries. The growing complexity of corporate structures combined with the inherent global nature of the cryptoasset industry have rendered the supervisory duty of regulators ever more challenging to execute. It is often unclear which authorities should oversee an organisation with no physical presence operating in a given jurisdiction and domiciled overseas. Some authorities and international bodies, such as FATF, have suggested that cryptoasset service providers should be licensed and regulated in the jurisdiction where they are 'created', obliging regulatory authorities from the jurisdiction of incorporation to supervise and regulate the entity.

This approach may, however, prove to be insufficient in the event of a company incorporated in one jurisdiction and domiciled in another through its subsidiaries, or in cases where the service provider is decentralised and has no home jurisdiction. While a coordinated risk based response to use of cryptoassets in criminal activities is desirable, consensus across nations on this front is still a work in process. A possible alternative approach could also be to implement the Place of Effective Management (POEM) or Permanent Establishment (PE) model prevalent in few jurisdictions to determine residency for taxation purposes, where individual jurisdictions define a threshold/nexus above which economic activity in that jurisdiction may be subjected to regulatory supervision. However, while the use of POEM may solve many concerns around round tripping, it may not always result in a clear determination of domicile or reflect outcomes which accord with policy intentions, given the highly decentralised nature of operations of the industry. Jurisdictions globally should, therefore, give due regard to substance over form in determining liabilities and preventing abuse.

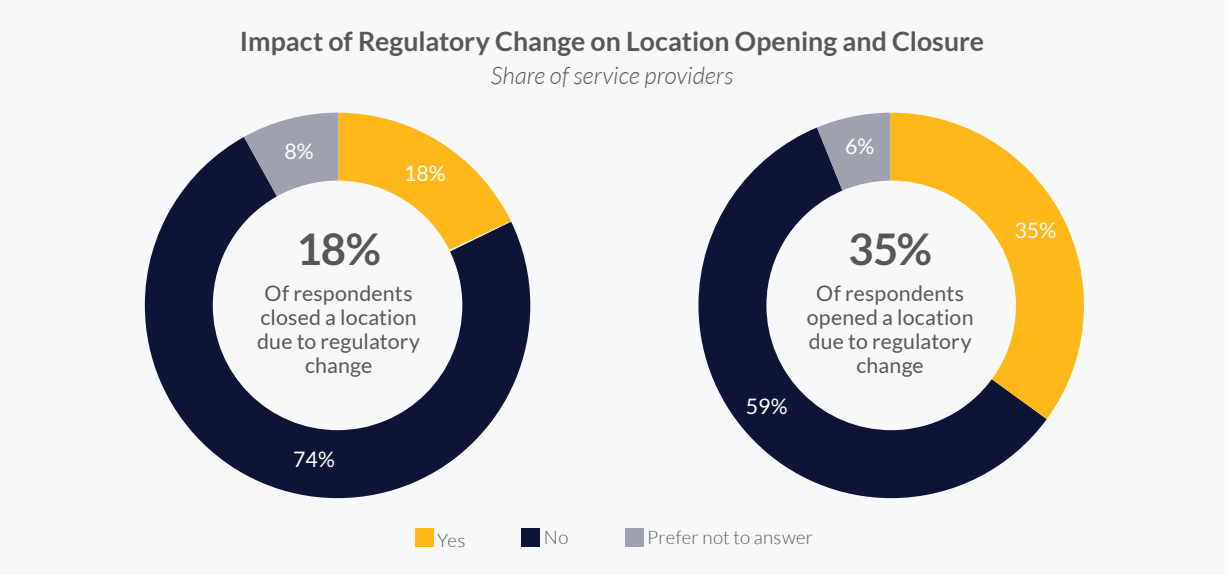
CLOSURE AND OPENING OF A LOCATION

The introduction of a new regulation, enforcement actions, or any other regulatory developments are believed to considerably influence a firms' decision to open or close an office in a jurisdiction. However, as **Figure 45** shows, changes in the regulatory environment affect location closure and opening to differing degrees: 35% of survey respondents indicate that regulatory changes have led them to open a new location, compared to 18% for location closure.[65]

Though the data does not show in which jurisdictions facility opening and/or closure takes place, this trend might be a direct consequence of the so-called "chilling effect of regulation". This concept refers to the vagueness of existing applicable rules, creating more confusion and uncertainty than the complete absence of regulations. Lack of explicit regulatory requirements for cryptoasset businesses in certain jurisdictions may have led some to seek greater regulatory certainty by relocating part of their activities in jurisdictions with bespoke regulatory framework, or at least unambiguous applicability of existing regulations.

65 The kind of changes inducing these decisions was not specified in the data. As such, regulatory change may refer to increased regulation, as well as relaxation in a regulatory regime.

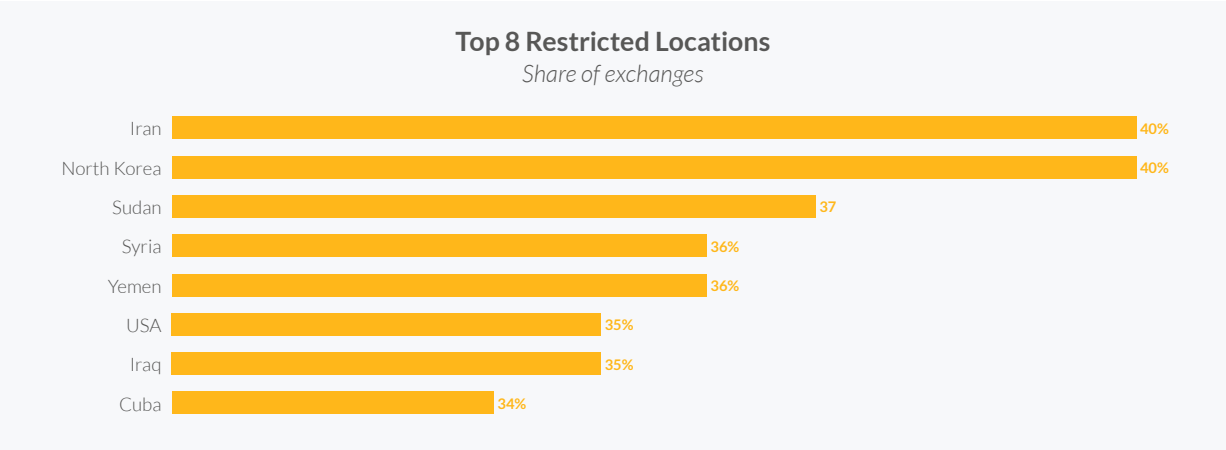
Figure 45: Changes in regulation are more likely to drive location opening than closure



USER BANS

Another well-documented impact of regulation is the geographic restrictions imposed by service providers to deny users from certain geographies access to their services. Unsurprisingly, these geographic restrictions replicate those that exist in other industries, namely countries subject to international sanctions, such as Iran, North Korea, etc (**Figure 46**). It has also been widely reported that US customers, mostly from New York City, were banned from these platforms due to the high cost of compliance to serve users in these locations.

Figure 46: Users from the USA are as often banned from exchanges than Iraqi users



Source: 21shares database[66]

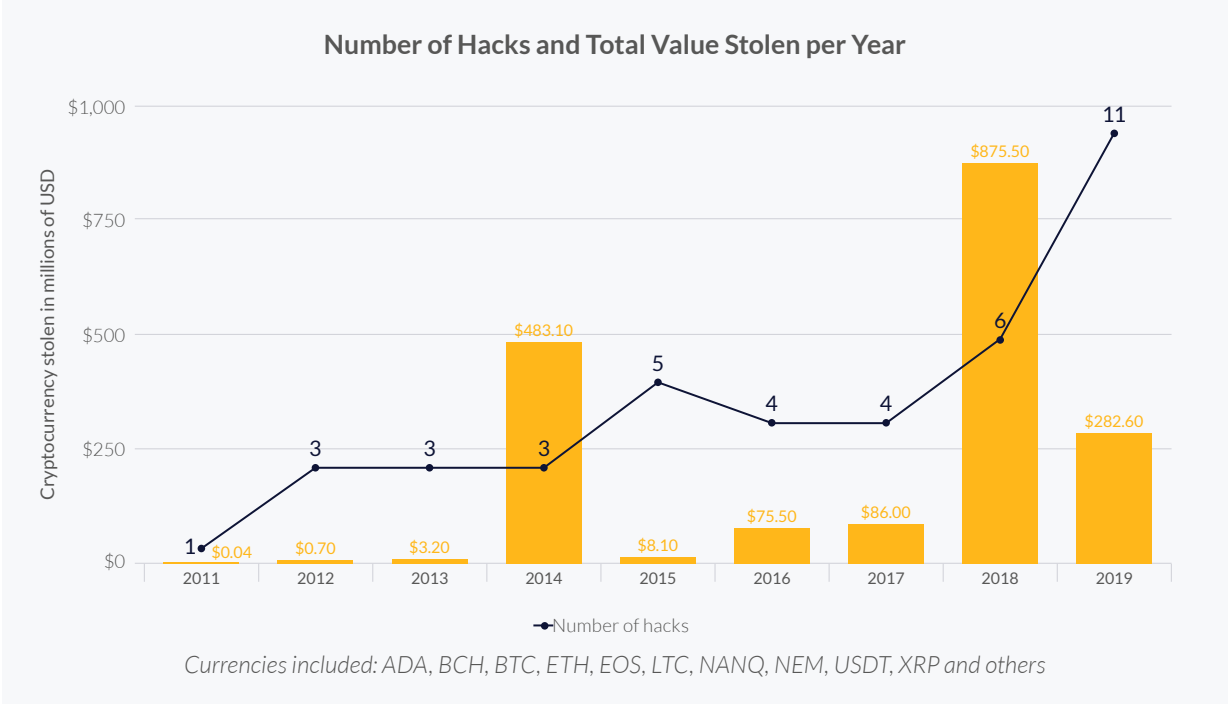
66 21shares (2020) *Crypto Exchanges Database by 21Shares-apr21,20*. Available from: https://docs.google.com/spreadsheets/d/1vhM-IYVzWx1xytLxbL9FVeZdnceNJKVuvwrNdtQ7qmo/edit#gid=0 [Last accessed: 24 August 2020].

SECTION 6: IT SECURITY

THE DEVELOPMENT OF BEST MARKET PRACTICES

Greater retail adoption post-2017 turned cryptoasset service providers into prime targets for hackers. Blockchain analytics firm Chainalysis reports that the number of attacks on service providers has been on the rise with the total value of stolen funds peaking at nearly USD 900 million in 2018 (**Figure 47**).[67] Companies have consequently ramped up their security measures, e.g. increased use of cold storage, additional verification layers for withdrawal, and a more stringent monitoring of transactions to detect suspicious activities.

Figure 47: Improved security measures by service providers have helped shrink down the amount of lost value between 2018 and 2019

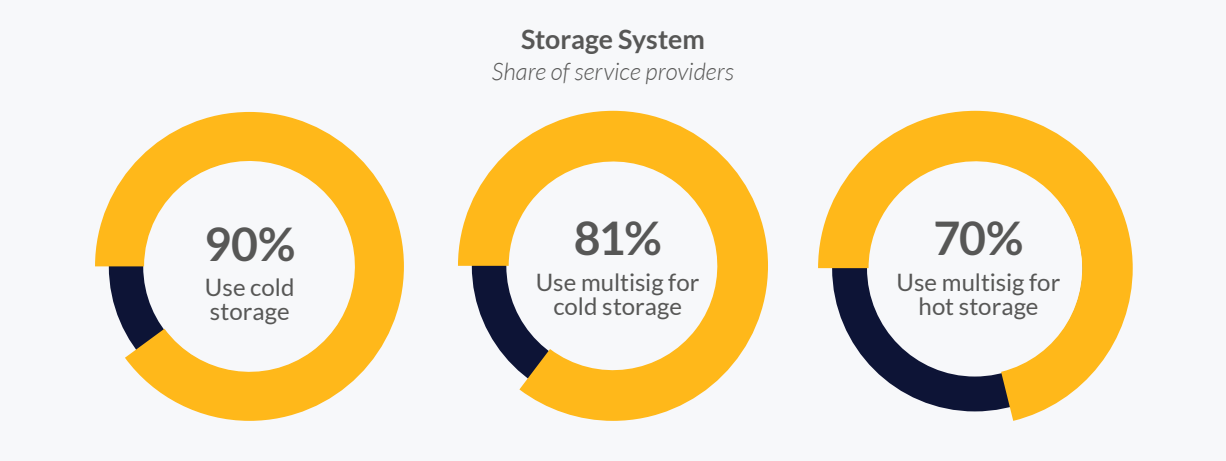


Source: Chainalysis, *The 2020 State of Crypto Crime*

Attackers on the other hand have adapted to these enhanced security measures by designing more sophisticated phishing attacks, or using enhancing-privacy methods (e.g. CoinJoin, mixers). The adherence to best market practices for IT security might be a signal that companies across the spectrum are keeping up with more advanced attacks.

67 Chainalysis (2020) *The 2020 State of Crypto Crime*. Chainalysis. Available from: https://go.chainalysis.com/rs/503-FAP-074/images/2020-Crypto-Crime-Report.pdf [Last accessed: 24 August 2020]

Figure 48: The use of cold storage and multisig is close to becoming an industry standard



"Hot" and "cold" storage: misnomers for cryptoasset custody

The notions of "hot" and "cold" have been borrowed from the data storage world to describe the level of security in the system used to safekeep users' private keys. Often, in the cryptoasset space, the low latency of 'hot' storage is associated with lower security level compared to 'cold' storage systems that are composed of several security layers to unlock funds, hence necessarily more time-consuming. However, these adjectives, which originally relate to the latency of different tiered storage plans, should not be conflated with the degree of security of a storage system. In fact several companies have started designing key storage systems that combine the security level of so-called 'cold' storage with the low latency of 'hot' storage.

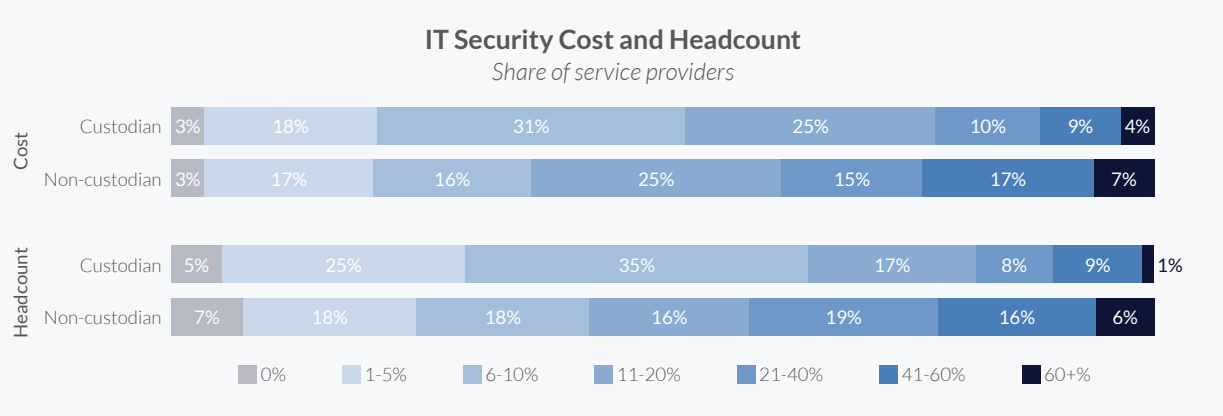
At the median, custodial platforms usually keep a slightly lower share of cryptoasset funds in cold storage (85%) compared to non-custodial ones (90%). This should not come as a surprise; platforms offering services generally associated with high user activity (e.g. trading platforms) often happen to be custodial ones. For instance, 79% of exchanges that have their own order-book have control over user funds (i.e. hold users' private keys). Therefore, to allow users to swiftly access their funds when trading, the service provider must hold a limited amount of customer funds in cold storage. This trend is also a reflection of users' perpetual trade-off between convenience and security.

RESOURCES ALLOCATION TO IT SECURITY

Non-custodial service providers generally spend a greater share of their resources, both financial and human, on IT security at between 11-20% compared to 6-10% for custodians (**Figure 49**). Development costs and timeline are believed to be generally higher for non-custodial systems, requiring greater allocation of resources over a longer period.

It is worth noting that service providers that allow both the user and the service provider to each hold a private key are classified as "non-custodians" for the purpose of this report. This form of *co-managed* custody is often complex and associated with several layers of security and iterative processes to unlock customers' funds, which would require additional staffing.

Figure 49: The median non-custodial service providers allocate a greater share of its resources to IT security than the median custodian



Small service providers are more likely to report higher figures for IT security headcount with at least 50% of small service providers indicating that 11-20% of their workforce is orientated towards IT security against 6-10% for large ones. However, both groups report a median IT security cost between 11-20% of total costs.

From a regional perspective, apart from LAC service providers, respondents from all regions reported the same median share of IT security headcount (6-10%). However, the median company in APAC and LAC reports a higher share of costs associated with IT security than the median companies headquartered elsewhere. This does not, however, mean that companies from other regions spend less overall on IT security. As discussed in **Section 5**, European and North American companies are more likely to spend a higher share of their financial resources on compliance; this variable cost in turn takes up some of the share of IT security resources. Similarly, costs associated with other activities, such as human resources, marketing, R&D, may also result in a lower share of resources being allocated to IT security overall. As such, IT security may be considered a large fixed cost component.

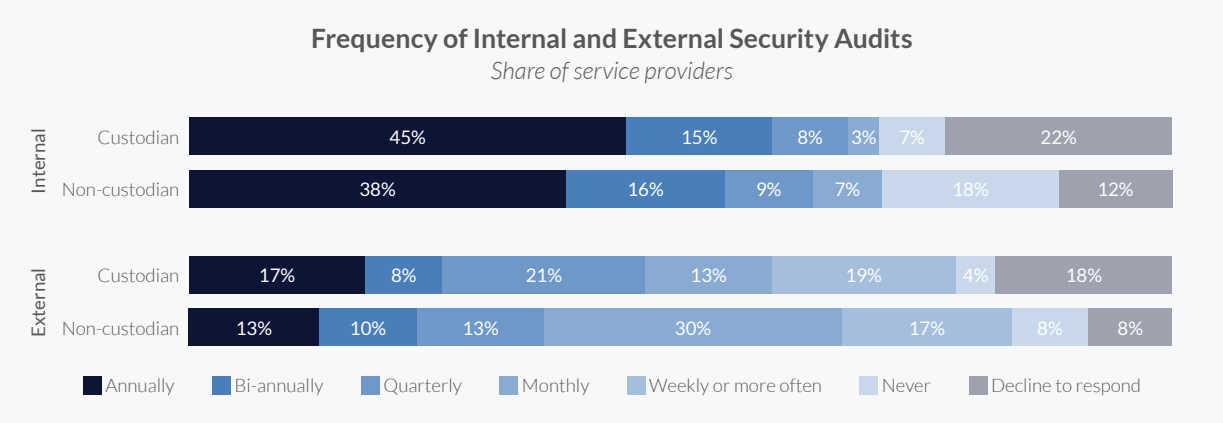
SECURITY AUDITS

The 2nd edition of the Global Cryptoasset Benchmarking Study found that a significant number of survey respondents were reluctant or unable to disclose information about both internal and external security auditing processes. It was speculated that this could be interpreted as either a general lack of awareness around formal security standards, or that entities do not follow security auditing best practices, or in some cases both. The results of this year's survey confirm the hypothesis from the previous study that the adoption of best practice standards and formal security processes varies considerably across regions and jurisdictions.

Unsurprisingly, internal audits were undertaken more frequently than external audits across all five regions; internal audits are generally easier to carry out and do not require the disclosure of sensitive information to third parties, or additional external cost. For example, in APAC, North America and MEA (31%), a significant proportion of internal audits were carried out monthly. In Europe and LAC, the highest proportion of internal audits were carried out on a weekly basis. Whereas, in all regions, the highest proportion of respondents, carried out external audits on an annual basis.

Up to 12% of respondents from all regions stated that they never engaged in internal audits. As for external audit, this figure is particularly high for respondents from MEA: 31% indicated they had never engaged in external audits. This figure is 20% for LAC, 18% for North America, 14% for Europe, and at a noticeably low 3% for APAC respondents.

Figure 50: On average, non-custodians conduct external and internal security audits more frequently



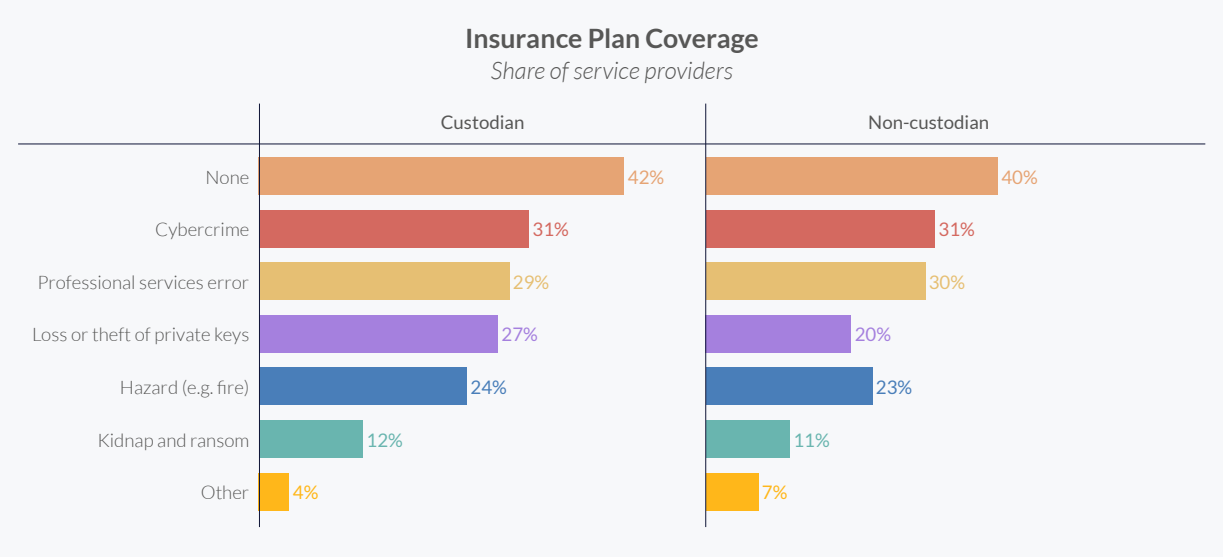
INSURANCE

The safety of cryptoasset storage should not be left to well-designed IT security systems alone. The insurance of funds is a key component of a sound service offering. Nevertheless, 46% of surveyed service providers indicated not being insured against any risk. Companies with insurance plans are primarily insured against cybercrime, professional errors (including directors and officers liability insurance), loss or theft of private keys, and hazards. These observations hold true for both custodial and non-custodial service providers, although a slightly largest proportion of custodians is insured against the loss or theft of private keys (**Figure 51**).

Nearly half of service providers are left fully uninsured

The insurance sector for cryptoasset services is undeniably underdeveloped. Other studies have shown that less than 0.5% of the insurance market goes to cryptoasset coverage.[68] The relatively small size of the cryptoasset industry and the reluctance of insurance carriers to enter this volatile market are the most probable explanatory factors for this finding.

Figure 51: Little difference appear between the insurance plans of custodian and non-custodians

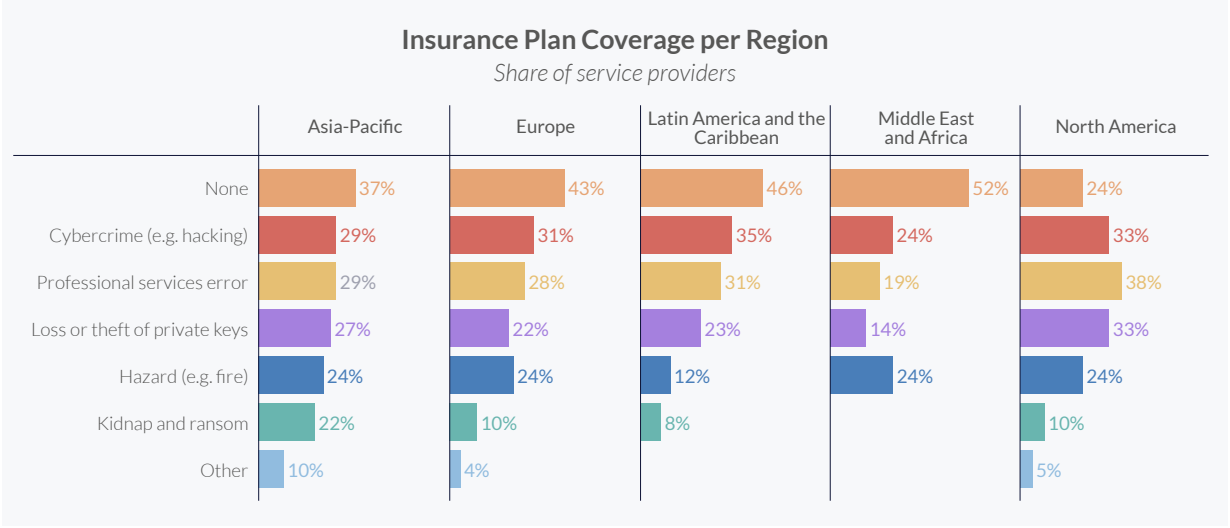


68 Evertas (2020) *Huge lack of capacity in insurance sector for cryptoassets*. Evertas. Available from: https://www.evertas.com/in-the-news/huge-lack-of-capacity [Last accessed: 24 August 2020].

Although service providers often do not have formal insurance policies in place - nor access to such - certain service providers have earmarked funds allocated to cover specific insurable events for the users.

Regional breakdown unearthed some interesting disparities (**Figure 52**). For instance, a great proportion of European companies are not insured at all (43%), so are companies in Latin America (46%) or MEA (52%). In comparison, 24% and 37% of North American and APAC entities respectively indicate not having any insurance coverage. For insured companies, the proportion of the types of insurance coverage are somewhat similar across regions.

Figure 52: Companies in APAC tend to be insured against a wider range of risks



SECTION 7: BALANCING BETWEEN INTEGRATION AND INNOVATION

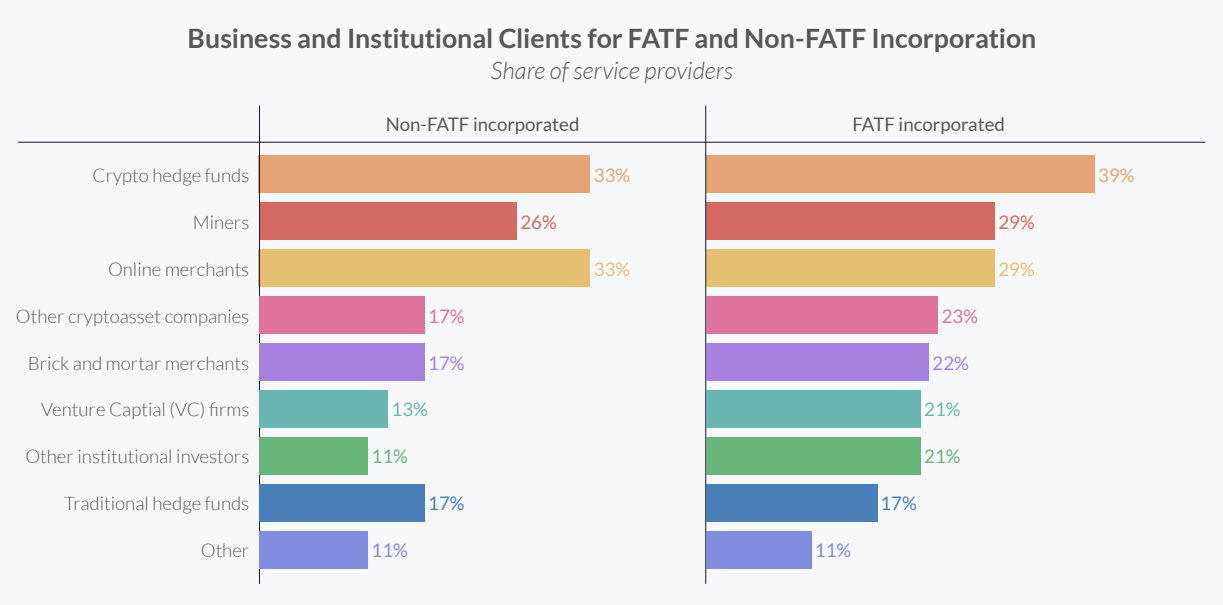
As the industry enters a new decade, it faces several challenges to further expansion, including integrating with traditional market infrastructures and maintaining a sustained pace of innovation. To fulfil both objectives, industry participants may have to invest more time and resources into compliance and industry restructuring, while bringing continuous improvements to innovative solutions, such as decentralised finance.

ENHANCED TRANSPARENCY AND COMPLIANCE

The 12-month review report released by FATF in June 2020 reveals that a growing number of jurisdictions have implemented the revised FATF standards on cryptoasset service providers.[69] As discussed in **Section 5**, wider implementation of AML/KYC rules would help bolster legitimacy and trust in the industry. Previous investor surveys often quote the lack of transparency and regulatory certainty around cryptoassets as a concern for institutional investors, along with other concerns, such as volatility and absence of reliable valuation models.

Survey data suggests that compliance and institutional investor adoption are indeed closely related. For instance, **Figure 53** indicates that service providers incorporated in a member jurisdiction of FATF tend to serve investors from the traditional financial system more often that firms from non-FATF countries: the share of business and institutional clients for the median service provider legally headquartered in a FATF country is two times higher than that of enterprises incorporated in a jurisdiction that is not part of the inter-governmental body. Although both groups equally deal with traditional hedge funds (17%), companies incorporated in a FATF member state are nearly twice as likely to also serve other types of institutional investors, such as family offices and asset managers.

Figure 53: Cryptoasset service providers incorporated in a jurisdiction member of FATF are more likely to serve traditional institutional investors

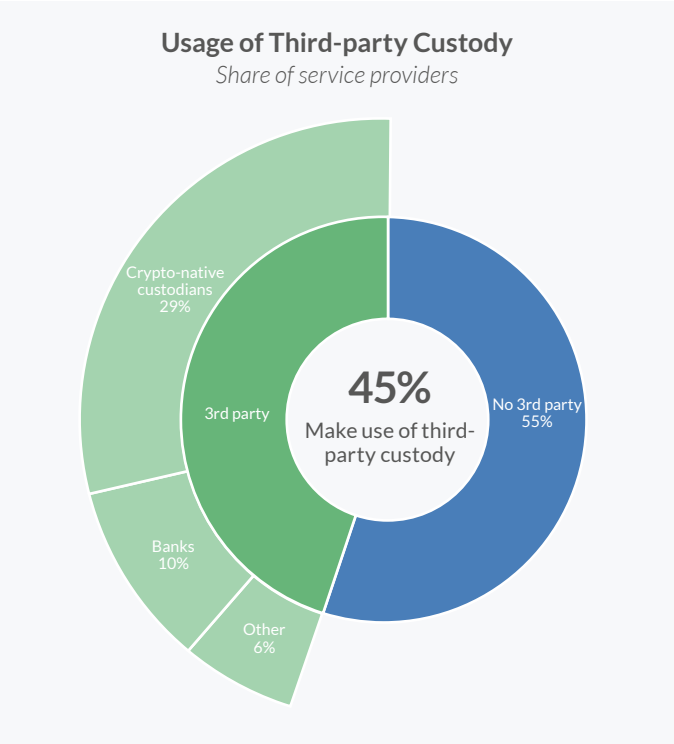


69 FATF (2020) *12-month Review of the Revised FATF Standards on Virtual Assets and Virtual Asset Service Providers*. Available from: https://www.fatf-gafi.org/publications/fatfrecommendations/documents/12-month-review-virtual-assets-vasps.html [Last accessed: 30 August 2020].

A DECOUPLING OF FUNCTIONS ACROSS THE VALUE CHAIN

Another possible driver of institutional adoption is the evolution of cryptoasset market structure towards a more traditional setup. As the cryptoasset industry configures to resemble traditional financial market infrastructure, institutional investors might be in a better position to engage with the industry. An emerging trend in this evolving configuration is the decoupling of activities amongst different firms, as well as within firms (via the setup of subsidiaries). To a certain extent, the segregation of functions across the value chain similar to traditional market infrastructure is already happening. For instance, 45% of respondents indicate using a third-party as part of their cold storage system (**Figure 54**). Cryptoasset-native custodians have dominated the market (64%) and been the go-to for service providers willing when outsourcing custodial duty to a third-party. The relatively limited custodial role played by banks and other more traditional custodians may be simply explained by the persisting reluctance of these actors to enter the cryptoasset space due to regulatory barriers. This figure is likely to grow as the regulatory landscape evolves for traditional banking actors.[70]

Figure 54: More than one in three service providers outsource its custody responsibility to a cryptoasset native custodian



THE GROWTH OF 'DECENTRALISED FINANCE'

DeFi is an umbrella term that refers to an emerging financial software stack that consists of several protocols, platforms and applications built on top of public blockchains.

DeFi development and usage has gained most traction on the Ethereum blockchain, but decentralised finance applications may also emerge on other smart contract blockchains that offer different trade-offs around scalability, transaction speed and degree of decentralisation.

The DeFi space is still largely experimental and, in general, most DeFi applications cannot be considered meaningfully decentralised by any measure. The majority of these applications are still dependent on kill switches, centralised oracles, or some other centralised support or maintenance. A stated core objective for many developer teams is to focus on increasing decentralisation over time. The emergence of governance tokens and new incentive mechanisms are examples of experimental approaches designed to make DeFi protocols less dependent on centralised control. Depending on the region, DeFi is in fact the second or third most cited future development that may be a game changer for service providers (**Table 4**).

70 For instance, in July 2020, the US Office of the Comptroller of the Currency issued an interpretative letter allowing US national banks and savings associations to offer services for the custody of cryptoassets. See, Gould, J. (2020). *Interpretive Letter #1170.* Office of the Comptroller of the Currency. Available from: https://www.occ.gov/topics/charters-and-licensing/interpretations-and-actions/2020/int1170.pdf [Last accessed: 24 August 2020].

Notably, decentralised finance protocols are subject to several risks such as:

- **smart contract risk:** as the amount of money locked into decentralised financial systems grows, they inevitably become targets for hackers who look to exploit vulnerabilities in smart-contract code security. Stacking and composability of smart-contracts also pose a risk. Should an underlying smart-contract break then the stack may fall like a house of cards,
- **oracle risk:** some decentralised protocols rely on so-called oracles to access off-chain data (e.g. cryptoasset exchange rate against fiat currencies). Oracles, either hardware or software, funnel real world data to the smart contract. As several attacks targeted at decentralised protocols have shown, oracles are a possible source of systemic risk and their data feeding role is prone to manipulation,[71]
- **financial risk:** many DeFi protocols are dependent upon underlying cryptoasset collateral that is subject to volatility. Hence, a large and sudden drop in cryptoasset price presents a liquidation risk to users of the protocol,
- **regulatory risk:** regulation regarding the DeFi space is unclear and untested in many jurisdictions. As the space grows, the response of regulators to decentralised financial applications is a regulatory risk that needs greater study and understanding.

Table 4: Service providers' sentiment over future developments per respondent's region of operations

Service providers assess impact of future developments (per region)

Respondents scored these categories on a 1-5 scale:

1: Not important at all 2: Not important 3: Neutral 4: Somewhat important 5: Very important

Lowest average score — Highest average score

	Asia-Pacific	Europe	Latin America and the Caribbean	Middle East and Africa	North America
Stablecoins	4.0	3.7	3.5	4.1	4.3
Staking	3.8	3.3	2.8	3.3	3.1
Decentralised finance (DeFi)	3.6	3.2	3.4	3.4	3.2
Layer-2 solutions (e.g. Lightning network)	3.0	3.1	2.9	3.3	3.0
Central Bank Digital Currencies (CBDCs)	3.3	2.9	2.7	3.5	3.1
Security tokens issued on a public blockchain	3.2	2.9	3.1	3.4	2.7
Sidechain	2.9	2.8	2.5	3.3	2.9
Privacy enhancing overlays	3.1	2.7	2.8	3.5	3.1
Non-fungible Tokens (e.g. ERC-721)	2.8	2.5	2.9	2.3	2.5
Other developments	1.8	3.1	4.0	3.5	N/A

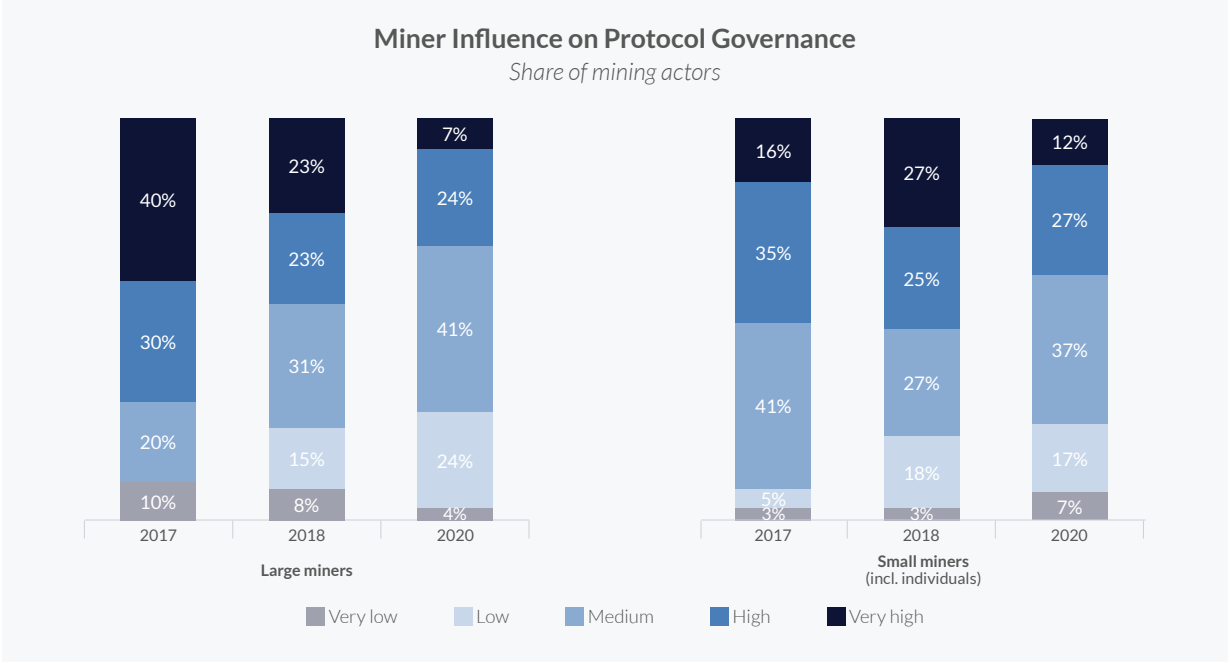
"Other" includes "tokenised rights", "FATF guidance", "lending"

71 See for instance the double attack on the bZx ethereum-based ending project in February 2020. Available from: https://etherscan.io/address/0x360f85f0b74326cddff33a812b05353bc537747b#internaltx [Last accessed: 24 August 2020].

APPENDIX

MINERS' INFLUENCE

Figure 55: Large miners are less likely to think that they have very high influence on protocol governance than small and individual miners



OPERATIONAL RISKS FOR MINERS

Table 5: Miners rank their concerns over operational risks (per region)

Miners ranks concerns over operational risks (per region)

Respondents scored these categories on a 1-5 scale:

1: Not important at all | 2: Not important | 3: Neutral | 4: Somewhat important | 5: Very important

Lowest average score — Highest average score

	Asia-Pacific	Europe	Latin America and the Caribbean	Middle East and Africa	North America
Government Seizure or shutdown of your mining-supporting facilities	3.3	2.4	3.1	2.5	1.8
Halving	3.3	2.9	3.0	3.5	2.9
Regulations creating barriers to mining	3.3	2.8	3.7	2.5	3.2
Sudden increases in energy prices	3.2	3.0	3.5	3.0	2.6
Increased taxation of mining profits	3.0	2.6	3.4	1.5	2.8
Unplanned protocol change	2.9	2.5	2.6	3.5	2.0
Intensive competition among miners of the same cryptoasset	2.9	2.7	3.0	3.0	3.0
Cyber attacks (e.g. DDoS)	2.8	2.4	3.7	3.0	2.1
Declining popularity of the cryptoasset you mine	2.7	2.2	3.3	3.0	2.2
Lack of immediate availability of state-of-the art hardware	2.7	2.5	3.7	2.5	2.9
Planned protocol change	2.5	2.7	2.6	3.5	1.7

Table 6: Miners rank their concerns over operational risks (per size)

Miners ranks concerns over operational risks (per size)

Respondents scored these categories on a 1-5 scale:

1: Not important at all 2: Not important 3: Neutral 4: Somewhat important 5: Very important

Lowest average score — Highest average score

	Small Miners (incl. individuals)			Large Miners		
	2017	2018	2020	2017	2018	2020
Halving	N/A	N/A	3.0	N/A	N/A	3.2
Regulations creating barriers to mining	N/A	3.3	3.1	N/A	2.9	3.2
Sudden increase in energy prices	N/A	3.1	3.0	N/A	3.5	3.1
Government seizure or shutdown of your mining facilities	N/A	3.6	2.4	N/A	2.4	3.0
Intensive competition among miners of the same cryptoasset	3.2	3.3	2.9	3.3	3.2	2.9
Increased taxation of mining profits	N/A	3.2	2.8	N/A	2.9	2.9
Cyber attacks (e.g. DDoS)	2.8	3.1	2.5	3.0	3.3	2.7
Lack of immediate availability of state-of-the art hardware	2.9	3.4	2.9	2.4	2.5	2.6
Unplanned protocol change	2.5	3.0	2.5	1.6	3.4	2.6
Declining popularity of the cryptoasset you mine	N/A	3.0	2.5	N/A	3.0	2.5
Planned protocol change	N/A	N/A	2.4	N/A	N/A	2.4

ADDITIONAL RISKS FOR MINERS

Table 7: Miners rank their concerns over additional risks (per region)

Miners ranks concerns over additional risks (per region)

Respondents scored these categories on a 1-5 scale:

1: Not important at all 2: Not important 3: Neutral 4: Somewhat important 5: Very important

Lowest average score — Highest average score

	Asia-Pacific	Europe	Latin America and the Caribbean	Middle East and Africa	North America
Unfavourable global regulation related to cryptoasset mining	4.0	3.4	3.6	4.5	3.4
Unfavourable global regulation related to cryptoassets	3.9	3.1	3.4	2.0	3.2
Centralisation of hashing power in the hands of a few	3.5	4.3	3.7	2.0	4.4
Criminal use of cryptoassets	3.1	2.7	3.5	4.5	2.3
Underdeveloped fee market	3.1	3.6	3.4	3.0	2.9
Risk of state-sponsored attack on a cryptoasset system	3.0	3.3	2.8	3.0	2.6
Lack of open-source mining software	2.9	3.5	2.6	2.0	2.5
Centralisation of hashing power in a particular geographic area	2.8	3.5	3.3	1.5	3.8
Centralisation of mining equipment production in a particular geographic area	2.7	3.7	3.4	3.5	3.7
Popularity of pre-mined/'mining-less' cryptoassets	2.7	3.0	3.0	4.0	2.4
Too many cryptoassets in the market	2.6	2.5	2.9	5.0	2.2
Emergence of Central Bank Digital Currencies (CBDCs)	2.3	2.7	3.1	5.0	2.6

Table 8: Miners rank their concerns over additional risks (per size)

Miners ranks concerns over additional risks (per size)

Respondents scored these categories on a 1-5 scale:

1: Not important at all 2: Not important 3: Neutral 4: Somewhat important 5: Very important

Lowest average score — Highest average score

	Small Miners (incl. individuals)			Large Miners		
	2017	2018	2020	2017	2018	2020
Unfavourable global regulation related to cryptoasset mining	N/A	3.3	3.5	N/A	3.0	4.0
Unfavourable global regulation related to cryptoassets	N/A	3.3	3.2	N/A	3.2	3.8
Centralisation of hashing power in the hands of a few	3.9	4.4	4.2	3.3	4.0	3.4
Criminal use of cryptoassets	N/A	3.2	2.7	N/A	2.8	3.1
Underdeveloped fee market	N/A	N/A	3.2	N/A	N/A	3.1
Risk of state-sponsored attack on a cryptoasset system	N/A	3.4	3.1	N/A	2.9	2.8
Centralisation of hashing power in a particular geographic area	3.7	3.9	3.5	3.1	3.7	2.7
Centralisation of mining equipment production in a particular geographic area	3.4	3.7	3.7	2.1	3.5	2.7
Lack of open-source mining software	N/A	N/A	3.0	N/A	N/A	2.7
Popularity of pre-mined/'mining-less' cryptoassets	N/A	3.1	2.8	N/A	2.8	2.6
Emergence of Central Bank Digital Currencies (CBDCs)	N/A	N/A	2.7	N/A	N/A	2.4
Too many cryptoassets in the market	N/A	3.1	2.6	N/A	2.1	2.4
Other risks	N/A	N/A	3.1	N/A	N/A	4.0

OPERATIONAL RISKS FOR SERVICE PROVIDERS

Table 9: Service providers rank their concerns over operational risks (per size)

Service providers ranks concerns over operational risks (per size)

Respondents scored these categories on a 1-5 scale:

1: Not important at all 2: Not important 3: Neutral 4: Somewhat important 5: Very important

Lowest average score — Highest average score

	Small Service Providers			Large Service Providers		
	2017	2018	2020	2017	2018	2020
IT security/hacking	3.9	3.8	3.5	3.2	4.2	3.5
Increasing regulatory burden	2.9	3.8	3.3	3.5	3.8	3.5
AML/KYC enforcement	2.6	3.2	3.0	2.8	3.4	3.1
Competitors / business model risk	3.0	3.2	3.1	2.6	3.3	3.1
Fraud	3.5	3.5	3.2	2.1	3.8	2.9
Tax treatment of cryptoassets	N/A	N/A	2.8	N/A	N/A	2.9
Difficulty of entering into banking relationships	3.8	3.7	2.9	2.7	3.6	2.8
Lack of talent	2.5	3.5	2.7	2.3	3.8	2.8
Negative industry publicity	2.9	3.3	2.9	2.8	3.5	2.7
Deteriorating banking relationships	3.8	3.5	2.8	2.7	3.5	2.6

Table 10: Service providers rank their concerns over operational risks (per region)

Service providers rank concerns over operational risks (per region)

Respondents scored these categories on a 1-5 scale:
1: Not important at all 2: Not important 3: Neutral 4: Somewhat important 5: Very important
Lowest average score — Highest average score

	Asia-Pacific	Europe	Latin America and the Caribbean	Middle East and Africa	North America
IT security/hacking	3.7	3.6	3.2	3.3	3.5
Increasing regulatory burden	3.4	3.4	3.5	3.6	3.1
Fraud	3.2	3.2	3.0	3.2	3.1
Competitors/business model risk	3.4	3.1	2.8	2.9	3.1
Difficulty of entering into banking relationships	2.4	3.1	3.1	3.2	2.5
AML/KYC enforcement (e.g. FATF Travel Rule)	3.4	3.0	2.6	3.4	2.8
Deteriorating banking relationships	2.3	2.9	2.8	3.1	2.7
Negative industry publicity	2.9	2.8	3.1	2.7	2.8
Tax treatment of cryptoassets	3.1	2.7	3.1	3.1	2.5
Lack of talent	3.1	2.7	2.9	2.5	2.3

FUTURE DEVELOPMENTS

Table 11: Service providers assess the likelihood of future developments (per size)

Service providers assess impact of future developments (per size)

Respondents scored these categories on a 1-5 scale:
1: Not important at all 2: Not important 3: Neutral 4: Somewhat important 5: Very important
Lowest average score — Highest average score

	Small Service Providers	Large Service Providers
Stablecoins	4.1	3.8
Staking	3.8	3.1
Decentralised finance (DeFi)	3.5	3.3
Layer-2 solutions (e.g. Lightning network)	3.2	3.1
Other developments	3.2	2.9
Central Bank Digital Currencies (CBDCs)	3.1	3.0
Security tokens issued on a public blockchain	2.9	2.8
Sidechain	2.8	3.0
Privacy enhancing overlays	2.8	2.6
Non-fungible Tokens (e.g. ERC-721)	1.4	3.5

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