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The Global RegTech Industry Benchmark Report

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Contents

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Logos of respondents to the CCAF Global RegTech Industry Benchmark Survey reproduced by explicit permission.

Executive summary

The Global RegTech Industry Benchmarking Survey, carried out by the CCAF with the sponsorship of EY Japan, is the Centre's first in-depth study of the RegTech sector. Based on a survey of 111 RegTech firms and in-depth qualitative interviews with industry experts and regulators, its purpose is threefold:

1. To build an evidence-based and data-driven classification of RegTech firms;
2. To establish industry benchmark figures on the size, growth and activities of RegTech firms using this market segmentation;
3. To better understand the key stakeholders and components of the global RegTech ecosystem as it develops.

The key findings from the RegTech industry benchmarking report are as follows.

RegTech is not an entirely new industry

RegTech includes any use of technology to match data to information taxonomies that are meaningful to both regulators and the firms they regulate, in order to automate compliance and oversight processes. Chapter 1 of this report argues that this is not a new sector; some of its constituent parts have been around for two or three decades. However, the various segments that make up the industry all experienced highly co-ordinated episodes of new market entry and product development, as documented in Chapter 4. During those, common methods of delivery (on the cloud, via APIs), as well as the common expectation of turning compliance into an end-to-end process, set the current RegTech industry apart from its predecessors.

The global RegTech industry is estimated to have generated $5bn in 2018

The years 2014 to 2018 saw a surge of new RegTech start-ups, driven by a combination of rapid regulatory change, technological advancements and regulator interest. Chapter 4 of this report discusses these sector demographics in detail: about 60% of all RegTech vendors were founded and 82% had their first funding round during this period. As of 2018, RegTech firms employed an estimated 44,000 people globally and earned in the region of $4.9bn in annual revenue, having raised about $9.7bn in external funding to date.

This is now a highly internationalised industry, with fewer than one third of RegTech vendors active in just one market, and just over a third present in

five or more jurisdictions (Figure E1 and Chapter 3). Almost two out of three vendors have a physical presence or significant market share in the United Kingdom, and nearly half in the United States (Figure E2). A small number of Pacific financial centres in Australia, Canada, Singapore, Hong Kong and Japan, and European financial centres in Luxembourg, Switzerland, Ireland, Germany and France, also attract significant interest. The United Arab Emirates stand out as a focus of activity in the Middle East, but no African or South Asian country made it into the group of top jurisdictions, based on the share of RegTech firms present or headquartered there.

Figure E1: Plot of sample firms by number of markets in which they are active

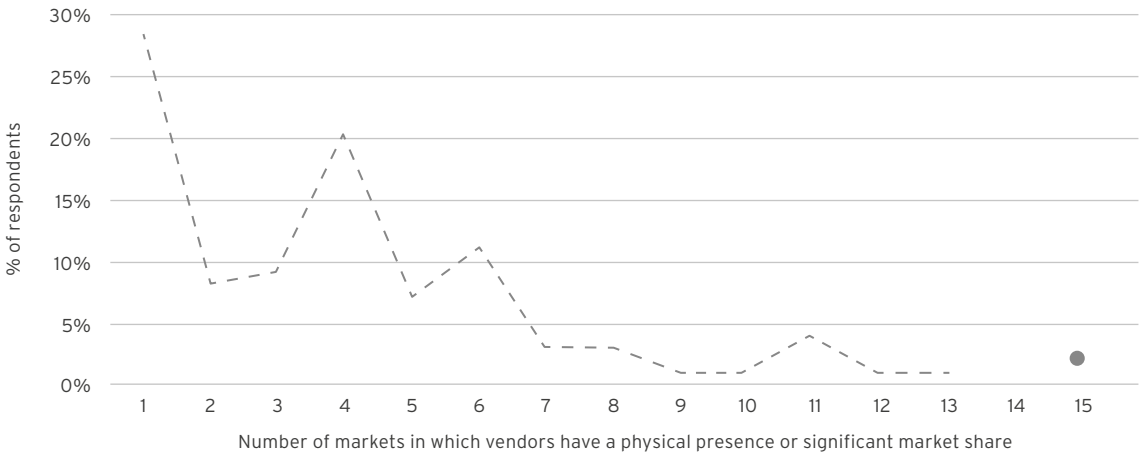
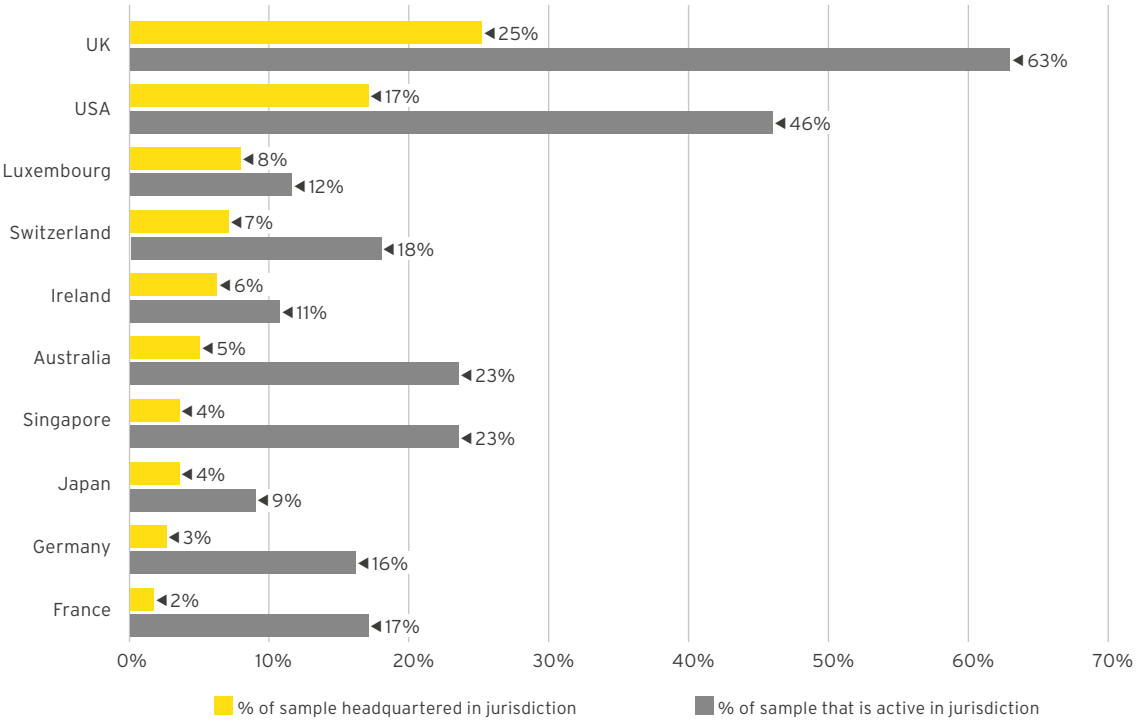


Figure E2: Top 10 RegTech markets, by % of firms present (headquarters or significant market share)



The global RegTech industry has developed into distinct market segments

The RegTech sector has been studied at length in industry publications, and numerous segmentations have been proposed, drawing on the expertise of market participants. It is possible to test and complement those with evidence-based taxonomies. Taking into account the technologies used and the functional characteristics of vendors' solutions, the RegTech sector can be divided into five segments, as shown on Table E3 below and discussed further in Chapter 7. By far the largest by fundraising are Profiling and Due Diligence and Dynamic Compliance firms, which together account for ca. 70% of funds raised to date (but just over 40% of revenue).

Table E3: RegTech market segments: estimated size and volume of activity

Segment	Activity of vendors in the segment	% of firms	% of est. turnover (2018)	% of est. funds raised	% of est. headcount
Profiling and Due Diligence	Collect or integrate data from multiple sources to build a profile of a person, entity or counterparty, confirm their identity, or categorise them according to regulatory requirements or business rules.	21%	10%	31%	25%
Reporting and Dashboards	Collect information from multiple sources within a firm in order to build standardised reports for management or compliance purposes.	25%	35%	6%	16%
Risk Analytics	Use big data to assess the risk of fraud, market abuse or other misconduct at the transaction level.	21%	34%	15%	27%
Dynamic Compliance	Facilitate and monitor regulatory change, ensuring that policies and controls adapt flexibly to changing requirements.	18%	10%	41%	18%
Market Monitoring	Match market-level adverse outcomes to regulatory or business rules, including poor product performance, adverse market conditions or market manipulation, by sourcing data from diverse external sources.	16%	11%	8%	11%
Total		100%	100%	100%	100%

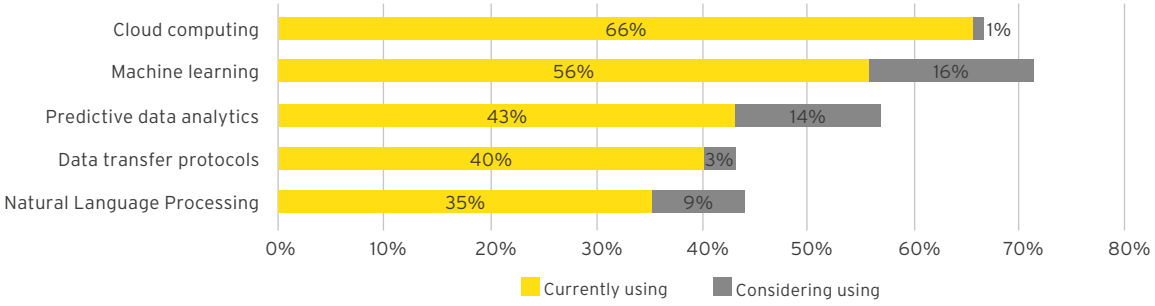
Source: CCAF Global RegTech Survey, RegTech Analyst population estimates and CCAF calculations. Industry-level estimates are based on extrapolations – See Chapter 4 for details.

The RegTech industry relies on a combination of key technologies to deliver its products and services

About two thirds (66%) of the sector delivers its offerings through the cloud, with 56% of vendors employing machine learning and 43% using predictive data analytics to describe patterns or predict behaviours. Finally, over a third (35%) use natural language processing (NLP) to parse regulatory content. Chapter 4 of this report argues that, taken together, these form the core technologies of the RegTech sector (see Figure E4). Looking forward, the use of machine learning and data analytics is set to grow further and could be used by nearly three quarters of vendors if current predictions are correct.

In proportional terms, however, it is voice recognition, Distributed Ledger Technology (DLT) and Geographic Information System (GIS) mapping that are likely to make the biggest gains from current levels. It remains to be seen whether growing interest in location mapping and graph analysis will translate into adoption.

Figure E4: Top 5 technologies employed in RegTech offerings:



Thanks to regulatory changes in the recent past, RegTech firms are operating in a more favourable environment

More than half of all RegTech vendors (56%) rate market conditions for their firms at 8/10 or above; and a similar share (55%) rate the regulatory environment in the same way. These figures rise to 76% and 62% respectively for those offering Profiling and Due Diligence solutions – the least-threatened of the market segments studied. Accordingly, Chapter 8 of this report argues that, if market conditions are currently conducive to RegTech growth, this is to a great extent due to regulators.

There is a clear link between the surge in RegTech market entry in the years 2014 to 2018 and the amount of new regulation introduced or implemented during that time. To date, adoption has been strongest where it has been supported by legislative initiatives that punish non-compliance with large fines or criminal sanctions, and that favour high data volumes and prescriptive data taxonomies. Areas such as anti-money laundering (AML) and transaction reporting provide particularly good examples of such initiatives (see Chapter 7). Thus, more than 60% of vendors report that their offerings address either Know Your Customer (KYC) or AML requirements. Data collection and reporting is a key competency for 55% of vendors (Figure. E5), and more than a third report that the collection, organisation and reporting of data are primary motivations for their typical client (Figure. E6). The automation of regulatory reports and their processing is usually the first area of focus for regulators engaging with RegTech– a matter explored in detail in Chapter 9.

Certain vendors have also benefited from more direct support from regulators: as detailed in Chapter 8 of this report, over one in five have applied to a regulatory sandbox, and those tend to report more favourable perceptions of the regulatory environment than their peers.

Figure E5: Top 5 functional areas of focus for RegTech solutions:

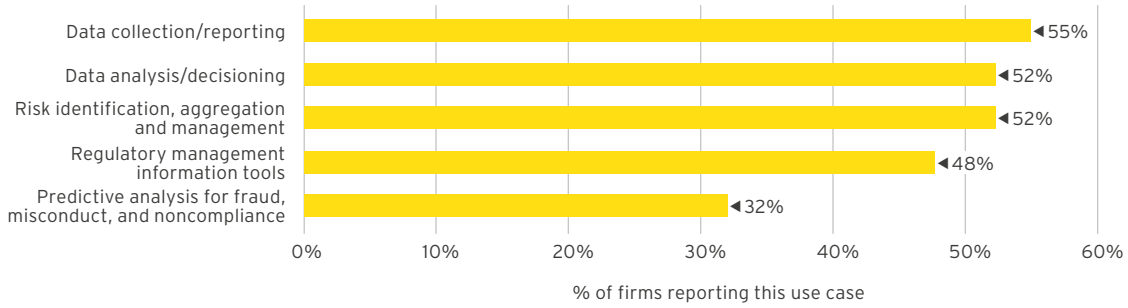
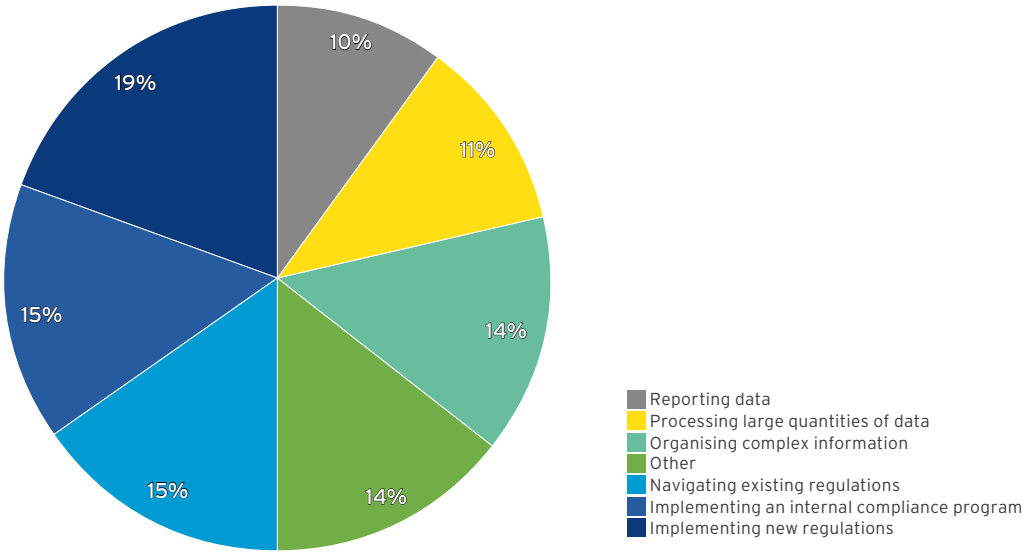


Figure E6: Primary RegTech buyer motivations, as reported by firms



Going forward, the globally coordinated regulatory push that began in the early 2010s and continues to date may well give way to slower, more fragmented regulatory change. As discussed in Chapter 9, regulators' focus is already shifting towards less readily quantifiable areas of compliance such as conduct and culture, and from descriptive to predictive analytics. Such a shift might favour those vendors who utilise versatile technologies and whose solutions are less domain specific.

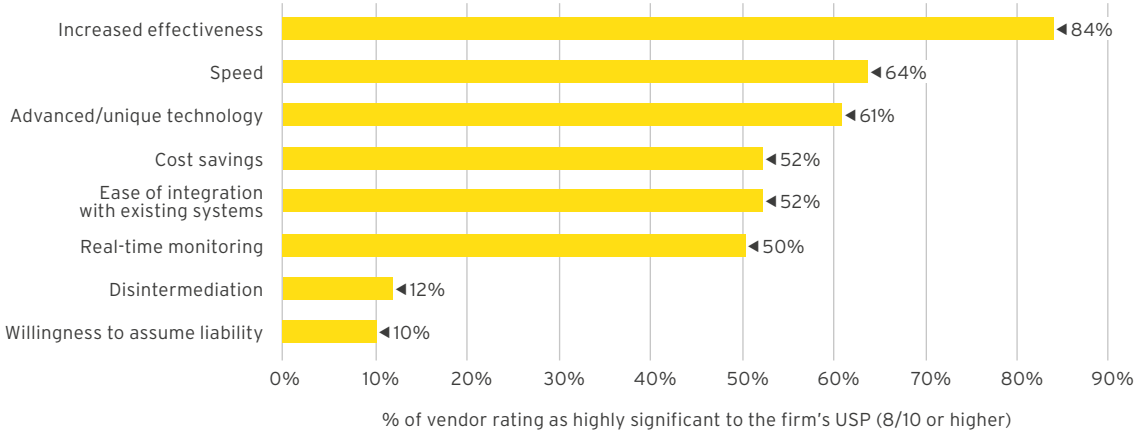
The sector is likely to see double-digit growth as it matures, and hot spots are emerging

Industry forecasts, summarised in Chapter 4, point to year-on-year growth of between 23% and 25% between 2018 and 2023, and are supported to some extent by primary data collection from the CCAF vendor survey.[1] Vendors frequently cite effectiveness and speed as part of their unique selling proposition (USP) (see Figure E7), whereas direct cost savings are less frequently cited, particularly among more mature firms.

1 Among those firms that provided turnover figures for more than one year, the average year-on-year growth rate was higher than these projected future growth rates. However, due to the small base size it is impossible to rely on those survey estimates alone.

A limited analysis of firm perceptions suggests that there is a market premium for technologies offering real-time insights or decisioning, and a strong interest from regulators in supporting such technologies (see Chapter 8). But the promise of machine-readable and machine-executable regulation, an end-to-end compliance offering, remains elusive despite regulatory support. Building and selling such platforms is demanding, expensive and a major stakeholder management challenge; it is a difficult and expensive offering for a vendor to switch to.

Figure E7: Most commonly cited USPs



RegTech isn't all about bank compliance; it increasingly caters to the needs of both financial and non-financial clients

The financial sector, and particularly large incumbents such as banks and insurers, continues to dominate demand for RegTech solutions – between 89% and 94% of vendors by cohort have an offering tailored to the needs of the banking sector. However, Chapter 5 presents evidence that the focus of RegTech firms is slowly expanding outwards from those core sectors and towards FinTechs, regulators and market infrastructure providers, as well as shifting back to non-financial industries, which newly founded vendors are more likely to market to. In total, 58% of vendors count non-financial, non-government and non-advisory sectors among their target clients.

Product offerings aimed at the non-financial sectors employ a much wider range of technologies than those that only cater to the financial sector, with particular emphasis on image recognition and deep learning. Cases in those sectors are also comparably more focused on privacy and data protection or fraud detection.

RegTech's strong focus on FinTechs as potential clients is worth noting – between 49% and 68% of vendors by cohort target FinTechs, which is likely due to the close fit between the offering of innovative financial services firms and RegTech applications.

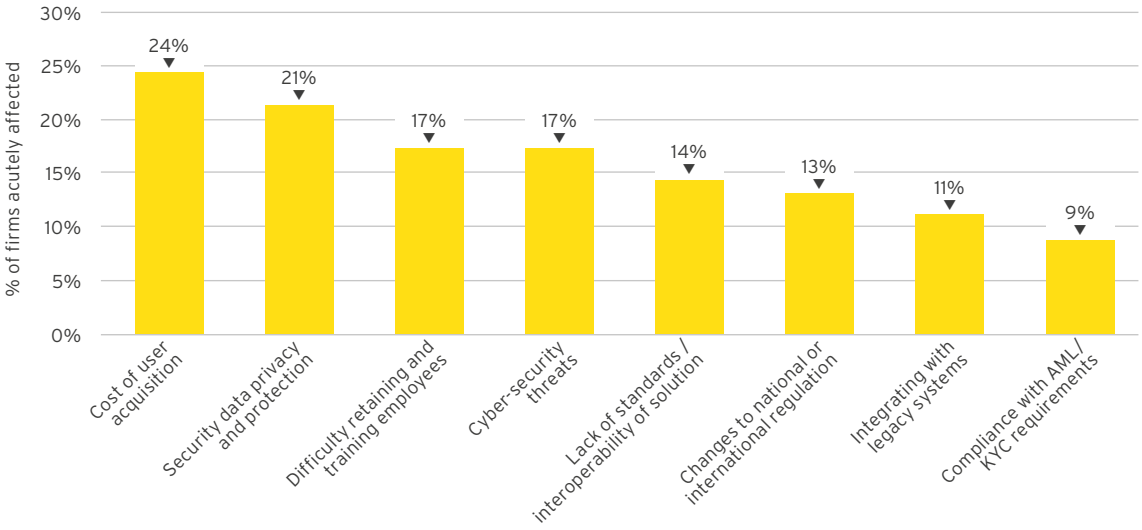
As the RegTech industry develops, more adversarial market dynamics will come into play

Respondents implied that the sector still sometimes fights for credibility, in part because the business case for investment has not been made internally by clients (see Chapter 8). They also spoke of problematic procurement and IT planning cycles that frustrate both sales and implementation at the expense of vendors. Consistently with this, nearly a quarter of the vendors surveyed (24%) cited the cost of client acquisition as an acute threat to their business models (see Figure. E8).

Finally, some vendors raised concerns about the dynamics of the sector, worried that some segments are becoming saturated, with too many undifferentiated firms fighting for the same limited pool of business. In such an environment it can be difficult for users to establish which vendors provide the best fit to their needs, potentially lengthening sales cycles and consequently applying more pressure on vendors that have yet to raise significant external funding.

A shakeout might soon whittle down the long tail of smaller vendors. Most funding and commercial activity is concentrated with a handful of vendors, and many RegTech firms are still very small: only 5% of all vendors have raised more than $50m, about half have raised less than $1.6m, and over a quarter have received no formal external funding.

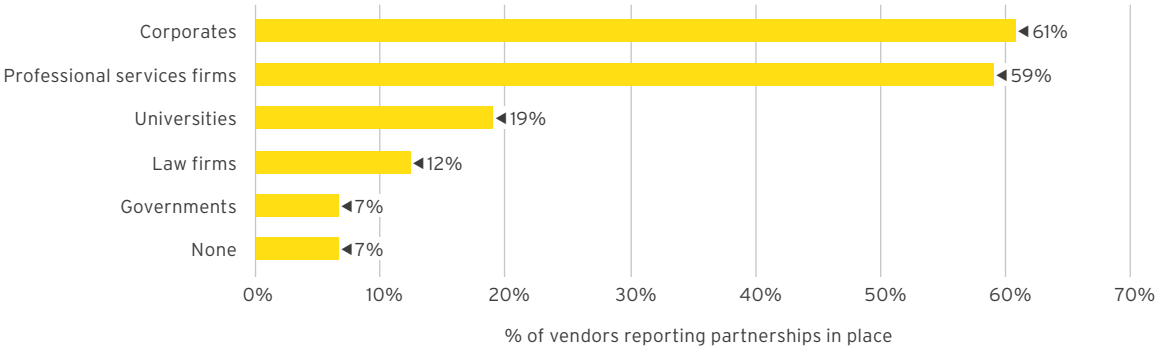
Figure E8: Self-reported ratings of threats to firms' business models



RegTech start-ups are leveraging partnerships to achieve growth

More than nine out of ten RegTech firms have external partnerships in place, and more than half of the sample are partnering with either a corporate (61%) or a professional services firm (59%) (Figure E9 and Chapter 8). Both strategic and tactical considerations may be driving these partnerships. For young firms trying to make the best use of early-stage funding, partnerships that combine investment, pre-qualification for procurement purposes, product co-creation and market feedback are potentially very valuable. Chapter 5 of this report discusses potential evidence that this helps unlock further funding for young vendors, and anecdotal evidence suggests that at least some users actively favour working with smaller, more agile vendors whose product offering they can shape.

Figure E9: Share of RegTech firms engaging selected partners



Regulators see potential for RegTech/SupTech, mainly as public goods

Regulators and, in less mature markets, private sector development partners are ready to work with or invest in the RegTech sector. As detailed in Chapter 9, about 16% of regulators are on course to have a live RegTech or SupTech initiative in place by mid-2020, and 27% are considering developing one in the future. However, in interviews regulators have been clear that their primary focus is on funding public goods, including shared utilities and data lakes (e.g. in the areas of identification and customer due diligence), shared ontologies, industry-standard data formats, and shared norms (e.g. in the use of big data and artificial intelligence). In relation to private goods, regulators expect regulated firms to meet them halfway: an approach driven by the fear of fines for non-compliance is likely to produce less value. There are signs that users are taking heed; most RegTech firms reported having partnerships in place with corporates (most likely their own clients) to drive innovation.

CCAF Foreword

The CCAF is proud to present our first comprehensive analysis of the global RegTech industry. Building on our Centre's previous work in benchmarking various FinTech sectors from crowdfunding and peer-to-peer lending to cryptoassets and blockchain applications, this report brings together empirical data in order to elucidate the size, growth, dynamics and development of the RegTech sector. The report findings point to a rapidly growing and technology-enabled global industry serving an increasingly diversified customer base, yet still working to test use cases, build value propositions, and establish trust and credibility as it matures.

It is also both interesting and important to contextualise the development of the global RegTech industry within wider trends in FinTech and the related regulatory environment. As financial innovation continues to gather pace, a tipping point is fast approaching where unaided human intelligence cannot keep track of emerging risks, or indeed opportunities. Left unchecked, artificial intelligence can pose grave challenges in terms of consumer protection, regulatory compliance, financial stability and cyber security, as well as ethics. From an academic standpoint, the CCAF sees the growing need for innovators to collaborate with regulators more closely. It is in the interest of both to promote the sharing of data and information for regulatory and supervisory purposes, and encourage regulatory innovation and cross-border cooperation.

The global RegTech industry can be a catalyst for more sustainable, effective, inclusive and considered financial and regulatory innovation. It is therefore important that the CCAF can collaborate with others to broaden the existing evidence-base of RegTech and produce a study that can help further the understanding of RegTech activities and industry dynamics, in turn, informing better business decision-making and regulation. I hope the readers of the report will find our analysis and insights interesting and useful.

This report would not be possible without the generous sponsorship of EY Japan and the support of RegTech industry associations, to whom we are very grateful. I would like to thank them and our research team led by Emmanuel Schizas profoundly for their outstanding contribution.

Bryan Zhang

Co-founder and Executive Director
Cambridge Centre for Alternative Finance

Cambridge **Centre for Alternative Finance**

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Foreword by EY

In close collaboration with the EY Global Network, EY Japan has been working with many parties in public and private sectors to create a global environment that boosts RegTech innovation. As we enter an era in which digital transformation is rapidly advancing on a global scale, the speed of developing disruptive technologies is accelerating.

In a highly complicated market driven by massive amounts of data and digitization, regulatory compliance has become an important management agenda for companies. At the same time, regulators of each jurisdiction are being forced to revisit their traditional supervisory approaches. Furthermore, the structure of industry and society itself are rapidly changing due to the continuous innovation, leading to widening gap with the existing regulations.

EY anticipates how efficiently the disruptive technologies can contribute to better regulatory compliance, and how effectively the public and private sectors can work together to implement those technologies in society and drive innovation.

A variety of key players, including regulated companies, regulators, technology start-ups, and research institutions, can contribute to each other and mutually benefit, and further drive innovation in the entire society. We hope that this report will provide them with some indication of to how to realize such a RegTech ecosystem.

Keiko Ogawa
Partner, Ernst & Young ShinNihon LLC
EY Japan RegTech Leader

Messages from the industry associations

International RegTech Association (IRTA)

"This report is an important piece of benchmarking on the impact of RegTech and opportunities for better industry alignment to scale adoption on a global basis. International RegTech Association (IRTA) members in a range of sectors and geographies have provided valuable input to this research and their contribution is recognised in this study. In addition, the key findings will help the IRTA to delivery our goal of supporting the development of the collaborative framework and initiatives between regulators, institutions and solution providers.

Building a shared understanding how and where the core technologies in RegTech are delivering more effective regulatory outcomes and the factors behind successful adoption is a vital building block for the industry. By sharing and building upon this insight, we can help shape and support the impact and growth of RegTech."

Richard Maton
Executive Board Member and Strategic Initiatives lead
International RegTech Association

The RegTech Association (Australia)

"The RegTech Association welcomes this study and the insights it contributes. We see our role as being a safe place to have the conversations that help break down the barriers to RegTech adoption, and allow the sector to deliver 'trust at scale.' It is only by deeply understanding the RegTech ecosystem that such breakthroughs can be achieved.

We are pleased to see more researchers recognize that RegTech extends beyond financial services compliance. The RTA has over 120 members covering a range of sectors; there are striking parallels between the learnings from this study and the experiences of many non-financial industries.

This study confirms something our members have long known: just how much of a challenge the long and tortuous adoption cycle poses to RegTech firms. We urge all participants in the ecosystem to measure themselves on time to value. We look forward to regulators learning more about what it takes to orchestrate and support the market for RegTech. In the private sector, we expect to see sales innovation emerging to combat the delays in the buying process, to rival the viral sales models of Salesforce or Slack. We also expect to see buying process innovation as regulated entities get more serious about RegTech. Faster adoption means more investment in the sector which in turn will help deliver on the promise of 'trust at scale'."

Lisa Schutz
Founding Director
The RegTech Association

Fintech Association of Japan

"I am very honored to have contributed to the CCAF Global RegTech Survey on behalf of the Fintech Association of Japan. These are exciting times for RegTech in Japan and the broader region. Japan's government and regulators have been proactive in utilizing new technologies in supervision and launched advisory boards to guide their approach to RegTech and SupTech. Already, experimentation in regulatory sandboxes at the national and regional level is feeding into legal and regulatory change.

Despite these efforts, very few start-ups are taking the initiative in RegTech innovation, and adoption remains slow. The Association has now formed a RegTech and SupTech sub-committee to build momentum for adoption in the public sector, and to address issues in the private sector. Earlier this year, the Fintech Associations of Japan, Singapore and Hong Kong established the APAC RegTech Network and started working closely to promote RegTech solutions for the problems laying across the APAC region.

We look forward to working with the public and private sectors to contributing to the RegTech ecosystem in Japan and globally."

Takeshi Kito
Director
Fintech Association of Japan (NPO)

1. Introduction

Regulatory definitions of RegTech and their limitations

Definitions of the term RegTech have largely originated from regulators, starting with the Financial Conduct Authority's (FCA) 2015 Call for Input, which popularised the term.[2] Given they were developed for exploratory purposes, regulators' definitions tend to be purposefully broad, encompassing most uses of technology to automate or improve compliance and supervision. Some authors, such as the Financial Stability Institute (FSI), additionally refer to a 'SupTech' sector, which is typically defined similarly to RegTech, but limited to the use cases most relevant to regulators, as opposed to regulated firms.[3]

Some definitions, though not most, consider RegTech to be a FinTech vertical. The relationship between FinTech and RegTech is nuanced, despite the dominance of financial services use cases within RegTech. Later in this report (Chapter 5) it is shown that a substantial share of RegTech vendors target non-financial clients alongside those related to the financial sector. Moreover, many sectors widely considered to be part of this industry have a history that long predated the FinTech boom. The Governance, Risk and Compliance (GRC) industry and the regulatory intelligence sector are both now well into their second decade of existence,[4] while Business Process Management (BPM) tools and business rules engines are each arguably in their third decade.[5]

A functional definition of RegTech

A functional definition might focus on the uses of technology at each stage of the compliance lifecycle (see Table A1.3. for relevant correlations). Under this alternative definition, ***RegTech includes any use of technology to match structured and unstructured data to information taxonomies or decision rules that are meaningful to both regulators and the firms they regulate, in order to automate compliance or oversight processes.*** This is achieved by facilitating compliance workflow, decision-making, and reporting, and the resulting linkages between data and actions enable efficient oversight. This was the working definition used in identifying the companies to be targeted for the purposes of the vendor survey.

A more comprehensive definition might also highlight aspects of the sector that are truly incremental to what came before. These include *delivery over the cloud and sharing or repurposing of data via Application Programming*

2 https://www.fca.org.uk/your-fca/documents/RegTech-cfi
3 https://www.bis.org/fsi/publ/insights9.pdf
4 https://www2.deloitte.com/content/dam/Deloitte/lu/Documents/risk/lu_en_ins_governance-risk-compliance-software_05022014.pdf In the case of regulatory intelligence platforms, the creation of Complinet provides a simple milestone.
5 https://books.google.co.uk/books?id=UENMJRkQB5sC&lpg=PP1&pg=PA24#v=onepage&q&f=false

Interfaces (APIs),[6] the increased *volume and scope of data processing* due to dramatic increases in processing power, the *interoperability introduced by shared data and reporting standards* and the growing expectation that different elements of compliance be integrated, regardless of where and how they are delivered, in a *single, end-to-end* process. The latter is exemplified in the industry's and regulators' call for 'machine-readable, machine-executable' regulation. This refers to the expectation that the information taxonomies and data formats used in the capture and parsing of compliance-relevant data must correspond unambiguously to those utilised in decision rules and in compliance operations such as monitoring and reporting, and eventually to those used by regulators for supervisory purposes, so that compliance can be engineered as an end-to-end process.

A comprehensive, functional definition has the advantage of transcending the distinction between RegTech and SupTech: from a functional perspective, a supervisor's use cases and those of a risk or compliance oversight function are arguably very similar. Nevertheless, SupTech is a useful shorthand when discussing regulators' use cases for RegTech and is used in that sense throughout this report.

Finally, an exhaustive version of the functional definition of RegTech should not focus solely on products and solutions as implemented by individual clients but as situated within a broader ecosystem, complete with shared data, taxonomies, norms and applications. Chapter 9 discusses common aspects of such an ecosystem in more detail.

Why is RegTech gaining in importance?

The cost of compliance (and non-compliance) is well-documented in the financial sector: firms reportedly spend about 4% of their revenue complying with regulations (Duff & Phelps 2018)[7], and banks, for instance, paid $320bn (just under 1% of revenue) in fines from 2007 to 2016 (BCG 2017).[8] Economy-wide estimates are more difficult to compile, but the United States Council of Economic Advisors have estimated the direct and indirect costs of regulation at ca 12% of US GDP in 2012[9], while estimates of the cost of the stock of regulation in the United Kingdom have historically exceeded 10% of GDP.[10]

While the cost of non-compliance may be endogenous, that of compliance is driven by the pace of regulatory change, which in the case of the financial

6 In the context of RegTech, APIs enable users to integrate multiple compliance applications, and the databases that support them, without juggling multiple user interfaces and environments. Each application can make requests of the other's API and receive data (including enriched and structured data) in response, to be used as inputs. Common unique identifiers (e.g., for transactions, clients, policies or controls) and shared metadata (e.g., topic tags applied to text) allow different applications to interpret the same data consistently.

7 https://www.duffandphelps.com/-/media/assets/pdfs/publications/compliance-and-regulatory-consulting/global-regulatory-outlook-2018.ashx?la=en

8 http://image-src.bcg.com/BCG_COM/BCG-Staying-the-Course-in-Banking-Mar-2017_tcm9-146794.pdf

9 https://www.whitehouse.gov/sites/whitehouse.gov/files/documents/The%20Growth%20Potential%20of%20Deregulation_1.pdf

10 See e.g., https://www.fsb.org.uk/docs/default-source/fsb-org-uk/fsb-regulation-returned-report.pdf?sfvrsn=0 and https://www.nao.org.uk/wp-content/uploads/2017/09/A-Short-Guide-to-Regulation.pdf

services sector has accelerated in the aftermath of the Global Financial Crisis (GFC). Thomson Reuters, for example, recorded 56,300 regulatory updates globally in 2017, up from just 8,700 in 2008 and 17,800 in 2012.[11] Additional costs are borne by firms having to navigate multiple, and divergent, regulatory regimes simultaneously. One estimate by the International Federation of Accountants (IFAC) and Business at OECD (BIAC) put the cost of regulatory fragmentation and divergence to international financial firms at ca 5%-10% of revenues.[12] The circumstances of the financial sector, and particularly of major banks, have been unique in the aftermath of the GFC. Nonetheless finance is hardly the only data-rich and heavily regulated sector, and emerging areas of regulatory focus, such as cybersecurity or data protection, have cross-sector application.

The pace of regulatory change matters regardless of how well-resourced a firm is. Faced with rapid change, firms' policies and controls might become redundant faster than previously, and systems put in place to facilitate compliance with individual major pieces of regulation might not prove adaptable to new ones. Against this backdrop, senior management might struggle to maintain visibility over compliance decisions. In the financial sector this contrasts with the attitude of regulators, who demand greater personal accountability through frameworks such as Australia's Banking Executive Accountability Regime (BEAR), Singapore's Guidelines on Individual Accountability and Conduct, Hong Kong's Manager-In-Charge (MIC) rules, or the United Kingdom's Senior Managers and Certification Regime (SM&CR).

Regulators are also challenged to maintain visibility over an evolving financial sector. They need to draw insights from the growing volume of traditional regulatory forms and reports submitted by firms as well as find ways of supervising against less quantifiable factors such as firm culture, all while making more efficient use of scarce supervisory resources. This combination of pressures on both industry and regulators drives a strong demand for technology-enabled compliance and oversight solutions.

11 http://www.complinet.com/net_file_store/new_editorial/f/i/FIGURE-8.jpg Note that the increase is likely to reflect improvements in Thomson Reuters' national and institutional coverage alongside actual change in volume.
12 http://biac.org/wp-content/uploads/2018/04/IFAC-OECD_Regulatory-Divergence_V9_singles.pdf

2. About the study

The CCAF, with the sponsorship of EY Japan, set out to survey the RegTech sector with three objectives: first, to build an evidence-based and data-driven classification of RegTech firms; second, to establish industry benchmark figures on the size, growth and activities of RegTech firms against this market segmentation; and third, to better understand the key stakeholders and components of the global RegTech ecosystem as it develops.

In December 2018, a CCAF research team used a semi-automated data extraction process to build a database of RegTech firms. The team developed an automated scraping tool which extracted firm information and key contacts from LinkedIn from a long list of likely RegTech firms identified via keyword searches. The resulting database was then verified and augmented through a manual search of industry rankings and industry award lists. Additional contacts were provided, in the case of Japan, by EY Japan and the Fintech Association of Japan. The final database encompassed 658 firms after de-duplication and accounting for subsequent respondents not on the original list. Higher estimates of the total size of the RegTech population are regularly reported, with different surveys of the sector counting over 800 firms.[13,] For the purposes of this study all estimates related to the total sector population are extrapolated based on a population of 824 vendors, which was the size of a reasonably comprehensive long-list of vendors active in 2018, compiled by RegTech Analyst, a specialist market intelligence platform. [14]

From 12 February 2019 to 29 April 2019, CCAF researchers undertook a global survey of RegTech vendors, supported by the IRTA and the RegTech Association (Australia), in which firms were invited to complete a questionnaire designed to address the core research questions described earlier in this chapter. A second iteration of the survey campaign was launched on the week of March 17. In the case of Japanese firms, support from EY Japan, the Japan Fintech Association and the Japan chapter of the IRTA allowed the researchers to reach a proportionately greater share of firms. In parallel, a team of four CCAF researchers contacted senior managers (at Director or C-suite level) of firms on the CCAF database and invited those via email to take the survey on behalf of their firms.

To ensure that results could be interpreted in a meaningful and consistent way, a decision was made to only actively target firms whose business was primarily in the RegTech sector, as defined in Chapter 1. Fieldwork thus excluded diversified IT vendors with a RegTech operation, or financial markets infrastructure operators and data providers with the same. An attempt was made to also avoid overlaps with adjacent sectors, such as technologies

13 http://beaver.madriverglen.com/companies?q%5Btags%5D%5B%5D=RegTech Accessed 30 April 2019
14 http://www.pressat.co.uk/releases/the-RegTech-100-for-2019-announces-the-pioneering-companies-transforming-compliance-risk-management-and-cybersecurity-b6283084936cf5a5bcedac0ec27091c6/ Accessed 30 April 2019

catering to the legal services sector (LawTech), or transactional legal technologies (DealTech). Where firms sourced via social media campaigns or directly were not in line with the definition, they were removed from the sample ex-post.

The final survey sample consists of 111 firms. Another 11 responses were rejected either due to poor sector fit or duplication, i.e. two different individuals responding on behalf of the same firm. Where duplication did occur, the response with the fewer non-response items was selected. Respondents were manually matched to publicly available data and estimates (e.g. in the case of fundraising totals), and turnover and headcount estimates were manually cleaned and sense-checked against vendor-reported headcount totals and vendors' own estimates of funds raised, as augmented by public data. Finally, all responses were cleansed to ensure appropriate formatting, before being anonymised ahead of processing. All market segmentation and clustering was exclusively data-driven to ensure anonymised data could be used throughout.

Qualitative research

One of the objectives of the present study was to better understand the key stakeholders and components of the global RegTech ecosystem as it develops, something which cannot solely be investigated through a structured quantitative survey. To capture more appropriate inputs, CCAF conducted a series of semi-structured interviews with 11 industry experts, including directors of RegTech vendors, investors in RegTech vendors and senior compliance staff at global banks. Focused insights from these interviews are used throughout this report, and two bank interviews have been expanded into more detailed procurement case studies (see Chapter 5: "Buyer Personas: In depth lessons from two North American Banks.")

Finally, this report incorporates findings from semi-structured interviews with six regulators in five jurisdictions in order to understand their approach to digitising the supervisory function, typical RegTech use cases, and the regulators' own role in shaping the RegTech ecosystem. Most interviews were carried out by the CCAF research team; however, two interviews with Japanese regulators were conducted by EY Japan, using the same interview schedule developed and used by CCAF to ensure consistency. Unlike industry interviews, the regulators' perspectives are aggregated and presented separately in Chapter 9. Interview material from one additional regulator was reused with permission and augmented through desk research.

Study limitations

Although the survey sample represents more than one eighth of the target population, it remains small. Throughout this report the authors have opted to suppress potentially misleading findings, but in any case, our findings at cross-section level should be treated as qualitative rather than quantitative.

To improve its reach, the CCAF leveraged social media campaign to recruit more RegTech companies to undertake the survey. The social media campaign made use of hashtags, particularly #RegTech #NLP #ArtificialIntelligence #AI and #compliance. This may have introduced a small bias in favour of AI- and NLP-powered RegTech solutions.

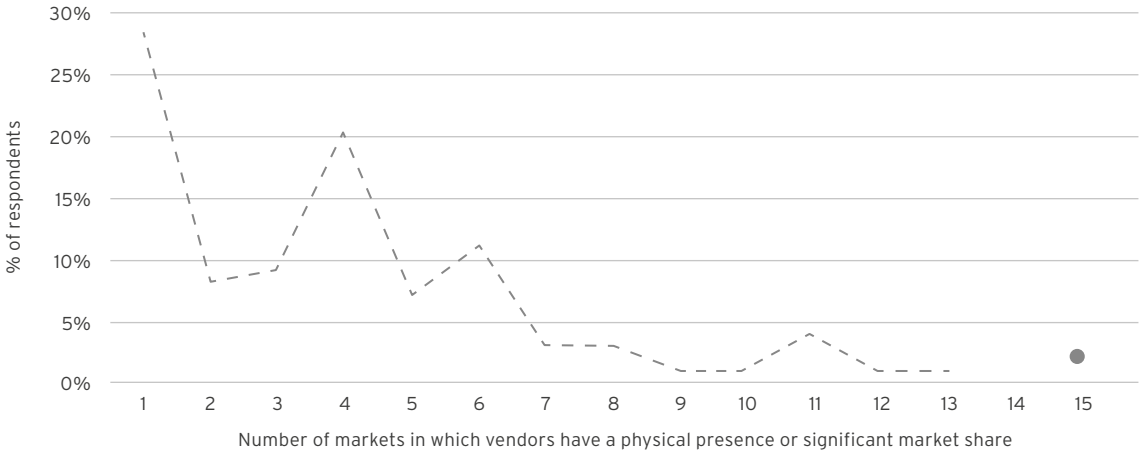
All business surveys suffer from survivorship bias; however, this is likely to be accentuated in surveys of technology start-ups. The most likely effect of this in the present study is to overestimate the fundraising record, growth rate and viability of the average firm in the sector. Similarly, because the target firm population was drawn up based on published historical lists of RegTech firms, very young firms are likely to be under-represented, again leading to overestimates of the average firm's fundraising record, turnover and employment.

Our analysis of the very limited sample of duplicate responses (see above) suggests that some items, particularly questions on the regulatory functions and objectives served by firms or the amount of funding raised, may suffer from poor inter-rater validity whereby two different senior executives often provide different answers to the same questions. The impact of this on the clustering analysis in Chapter 7 is partly mitigated by the use of principal components analysis to distil information from multiple questionnaire items.

3. The geography of RegTech Activity

A great deal of financial and other regulation either originates at the international level or has, over time, converged towards international standards of good practice. As a result, many RegTechs are 'born-global' firms, having an international focus from the start (see Figure 3.1). Fewer than one-third of RegTech firms in the survey sample were active in just one market, and just over a third named five or more jurisdictions in which they had a meaningful presence, i.e. a significant market share or physical presence.

Figure 3.1: Plot of sample firms by number of markets in which they are active



Although the small base size does not allow a completely robust comparison, these figures were virtually identical when looking only at firms that were up to two years old; in fact, more mature firms tended to be active in fewer markets.[15] This seemingly paradoxical finding makes sense if 'born-global' firms find it difficult to sustain the significant up-front investments needed to accommodate and reconcile divergent local regulatory requirements, concepts and data formats.

The geographical concentration of respondents' activities reflects the influence of the world's major financial services centres (Figure 3.2), with almost two thirds of respondents having a physical presence or significant market share in the United Kingdom, and nearly half did so in the United States. A small number of Pacific financial centres in Australia, Canada, Singapore, Hong Kong and Japan, and European financial centres in Luxembourg, Switzerland, Ireland, Germany and France also attract significant interest.

15 Additional support for this is provided by an independent-samples t-test testing whether the average number of markets was the same for firms up to two years of age and those between 2 and 5 years. Another t-test confirmed Firms older than 5 years were, on average, active in a significantly smaller number of jurisdictions than either of the other groups.

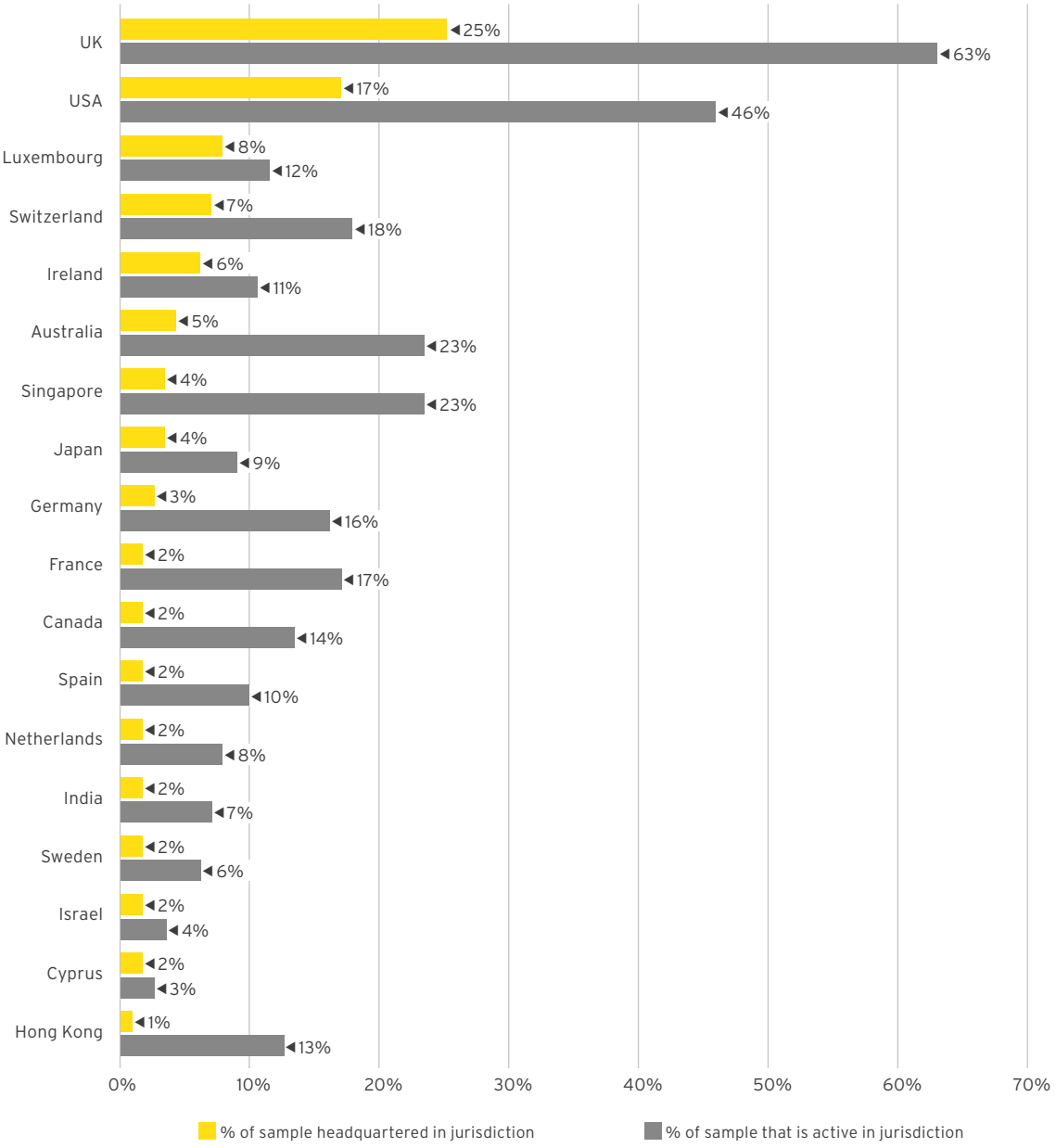
Some of the top RegTech markets are smaller jurisdictions but make up for this with strong sector specialisms and conducive regulation or government policy. Switzerland, for example, hosts multiple specialist financial services clusters, including, for instance, in private banking and wealth management, and is a hotspot for Initial Coin Offerings (ICO) and FinTechs utilising Distributed Ledger Technology (DLT). Luxembourg boasts a high concentration of asset managers, a regulatory sandbox and proactive partnerships with foreign regulators. Finally, Ireland hosts a large share of the world's largest internet firms, with a focus on knowledge-intensive headquarter operations, as well as a shared and outsourced services cluster.

Respondents were much less likely to be active in emerging markets. The United Arab Emirates stands out as a focus of activity in the Middle East, but no African or South Asian country was cited by more than 9% of the sample as a location in which they were active. About 14% of firms named regional or global aggregates instead of individual jurisdictions, likely implying that they did not see physical distance as presenting a significant impediment to the sales and implementation of their products.

Given the dominance of financial services use cases within RegTech, firms can be expected to gravitate to financial centres; and some over-concentration in continental Europe is to be expected given the unprecedented volume of financial regulation produced by EU institutions in the period between 2014 and 2018, which has presented a rare opportunity for vendors to raise awareness in this sector. There is also some evidence, discussed in detail in Chapter 5, that geography interacts with firms' product offering in subtle ways – for example, by making it harder for vendors to deploy Natural Language Processing (NLP) in non-English speaking countries.

Comparing the survey sample to the total target population, it is likely that firms headquartered in the United States are under-represented, whereas jurisdictions in Asia-Pacific and continental Europe are relatively over-represented. This bias could reflect the weight of the professional networks of CCAF, EY Japan, the IRTA and the RegTech Association, which led the dissemination of the survey.

Figure 3.2: Top jurisdictions by share of respondent headquarters



4. RegTech industry sizing, market volume and investment raised

One key objective of the study was to establish benchmark figures on the market size of the RegTech industry. To determine this, the survey sought estimates for firms' headcount, turnover and total funding raised, then extrapolated from those to the unobserved population in order to develop industry and segment-level estimates. The findings are summarised in Table 4.1 below and organised by estimated headcount, revenues in 2018 and fundraised to date (up to early 2019 at the time of the survey). All estimates were derived by aggregating totals for three employment size-bands, as shown in Table 4.1.

Table 4.1: Volume of RegTech Activity: CCAF Estimates by Employment Size-Band

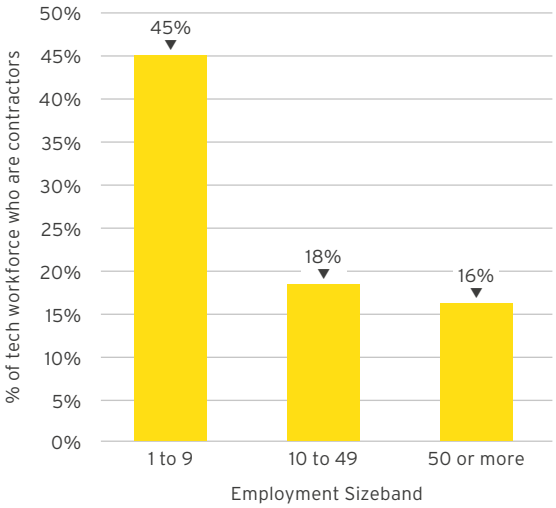
Number of employees	Estimated headcount	2018 Estimated revenues	Estimated funds raised to early 2019
1 to 9	1,000	$0.1bn	$0.3bn
10 to 49	7,000	$0.4bn	$1.8bn
50 or more	35,000	$4.4bn	$7.6bn
Total	44,000	$4.9bn	$9.7bn

Source: CCAF Global RegTech Survey, RegTech Analyst population estimates and CCAF calculations. Industry-level estimates are based on extrapolations. Estimated turnover and fundraising estimates are rounded to the nearest 100 million. Estimated headcount estimates are rounded to the nearest thousand.

It should be noted that these estimates were derived from a combination of survey responses and publicly available data, and that even the directly observed data were not always straightforward US dollar figures. As turnover and funding figures were likely to be commercially sensitive, respondents were offered the option to not provide a turnover estimate, and were invited to provide broad funding estimates by selecting from one of eight size-bands. The rest of this section discusses in more detail how these responses were used to derive industry-level estimates.

Headcount estimates and selected demographics

Figure 4.2: Contractors as a share of the RegTech workforce, by employment size band



Most survey respondents were willing to report their total headcount: self-reported figures from 102 firms suggest a total of 13,482 persons employed. Compared to the general business population,[16] RegTech firms thus tend to start life with a reasonably large headcount, most likely in order to quickly build credibility with prospective clients and funders. Almost 70% of the sector have 10 or more employees, and the median firm under three years of age already has 13 employees.

To extrapolate from individual responses to a total industry figure, the sample was split into three headcount size-bands: 0 to 9, 10 to 49 and 50 or more. For each size band, the total observed headcount was combined with an estimate for the firms that were not included in the survey sample (the unobserved population). This was based on size-band medians and grossed up to a total population of 824. This suggests an industry-wide workforce of just under 44,000. Within the survey sample, a third of the workforce were women, and about a third of those in turn occupied technical or technology roles. This implies a workforce that is demographically skewed, but possibly no more so than the FinTech sector in general.[17]

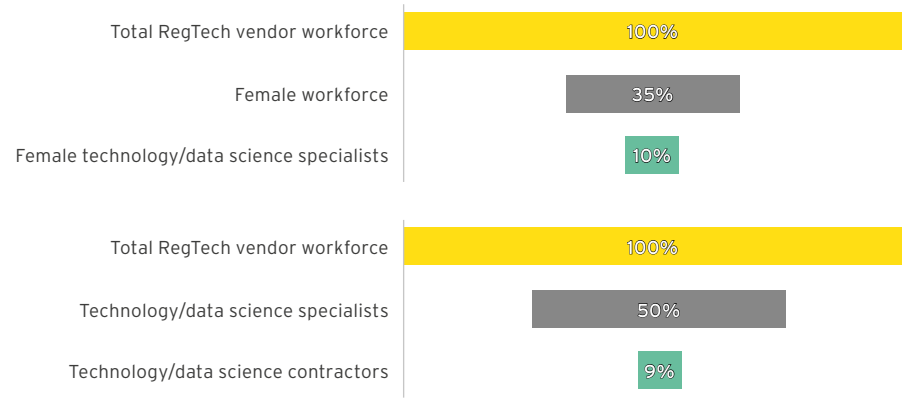
Although there is no clear pattern to female representation in the industry,[18] there are statistically significant patterns in the use of permanent employees versus contractors. About one half of the workforce of sample firms were technology experts, and about a quarter of those in turn were contractors working alongside the core team. This flexible technical workforce is particularly important to smaller firms (e.g. those with fewer than 10 employees or those who have raised less than $500k), which tend to have twice as many contractors as a proportion of their technical workforce as the industry as a whole (see Figure 4.2). The flexibility provided by non-permanent employees may be particularly valuable to younger firms whose funding is limited.

16 See e.g., https://www.oecd-ilibrary.org/docserver/entrepreneur_aag-2012-10-en.pdf?expires=1559176770&id=id&accname=guest&checksum=9C03CE81A5C20CFAB3BC8B9663962953

17 The UK FinTech workforce, for example, is 29% female https://www.ey.com/Publication/vwLUAssets/EY-UK-FinTech-Census-2017/$FILE/EY-UK-FinTech-Census-2017.pdf

18 The Annex demonstrates how the technologies used by RegTech vendors and the functional focus of their solutions can be described in terms of a small number of factors (number A1 through A6 for technologies and B1 through B9 for functional areas. There is a reasonably strong correlation between factor B5 (Client engagement) and women's share of the technical workforce. There is also a weak correlation between women's share of the technical workforce and factor A1 (Artificial or augmented intelligence). However, the relevant cross-sections of the sample are very small, and there isn't an equally strong relationship between female representation and most of the individual survey questions associated with factors A1 and B5.

Figure 4.3: Alternative breakdowns of the RegTech workforce: female representation and technical capacity (extrapolation of sample estimates to the total workforce)



Revenue estimates

Turnover totals provided by respondents were combined with approximations from Owler.com to produce turnover estimates for 60 vendors.[19] About 40% of those had turnover below $1m, and only about a quarter had turnover above $10m each, meaning that a handful of the largest firms accounted for the bulk of the sector's revenues. For the rest of the vendors surveyed, turnover was estimated based on headcount and the medium turnover/employee ratio of their respective size bands. Total turnover for the sector was thus estimated at ca $4.9bn. This is in line with some industry estimates,[20] although other estimates are significantly more conservative.[21] These industry estimates project year-on-year growth of 23% to 25% between 2018 and 2023, which is certainly plausible. On average, the 27 respondents that provided turnover figures for both 2017/8 and 2016/7 saw high double-digit turnover growth in 2017/8, with smaller firms growing faster than larger ones.

Fundraising estimates

Self-reported estimates[22] of funds raised to date were combined with estimates from Crunchbase.com to produce more accurate estimates of the amount raised by 87 respondents. About half of those had raised less than $1.6m, while about one in nine had raised more than $15m. Thus, the majority of funds raised is driven by a relatively small number of outliers. For the rest of the population, estimates were prepared based on the average[23] amount of funds raised by firms in the same employment size-band. The total sector

19 Owler estimates are crowdsourced, with manual validation of newly-submitted estimates. Due to the way in which estimates are sourced, a self-reported figure from survey respondents would always override the Owler estimate. A further discussion of Owler's approach to crowdsourcing can be found at https://blog.owler.com/owler-frequently-asked-questions-faq/owler-faq-basics/ Accessed 1 May 2019

20 https://www.researchandmarkets.com/research/r8ktnm/global_12_3?w=5 Accessed 1 May 2019

21 See for example http://www.arcognizance.com/report/global-regulatory-technology-RegTech-market-drivers-restraints-opportunities-trends-and-forecast-up-to-2023

22 Respondents were prompted to select from 8 ranges, from "Less than $100,000" to "More than $50m". The mid-point of the range selected by a respondent was provisionally recorded as the best estimate of funding to date.

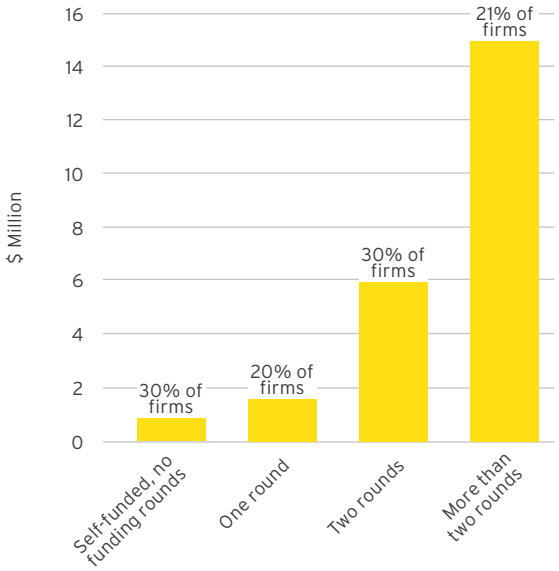
23 The reason for using averages in the fundraising estimates as opposed to medians used elsewhere is because outliers are likely to represent a much higher share of total fundraising than, e.g. employment.

was consequently estimated to have raised $9.7bn. This is higher than some industry estimates, e.g. RegTech Analyst (2018)[24] but in line with others, e.g. FinTech Global (2019).[25] Such estimates imply that funding activity has grown steadily in the years leading up to 2017, and was particularly strongly in 2018. The amount of funding raised by firms helps put the revenue estimate discussed above into context and vice versa: taken together they could imply that much of the sector's funding to date has gone into market entry and pre-revenue product development, including by vendors who subsequently left the sector or changed their business models.

Performance benchmarks

With most vendors still at relatively early stages in their development, funding rounds provide important markers for performance benchmarking purposes.

Figure 4.4: Average amounts raised by firms, by number of self-reported funding rounds



Note: Percentages do not add up to 100% due to rounding

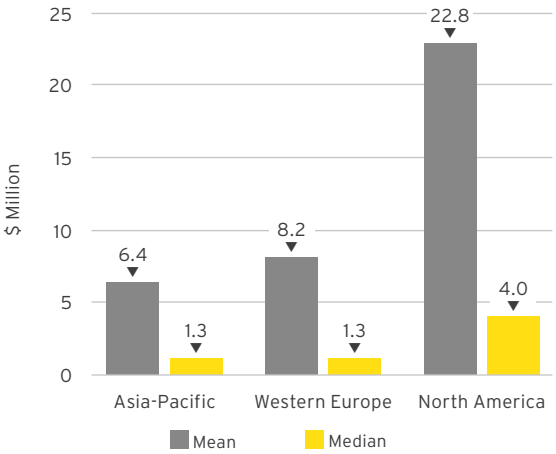
The average amount raised by firms in a single, first funding round was around $1.5m, while the average firm with two rounds of fundraising had raised ca. $6m. Those that had gone through even more funding rounds had raised around $14.9m on average (Figure 4.4). As the survey did not track fundraising round by round, it is not technically correct to extract increments from these figures– e.g. to say that the average second funding round is $4.5m - however the implied increments are likely to be of the right order of magnitude.

24 https://theFinTechtimes.com/total-RegTech-funding-has-already-surpassed-2-5bn-this-year/
25 https://FinTech.global/more-than-9-5bn-has-been-invested-in-RegTech-companies-globally-over-the-last-five-years/

These estimates disguise significant variation among firms: for example, about a third of all vendors have raised $500,000 or less, while about 5% have raised more than $50m. More surprisingly, more than a quarter of all firms had received no formal external funding (other than funds from directors or cross-subsidies from a sister company for instance). On average, such firms raised less than a tenth as much as the rest of the firms in the sample did – ca $800,000 against $12.5m for externally funded firms – and significantly less than the typical firm did after a single funding round. Even these modest totals might be inflated by the presence of firms benefiting from intra-group subsidies.

Further variation can be observed on a regional basis, with North American vendors typically having raised more funds than their counterparts in Western Europe or Asia-Pacific (see Figure 4.5).

Figure 4.5: Amounts raised by headquarter region



Note: Estimates are based on sample observations only and do not included extrapolated estimates

Table 4.6 expands on the analysis above to provide indicative benchmarks for age, turnover and headcount at different stages in vendor development. These must be treated carefully given the significant variation around the average in each case.

Table 4.6: Performance benchmarks by funding round

Funding Rounds - three brackets	Months since founding	Months since first product launch	Best estimate of funds raised	Best estimate of 2018 turnover	Total estimated headcount
One round	28	16	1,500,000	1,400,000	13
Two rounds	46	25	5,900,000	2,400,000	29
More than two rounds	71	57	14,900,000	9,000,000	59

Note: All estimates are cross-section averages and do not include imputed turnover estimates. Age and estimated headcount estimates are rounded to the nearest integer. Estimates of funds raised and estimated turnover are rounded to the nearest hundred thousand.

A maturing sector driven by organic growth

To help put estimates of sector activity and growth in context, respondents were asked to share key milestones such as when their firms were founded, launched their first product, or first received external funding. All such measures of market entry peaked between 2014 and 2017, suggesting a maturing sector in which growth is driven by organic growth rather than market entry.

In part, this may be related to the EU/EEA bias in the survey sample. These dates coincide, for example, with the publication and the implementation respectively of the Revised Markets in Financial Instruments Directive (MiFID II) and the Markets in Financial Instruments Regulation (MIFIR). The period in between also saw a large amount of regulatory output from the European institutions and the European Supervisory Authorities (ESAs), including the General Data Protection Regulation (GDPR), the revised Payment Services Directive (PSD2), and the Securities Financing Transaction Regulation (SFTR). Major regulatory initiatives would be expected to increase the demand for RegTech solutions, encourage market entry and improve funding conditions. In interviews, industry experts emphasised the importance of auditability requirements. Readily auditable controls necessitate dynamic, time-stamped data with guaranteed integrity.

It is very likely that the method by which firms were selected into the target population for the survey has skewed the sample away from recently launched or recently funded firms. Even allowing for this, the combination of robust sector-level growth and what appears to be a peak in market entry in 2017 suggests that growth in the sector is now primarily driven by organic growth of established firms, as opposed to market entry.

5. RegTech – User perspectives

Who are the users of RegTech solutions?

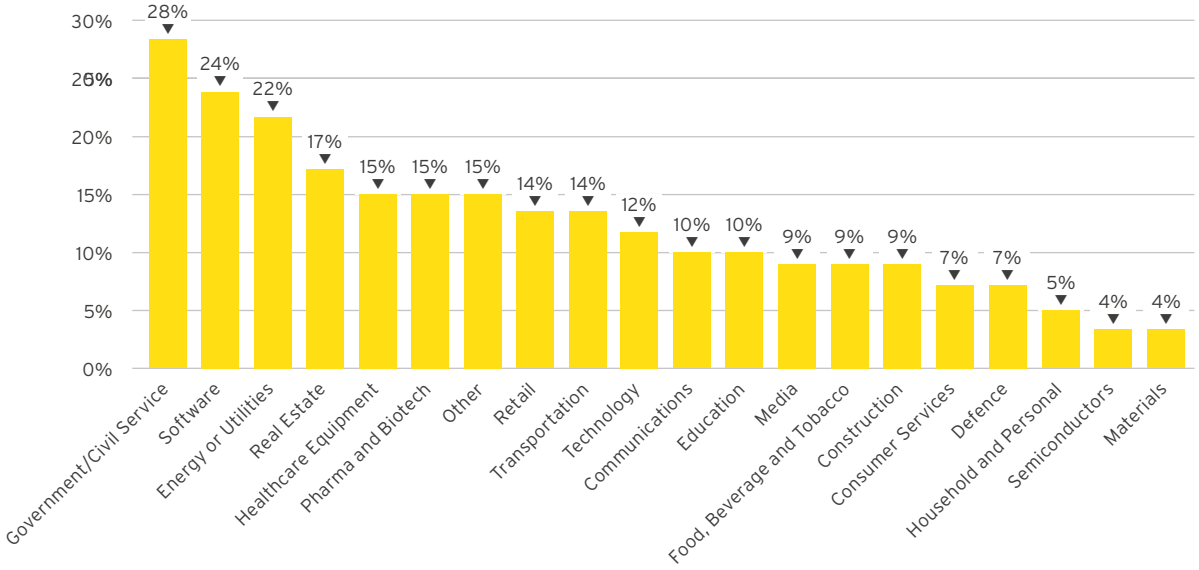
Almost all the vendors surveyed (89% to 94% of firms, depending on cohort) targeted banks as potential clients. Thus, banks were the most commonly cited clients by a significant margin. Insurers (cited as prospective clients by 61% of vendors) and FinTechs (cited by 57% of vendors) were a second and third respectively.[26]

However, more than half of the firms in the survey sample (58%) considered themselves to have clients outside of both the financial services sector and also advisory, consultancy, legal and regulatory industries (including regulators). This percentage is even higher among younger vendors (about two thirds), suggesting an increasing focus on non-financial clients. Core non-financial clients were to be found in the software industry, which was targeted by almost a quarter of the sample, in real estate, and in highly regulated sectors such as energy/utilities, pharma and health equipment (see Figure 5.1). About two thirds of the survey sample (66%) also reported targeting at least some public sector users with their offering.

Non-financial sectors are undoubtedly under pressure from consumers and regulators to adopt higher standards, but this potential has yet to translate into the volumes of demand for RegTech products seen in the financial industry. One interviewee, a vendor specialising in privacy and data protection, noted a significant gap between consumer expectations and regulatory reality in the advertising sector. Consumers, they explained, are very sensitive to the misuse of their personal data.[27] However, regulators are not yet conducting routine audits and relatively few RegTechs have entered this space.

26 Respondents could select multiple industries, and thus the sum of percentages across sectors greatly exceeds 100%.
27 https://www.bcg.com/en-gb/publications/2016/big-data-technology-digital-bridging-trust-gap-data-misuse.aspx

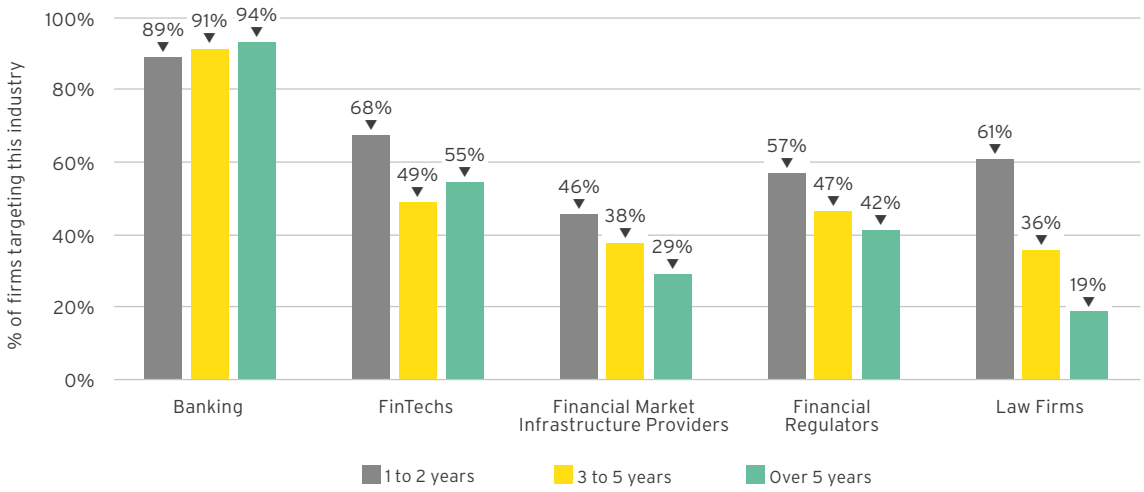
Figure 5.1: RegTech vendors' target non-financial industries, ranked



Overall, these findings call into question those definitions of RegTech which describe the sector as a FinTech vertical, even though it is clear that financial services use cases dominate the sector. Moreover, it is likely that the sector focus of RegTech vendors is shifting over time; about one in six (15%) vendors reported having carried out a 'complete overhaul' of their target users, switching to entirely new use cases over the last five years. Although the emphasis on selling to banks remains the same, younger RegTech firms appear more likely than their more mature counterparts to be targeting regulators, law firms and financial market infrastructure providers such as clearing houses, exchanges and benchmark administrators (Figure 5.2).[28] The survey did not seek to establish the actual level of penetration among these user groups; however, there is good reason to believe that the range of sectors targeted is much wider than that of sectors served. For example, nearly half (46%) of all vendors claimed to have some kind of offering for regulators, although only 20% claimed to have an offering specifically aimed at supervisory use cases (see Figure 5.4 for a full list of the use cases that respondents were prompted with).

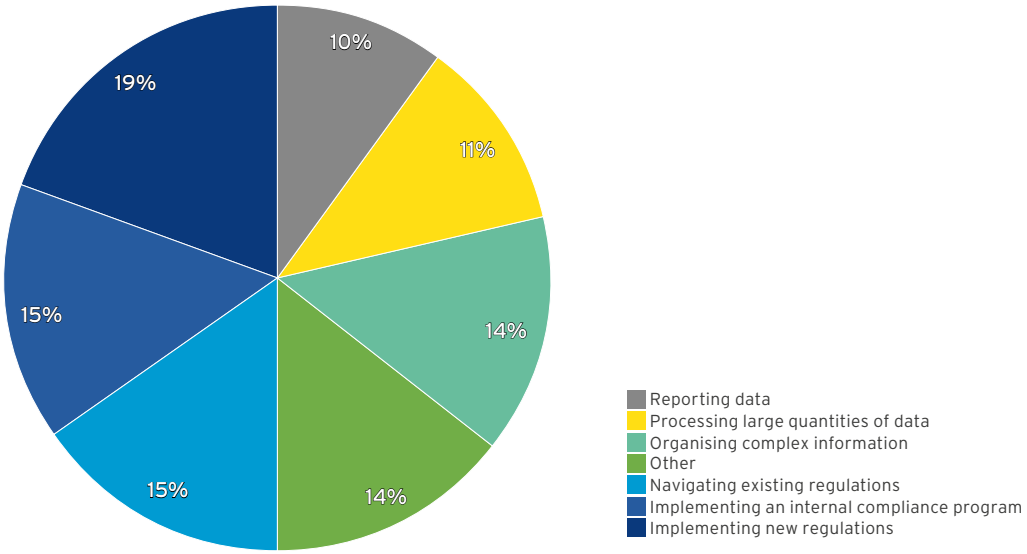
28 Demand from this sector dates back to the 2012 Principles for Financial Market Infrastructures (PFMI). Published by the Committee on Payments and Market Infrastructures (CPMI) and the International Organisation of Securities Commissions (IOSCO) at the request of the G20, The Principles set out standards for payment, clearing and settlement systems, including central counterparties, and have since cascaded into national law and regulation.

Figure 5.2: A selection of target industries reported by RegTech firms, by age cohort



Looking at the users in more detail, qualitative interviews with vendors suggest that project ownership typically sits with a risk, governance or compliance team, or - in the case of technology and data-heavy projects - with a Chief Data Officer (CDO) or Chief Technology Officer (CTO). When responding to the survey, vendors reported a variety of user motivations (see Figure 5.3), with the most commonly cited ones revolving around the management of regulatory change, namely implementing new regulations and new compliance programmes. While the distribution of reported user motivations appears to be even across the total sample, there are clear areas of specialisation, discussed in depth in Chapter 7.

Figure 5.3: Primary RegTech buyer motivations, as reported by firms



Target use cases

Most RegTech firms cater at least in part for reporting use cases or providing dashboards to support decision-making (see Figure 5.4). Much rarer are offerings focused on dynamic compliance or machine-executable regulation: just over a quarter of vendors offer solutions to automate compliance audits and fewer than one in five can support the automated testing of internal controls. About one in six vendors claim to provide solutions supporting end-to-end, machine-executable regulation, which is higher than expected given the complexity and difficulty of such offerings. The distribution of use cases likely reflects the evolution of regulatory requirements: reporting is a reliable constant whereas dynamic compliance tools and end-to-end execution of regulatory requirements are not mandated, nor do regulators provide detailed guidance on their application. Looking particularly at those vendors with non-financial clients, their target use cases appear very similar to those of vendors focusing exclusively on the financial sector; a greater emphasis on customer engagement and analysis being the notable exception.

In terms of the regulatory themes on which vendors are concentrating, it is clear that most firms feel the need to demonstrate some application to financial crime, AML and customer due diligence – more than half for each use case, and just over 60% on aggregate (Figure 5.5). The high stakes and data-heavy nature of these areas have historically made them the leading drivers of RegTech adoption. Much less common are offerings aimed at non-financial regulation, such as competition or labour law. Comparing vendors with non-financial clients against those focused exclusively on financial services, it is clear that the former are more likely to have an offering focused on privacy and data protection or fraud detection, while AML and customer due diligence offerings also appear to be in reasonably strong demand among non-financial sectors.

Figure 5.4: Target uses of RegTech solutions, as reported by firms

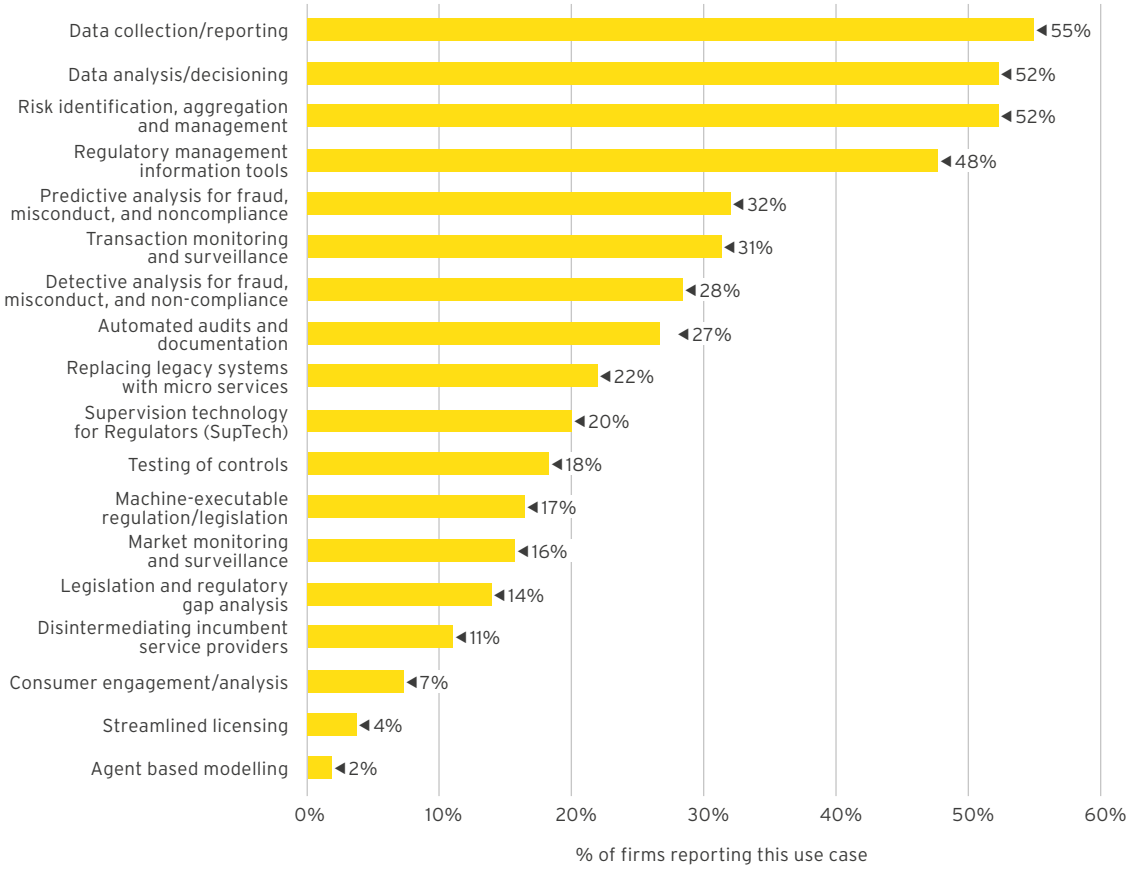
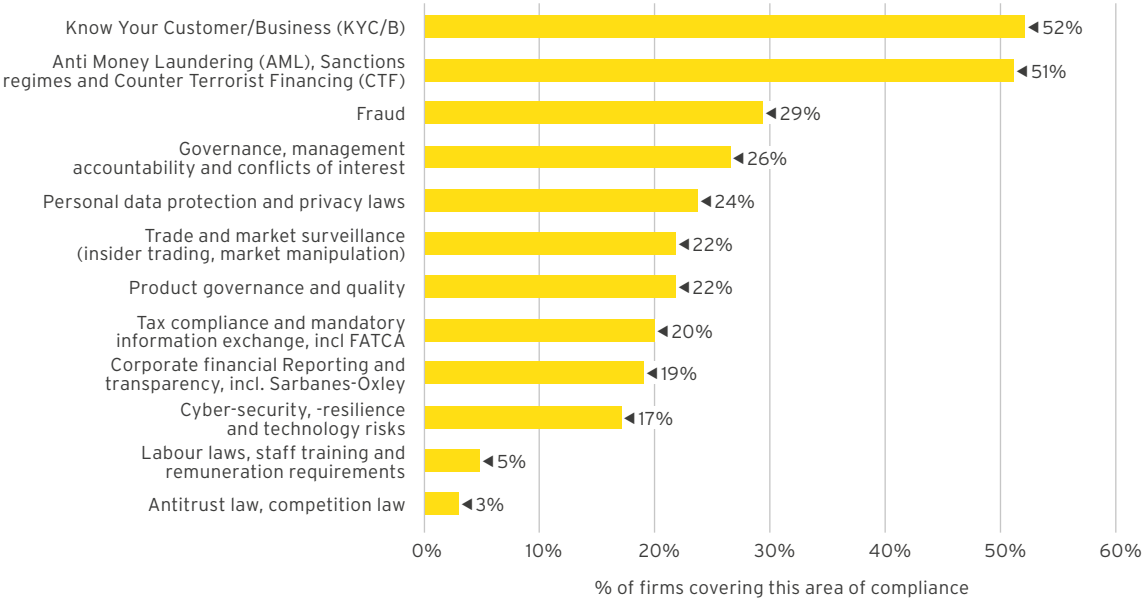


Figure 5.5: Regulatory areas served by RegTech vendors' offerings



Buyer Personas: In-depth lessons from two North American Banks[29]

Bringing it all together: Bank A's quest for operational risk transparency

As Global Head of Operational Risk at Bank A, 'CP' owns about 2,000 distinct controls,[30] and she knows of firms who claim to have 50,000. Yet even with her more focused dashboard, operational risk management is often like looking for needles in a haystack; without intelligent aggregation it is simply impossible.

There had been previous attempts to connect the bank's disparate risk management and compliance platforms. But by 2016 it was clear that a single platform would provide much clearer oversight and access to the many risks to that were documented across multiple business functions and geographies. Having such information in one place would allow users to risk-rate and prioritise items consistently, rather than forcing them to navigate the various risk functions' individual glossaries and priorities.

Operational Risk took on the challenge by onboarding a Governance, Risk and Compliance (GRC) application and its vendor. They initially applied their solution to a small, highly focused group of use cases. In particular, the bank has focused on automating the auditing of operational risk controls, linking controls to regulations in order to identify the impact of control failures, and aggregating risks.

Over time, the scope of the project has grown – now all regulations the bank is subject to have been onboarded. Yet despite increasing automation of the system, matching regulations to controls is still a largely manual process. The bank has plans to use AI in order to automate matching and quality control, but this requires patient planning and influencing. The resources required are an order of magnitude higher than the seven-digit sum the original GRC implementation cost.

Coming late to the RegTech party, CP feels, meant the bank could learn from others' mistakes; RegTech implementations elsewhere had run into co-ordination problems due to the need for multiple departments to co-sponsor. Unlike Operational Risk teams in other banks, CP's team alone owns the implementation of the GRC solution, with other stakeholders funding their share of the costs if they want to join the core user group. While the status quo is relatively straightforward today, it took a period of very extensive internal stakeholder consultation, lobbying and negotiation to set it up. CP remembers it as a very painful exercise with many stakeholders bringing their own needs and preferences into the project. Nevertheless, all of them recognized that a single platform will enable aggregation of risk and provide a complete operational risk profile for the bank. The local regulators were also interested in understanding how the bank deploys its GRC application and what information they could get from the bank's GRC system.

29 The interviewees are anonymised as 'CP' and 'AF' respectively.
30 In this context a 'control' refers to any individual action, test or calculation that cascades from a compliance policy, contributes to compliance with a specific standard or rule, and can be owned by an individual.

The bank is still exploring the possibilities. In an ideal world, it would combine both internal and external data. However it is nowhere near to getting value out of all its internal data as it is; last year, a project looking for patterns in seven years' worth of transactions data meant the bank's data scientists churning through two billion data points. "Every week I meet someone who claims they can anticipate conduct issues", says CP. The bank remains sceptical, but not sceptical enough to put it off developing an in-house solution sometime in the future.

Small is beautiful: Onboarding a regulatory change solution at Bank B

It took seven years for Bank B to go from concerns about regulatory risk to implementing a regulatory change management platform. "AF," Vice President at the Capital Markets division of the bank, traces this process back to 2011, when a growing awareness of regulatory risk began to percolate through the organisation. Slowly, demand was building up for risk levels to be made explicit, and for a house view of regulatory change and how it would affect firms. "The questions started to be asked at exec level, then in exec committee and risk committee discussions."

The bank had been some way down this road before. Previously, task forces set up in response to Dodd-Frank had found that there were competitive advantages to being proactively compliant with the regulations. By 2011, senior management were working to articulate a 'competition strategy' in relation to regulatory change, in the conviction that to manage regulatory change faster and better than peers was a source of competitive advantage.

By 2013, a Regulatory Transformation Group had been created within the bank's Capital Markets business and the bank had set itself a target to build a centre for regulatory excellence over a 2-3 year time frame. Over the course of the next few years, processes and policies were established, as were a competency framework and the rules of engagement with first-line and second-line compliance staff.

Five years after the original trigger, in 2016, senior buy-in was strong and the firm was finally ready to invite bids, with colleagues scouring industry events for appropriate solutions. By then, regulatory change management costs were ballooning, and the need to improve on internal KPIs was growing. But no less important was the pressure to ensure continuity in compliance. This meant handling the transition from ad-hoc compliance project teams to staff carrying out business-as-usual compliance work better and ensuring project staff can be released to be available elsewhere.

The bank's original use case focused on triaging incoming regulations and on current state assessment. The bank was hoping to use technology to help clearly determine which regulations were applicable to the firm, what changes to internal policies and controls might be needed to comply, and what impact those would have. First five, then three vendors were shortlisted and taken through two Proofs of Concept (POC) aligned to this use case.

An internal scorecard was developed to evaluate the offering of a few key providers and the associated costs. Products were assessed against a "cost structure x flexibility of implementation" grid, with the bank keen to establish not just out of the box functionality but the ability to customise. This is because the project was a first for the bank and indeed much of the wider banking industry – it was meant to integrate a RegTech solution into business-as-usual as opposed to an ad-hoc project.

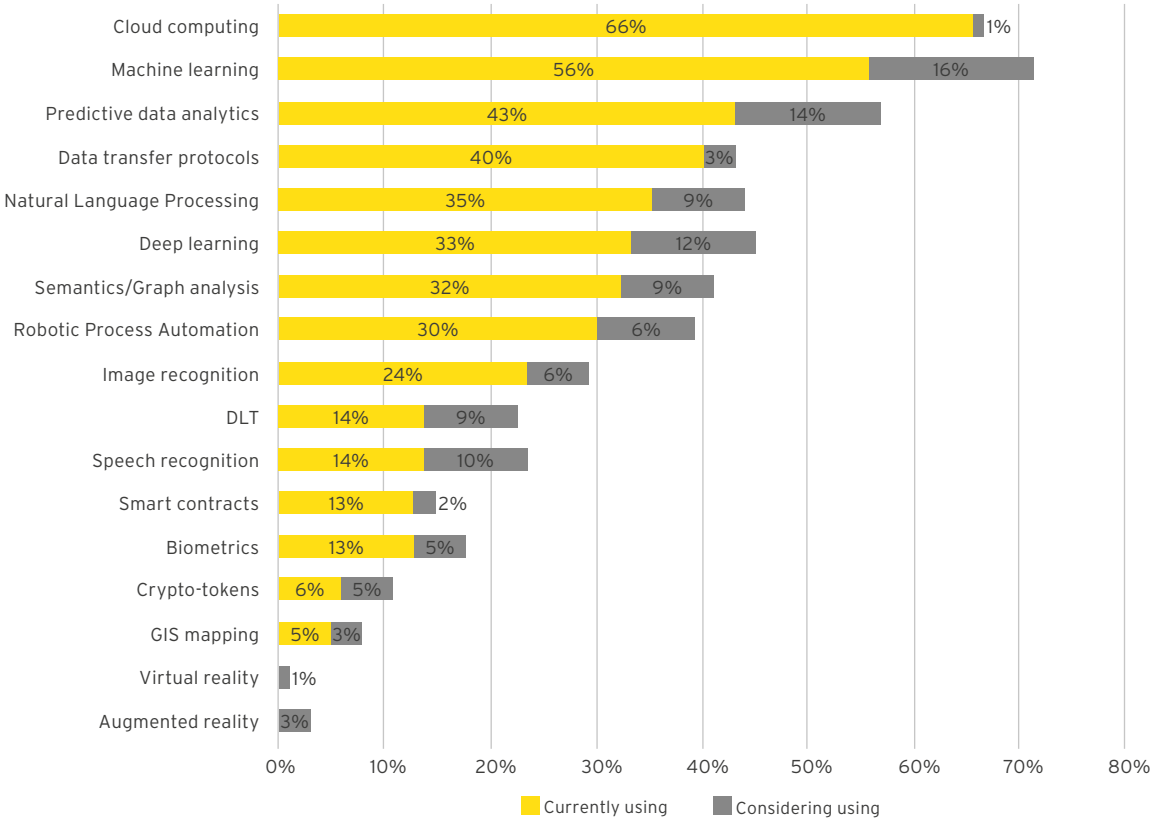
All suppliers offered elements of what the bank was after, but it was understood and expected that none would tick all the boxes. When a supplier was finally chosen, it was therefore a relatively small and young firm that had shown a greater willingness to adapt their product, backed by a strong commitment from its senior management to partner with the bank in the development of their future roadmap. The vendor's size and level of maturity were not liabilities- Bank B saw them as a partner who could be flexible, was committed to building around the bank's needs and who could make changes quickly if their system didn't work well. Since onboarding the vendor in 2018, much of the bank's work has focused on customisation: learning from the experiences of early users and working with the vendor to ensure the bank's needs are reflected in their product roadmap going forward.

6. The RegTech Value Proposition

Technologies employed

Survey findings confirm the cloud, machine learning, NLP, data analytics and data transfer protocols as the primary tools and technologies involved in RegTech solutions (Figure 6.1). Delivery over the cloud is particularly common across the sector, with over two thirds of the sample offering Software-as-a-service (SaaS) solutions of some kind. Less commonly used are biometrics in the broadest sense (including voice and image recognition), while adoption of DLT and spatial mapping are still at the earliest stages in this sector.

Figure 6.1: Technologies and tools reportedly used by RegTech firms

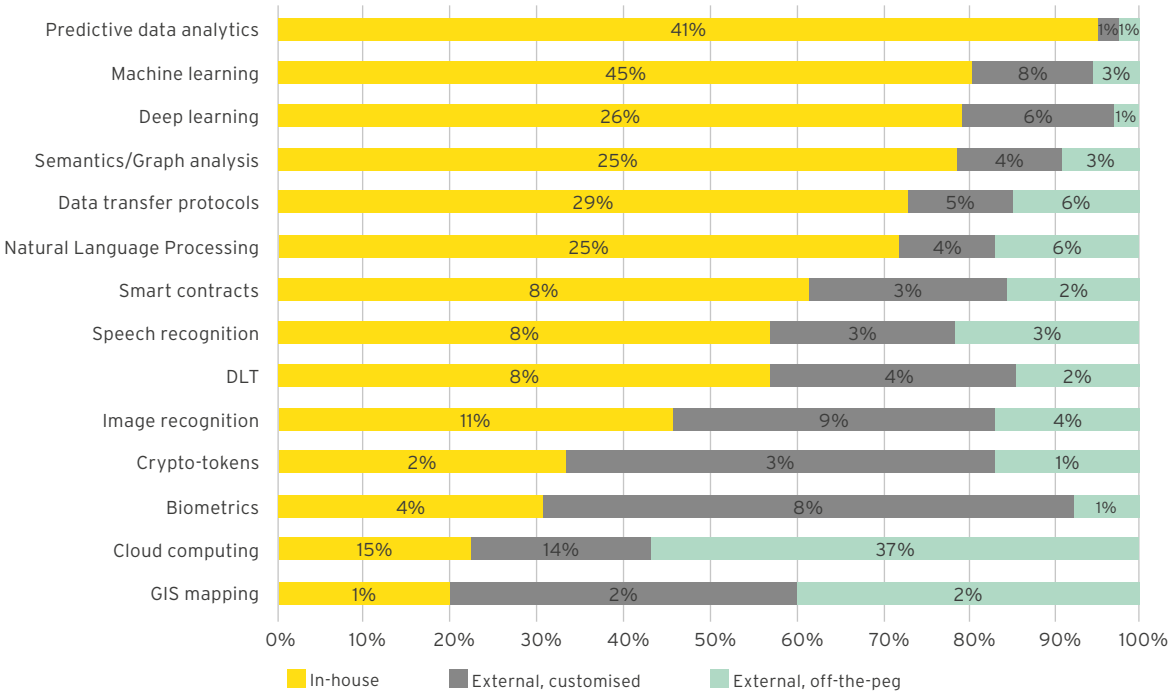


Many of the technologies used by RegTech vendors are in fact outsourced. Biometrics, location mapping and image recognition are particularly likely to be outsourced (see Figure 6.2). At the other end of the spectrum, data analytics, data transfer protocols and graph analysis applications are almost always developed in-house, with predictive models tending to be closely guarded core resources.

In relation to outsourced technologies, respondents were asked to distinguish between inputs that were applied by their business without any adaptation or

customisation, and those which they worked closely with vendors to customise for their business needs. The survey data thus points to the existence of a few types of infrastructure and platform providers within the RegTech ecosystem whose offering is generally accepted as-is, particularly cloud hosting providers and location data providers.[31] These are distinct from the other major group of third party suppliers, particularly of biometrics and DLT solutions, who develop tailored versions of their offering to fit individual RegTechs.

Figure 6.2: Technologies used by RegTech vendors: Degree and nature of outsourcing



The shape of things to come?

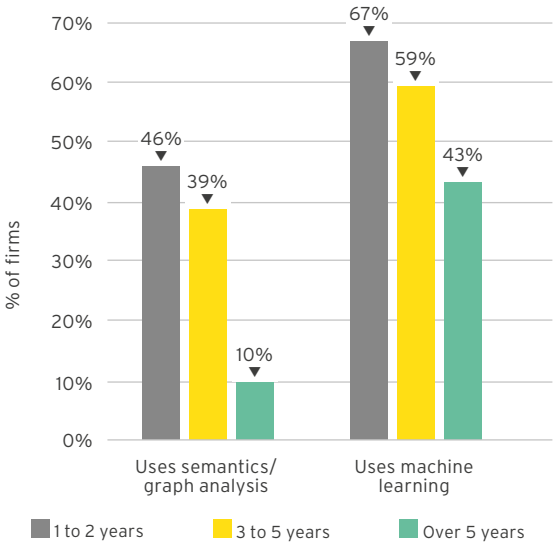
Looking to the future, uses of machine learning and data analytics are likely to become more prominent, according to vendors' reports of expected usage (see Figure 6.1). If the rate of adoption is measured as a proportion of current levels of uptake (again based on Figure 6.1) rather than in absolute terms, it is voice recognition, DLT, crypto-tokens and Geographic Information System (GIS) mapping that are likely to make the biggest gains, the latter three starting from a low base in 2019.

A complementary way of exploring trends in technology usage, however, is to examine how patterns of current use differ according to a firm's birth cohort – i.e. whether younger firms offer substantially different solutions than older ones. This approach corroborates the finding, discussed earlier in this

31 The latter including both providers of e.g., GPS location mapping and owners of taxonomies and frameworks through which location data might be allocated to specific areas.

Chapter, that use of machine learning is growing; but also points to a possible increase in the use of graph analysis (Figure 6.3). The same analysis suggests that younger vendors are more likely to partner with third parties in order to develop machine learning capabilities rather than do this in house or outsource machine learning completely.

Figure 6.3: Technologies seeing increasing use, by RegTech firms' birth cohort

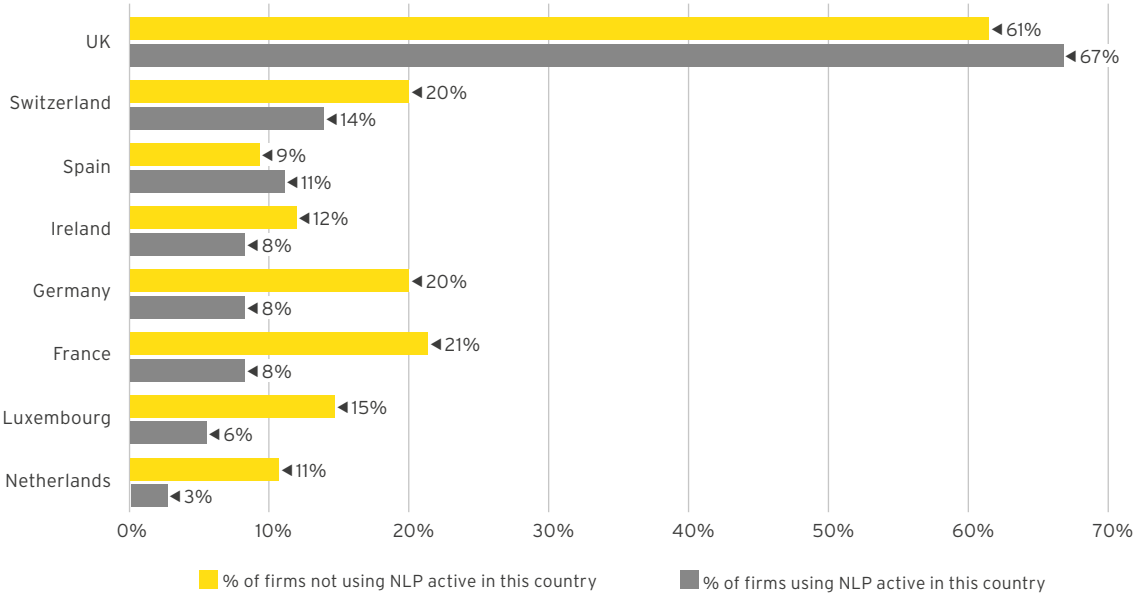


The same approach can be applied, with caveats, to RegTech use cases. Survey responses suggest that younger firms are more likely to focus on use cases related to product governance than more established ones, while fraud and tax compliance, and solutions aimed at dynamic compliance (e.g. gap analysis or automated controls testing) tend to be the preserve of more mature firms. Interpreting such findings is more complicated because what appear to be cohort effects are often driven by other factors which correlate with the age of the firm – for example, the availability of funding or a firm's track record or reputation.

Not all technologies can be deployed as readily across all markets. Firms utilising NLP as part of their offering might be more likely to enter markets successfully where the language of business (and regulation) is English – if this gives them easier access to training data and applicable language models. Survey responses lend partial support to this. As Figure 6.4 demonstrates, firms relying on NLP do not appear to have made as much headway in non-English speaking countries in the European Economic Area (EEA), despite a substantially harmonised regulatory framework for financial services.

Vendors addressing the needs of non-financial industries were likely to employ a much wider range of technologies than those that only catered to the financial sector. Image recognition and, to a lesser extent, deep learning stood out as particularly adaptable to the offering of such vendors, suggesting that they might be highly adaptable to the use cases of non-financial sectors.

Figure 6.4: Geographic distribution of activity in EEA countries, among users and non-users of NLP



7. Understanding RegTech market segments

From technologies and use cases to market segments

The RegTech sector has been studied at length in industry publications, and numerous segmentations have been proposed, drawing on the expertise of market participants. Figure 7.1 provides a quick summary of some of the most commonly cited segmentations.

Figure 7.1: Commonly cited segmentations of RegTech vendors and offerings

Source	Segments
Alvarez & Marsal 2018[32]	Regulatory compliance; Risk management; Financial crime; Identity management
ARCognizance (2018)[33]	Risk Management; Identity Management & Control; Regulatory Reporting; Transaction Monitoring
Bafin (2018)[34]	Compliance Management; Risk Management; Customer Verification; Fraud Detection
CB Insights (2017)[35]	AML/KYC; Blockchain/Bitcoin; Enterprise Risk Management; Operations Risk Management; Portfolio Risk Management; Quantitative analysis; Reporting; Tax Management; Trade Reporting
EY and Medici (2018)[36]	Regulatory Reporting; Transaction Monitoring; Risk Management; Compliance; Identity Management & Control
FINRA (2018)[37]	Surveillance and Monitoring; Customer Identification and Anti-money Laundering Compliance; Regulatory Intelligence; Reporting and Risk Management; Investor Risk Assessment
RegTech Analyst (2019)[38]	Compliance Management; Onboarding Verification; Reporting; Transaction Monitoring; Communications Monitoring; Risk Management; Cybersecurity/ Information Security; Capital Planning/Stress Testing
RegTech Associates (2019)[39]	Cyber/Data Privacy/Identity; Regulatory Data and Information Management; Financial Crime; Regulatory Change; Regulatory Risk Analytics; Market Integrity & Transparency; Regulatory Reporting; General Compliance; Other
Swisscom (2019)[40]	Authentication; AML/KYC; Background Check; Crossborder & Tax Solutions; Enterprise Risk Management/Fraud Detection; Investment Risk Management/ Quantitative Analytics; Regulatory Mapping
Toronto Centre (2017)[41]	Compliance; Identity Management & Control; Risk Management; Regulatory Reporting; Transaction Monitoring; Trading

32 https://www.alvarezandmarsal.com/sites/default/files/regtech_2.0_report_final.pdf
33 https://amarketresearchgazette.com/regulatory-technology-regtech-market-2019-global-industry-analysis-by-key-players-segmentation-application-demand-and-forecast-by-2024/
34 https://amarketresearchgazette.com/regulatory-technology-regtech-market-2019-global-industry-analysis-by-key-players-segmentation-application-demand-and-forecast-by-2024/
35 https://www.cbinsights.com/research/regtech-regulation-compliance-market-map/
36 https://gomedici.com/uploads/RegTech-Top-21.pdf
37 https://www.finra.org/sites/default/files/2018_RegTech_Report.pdf
38 http://member.regtechanalyst.com/category/sector-updates/regtech/ (segmentation implied from the website sections)
39 https://www.rtdirectory.co/directory/browse/
40 https://www.swisscom.ch/en/business/enterprise/downloads/banking/swiss-regtech-start-up.html
41 https://res.torontocentre.org/guidedocs/FinTech%20RegTech%20and%20SupTech%20-%20What%20They%20Mean%20for%20Financial%20Supervision.pdf

The present study does not claim to supplant these. However, where industry segmentations are driven by the need to map offerings against commercial use cases, this study aims to develop a complementary, evidence-based taxonomy built from the bottom up and focused on the functional characteristics of vendors' solutions. In particular, the intention was to recognise the flexibility of the underlying technologies and thus build a taxonomy that is independent of the specific regulatory requirements addressed.

A two-stage approach was taken to producing a data-driven taxonomy of RegTech vendors and is detailed in the rest of this chapter.

Factor analysis

In the first stage, principal components analysis was used to summarise a large portion of the survey questionnaire into two sets of standardised factors. Six 'technology' factors, named A1 through A6, were distilled from the long-list of technologies detailed in Figure 6.1, while nine 'functional' factors, named B1 through B9, were derived from the lists of use cases and regulatory themes presented in Figures 5.3 and 5.4.

Tables A1.1 and A1.2 in the Annex demonstrate how the technology and functional factors were associated with the actual questions asked of respondents. Each observation was automatically assigned a score for each of the factors, based on firm responses.

Cluster analysis

For the purposes of this report, CCAF researchers developed a data-driven taxonomy of five RegTech market segments. The taxonomy is consistent with a functional definition of RegTech, but not an exhaustive one as described in Chapter 1. This means that the resulting segmentation is one of vendors or at best products; it is not an attempt to map other complementary elements of the RegTech ecosystem. Those are discussed separately in Chapter 9.

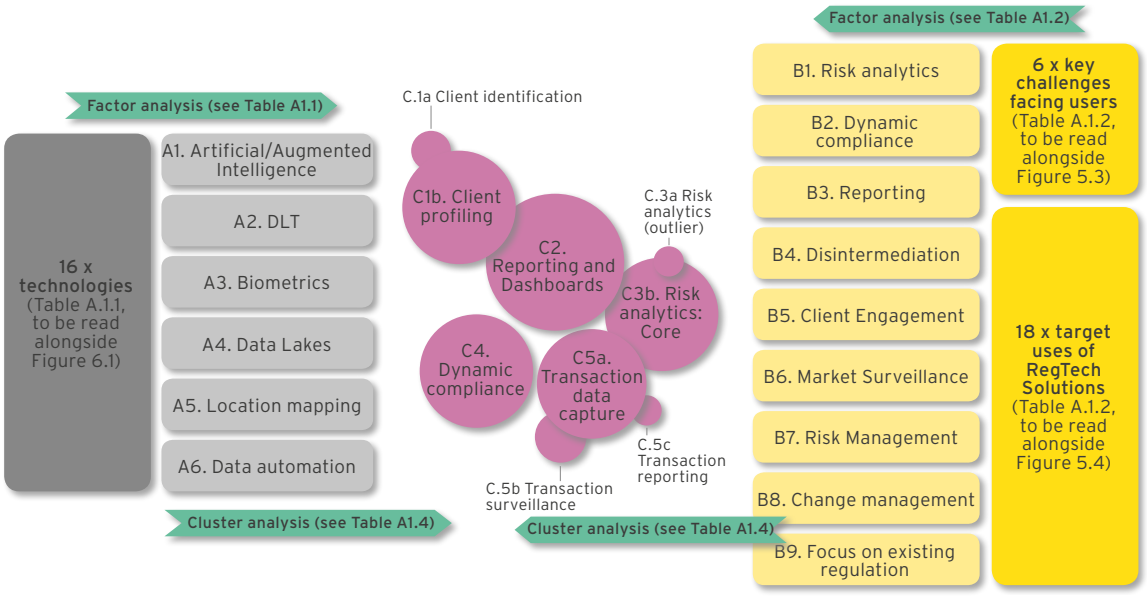
A subset of the fifteen functional and technology factors discussed above were selected for use in clustering. In particular, and given the relatively small sample size, A2 (DLT) and B9 (focus on existing regulation) were not used in order to avoid very niche groupings (e.g. 'Crypto ID validation') that would be impossible to analyse due to sample size. Various iterations of the clustering method were tested, until all 13 remaining factors were statistically significant in driving cluster membership. This process produced five major clusters (at least 10 observations each) and four satellite clusters, which were merged with the most relevant large cluster. Figure 7.2 describes the full process by which clusters were derived and provides references to the discussion of the input variables elsewhere in this report. Figure A1.4 in the Annex further explains how the clusters were interpreted, by showing the factors against which each cluster scored highly. Once interpreted in this way, the clusters are meaningful, and the resulting framework broadly validates existing taxonomies.

Cluster demographics

Due to the relatively small number of observations per cluster, it is not possible to analyse trends in market entry and product development by segment to the same level of detail as for the industry. Nevertheless, some general observations are possible.

There were significant levels of market entry across all segments between 2013 and 2016, with activity in the Profiling and Due Diligence and Risk Analytics segments picking up earlier than market entry in the rest of the industry. Product roll-out, on the other hand, has been fairly synchronised across almost all the market segments, with most activity clustered around 2016 to 2018.

Figure 7.2: RegTech market segmentation



See the Annex for details of factors' correspondence with actual questionnaire items.

Table 7.3: RegTech Market Segments

Segment	Explanation	Examples	Notes
C1. Profiling and Due Diligence (C1a + C1b)	RegTech solutions that collect and integrate data from multiple sources in order to build a profile of a person, entity or counterparty, confirm their identity, or categorise them according to regulatory requirements or internal rules.	Onfido, Jumio, Algoreg	This segment incorporates two sub-clusters, one focused on verification of client identity and another focused on counterparty profiling.
C2. Reporting and Dashboards	RegTech solutions that collect information from multiple sources within a firm in order to build standardised reports for management or compliance purposes.	BearingPoint, Kaizen Reporting, RegTek Solutions, Nadi Solutions	
C3. Risk Analytics (C3a + C3b)	RegTech solutions that use big data to assess the risk of fraud, market abuse or other misconduct at the transaction level.	Starling Trust, TookiTaki, ThoughtRiver	This cluster includes a smaller, niche grouping related to risk analytics, whose meaning could not be determined due to the small number of firms included in it.
C4. Dynamic Compliance	RegTech solutions that facilitate and monitor regulatory change or ensure that policies and controls adapt flexibly to changing requirements. Their offering includes management information on the compliance function, gap analysis and regulatory oversight tools.	Cube, MetricStream, Alyne, Clausematch	
C5. Market Monitoring (C5a + C5b + C5c)	RegTech solutions aimed at matching market-level outcomes to regulatory or internal rules, by sourcing data from diverse external sources. Key outcomes might include poor product performance, adverse market conditions or market manipulation.	Clarus, Scaled Risk	This segment incorporates three smaller clusters: one focused on data capture, another on transaction surveillance and another on aggregate reporting of transactions.

Segment sizing

Table 7.4 summarises the size and volume of activity of each market segment. As in Chapter 4, the figures cited here are estimates and the method of calculation is identical to that for the total market. Estimates were prepared by employment size-band and combined an observed element with an extrapolated element based on cross-section medians (in the case of turnover and headcount) or averages (in the case of funding). As with the total industry figures, an estimated turnover per employee ratio was used to derive expected turnover where observations were not available. All estimates were then normalised by calculating each segment x size-band cross-section's share of total activity (e.g. employment, fundraising or turnover) and then multiplying that by the original industry-level estimate.[42]

This exercise suggests that the bulk of investor funds flowing into the sector are attracted to Profiling and Due diligence (30%) and Dynamic Compliance applications (40%). Both sectors benefit from regulatory requirements around, e.g. AML or data protection, whose steep non-compliance costs have helped boost demand for compliance technology. However, the relatively low revenue per employee is consistent with firms largely still raising early funding rounds to expand their offering and capabilities. While this may seem counterintuitive

42 Because of the small cross-section base sizes and use of medians, segment-level estimates derived in this way do not add up to the industry-level estimates discussed earlier; the segments' combined fundraising estimates were about 12% below the industry-level estimate, and turnover estimates were about 20% above the industry-level estimate.

given the acute interest in this sector for AML purposes and the huge sums at stake for clients, these same factors have likely forced buyers to thoroughly test early offerings, with the vendors' early investors subsidising such trials. The bulk of the RegTech sector's revenue is instead driven by the Reporting and Dashboards segment, which, due to the highly standardised nature of reporting, has been able to scale dramatically to date with relatively little funding.

Table 7.4: RegTech market segments: estimated size and volume of activity

	Firms	Estimated turnover (2018)	Total amount raised	Estimated headcount
Profiling and Due Diligence	171	$494m	$2,967m	11,000
Reporting and Dashboards	210	$1,701m	$542m	7,000
Risk Analytics	169	$1,679m	$1,428m	12,000
Dynamic Compliance	145	$470m	$3,939m	8,000
Market Monitoring	129	$558m	$797m	5,000
Total	**824**	**$4,901m**	**$9,673m**	**44,000**

Turnover and fundraising estimates are rounded to the nearest million. Headcount estimates are rounded to the nearest thousand.

Table 7.5: RegTech market segments in detail

Segment	Profiling and Due Diligence	%[43]	Reporting and Dashboards	%[43]	Risk Analytics	%[43]	Dynamic Compliance	%[43]	Market Monitoring	%[43]
Top client pain points	Implementing new regulations	40%	Processing large quantities of data	38%	Organising complex information	38%	Implementing an internal compliance program	68%	Navigating existing regulations	75%
			Reporting data	24%						
Target client sectors with high concentration[44]	Fintechs	76%	Real Estate	31%	Regulatory Consultancies	55%	Insurance	79%	Financial Regulators	80%
							Energy or Utilities	37%	Real Estate	33%
Most common technologies	Image recognition	76%	Cloud computing	48%	Data transfer protocols	91%	Cloud computing	84%	Cloud computing	73%
	Machine learning	76%	Machine learning	34%	Predictive Analytics	82%	Machine learning	58%	Data Transfer protocols	60%
	Speech recognition	52%			Semantics/ Graph analysis	77%	NLP	53%		
Technologies with high concentration[44]	Image recognition	76%	None		Data transfer protocols	91%	Cloud computing	84%	GIS mapping	33%
	Speech recognition	52%			Predictive Analytics	82%				
	Biometrics	43%			Semantics/ Graph analysis	77%	NLP	53%		
Most common objectives	Detective analysis for frauds, conduct risks, and compliance violations	38%	Data collection/ reporting	72%	Data analysis/ decisioning	91%	Regulatory management information tools	74%	Data analysis/ decisioning	53%
	Transaction monitoring and surveillance	38%	Data analysis/ decisioning	52%	Predictive analysis for frauds, conduct risks, and compliance violations	82%	Predictive analysis for frauds, conduct risks, and compliance violations	63%	Regulatory management information tools	53%
					Transaction monitoring and surveillance	82%			Risk identification, aggregation and management	53%
Objectives with high concentration[44]	None		Data collection/ reporting	72%	Supervision technology for Regulators (SupTech)	41%	Supervision technology for Regulators (SupTech)	42%	Streamlined licensing	20%
					Data analysis/ decisioning	91%	Legislation and regulatory gap analysis	47%	Market monitoring and surveillance	40%
					Detective analysis for frauds, conduct risks, and compliance violations	73%	Regulatory management information tools	74%		
					Transaction monitoring and surveillance	82%				

43 The percentages reported here are derived from small base sizes and should not be relied upon for comparisons.
44 For the purposes of this table, 'high concentration' denotes any figures that is relatively much higher than the equivalent for other market segments, regardless of ranking. E.g. Product Governance and Quality is not a top-ranking regulatory theme for vendors in the Market Monitoring segment. It is, however, much more commonly reported by those firms than their peers in other segments of the market.

Table 7.5: RegTech market segments in detail *continued*

Segment	Profiling and Due Diligence	%[43]	Reporting and Dashboards	%[43]	Risk Analytics	%[43]	Dynamic Compliance	%[43]	Market Monitoring	%[43]
Most common USPs (8+ out of 10)	Advanced/ Unique Technology	86%	Increased effectiveness	76%	Increased effectiveness	91%	Increased effectiveness	84%	Increased effectiveness	87%
	Increased effectiveness	81%	Speed	66%	Cost Savings	77%	Advanced/ Unique Technology	74%	Speed	67%
Most common areas of compliance	Know Your Customer/ Business (KYC/B)	62%	Other	45%	Anti Money Laundering, Sanctions and Counter Terrorist Financing	77%	Know Your Customer / Business (KYC/B)	68%	Know Your Customer / Business (KYC/B)	47%
	Anti Money Laundering (AML), Sanctions regimes and Counter Terrorist Financing (CTF)	48%	Know Your Customer/ Business (KYC/B)	31%	Know Your Customer / Business (KYC/B)	59%	Anti Money Laundering (AML), Sanctions regimes and Counter Terrorist Financing (CTF)	68%	Anti Money Laundering (AML), Sanctions regimes and Counter Terrorist Financing (CTF)	40%
	Fraud	43%			Fraud	55%	Personal data protection and privacy laws	63%		
							Governance, management accountability, conflicts of interest	63%		
Compliance areas with high concentration[44]	Know Your Customer/ Business (KYC/B)	62%	Other	45%	Anti Money Laundering (AML), Sanctions regimes and Counter Terrorist Financing (CTF)	77%	Personal data protection and privacy laws	63%	Product governance and quality	33%
							Governance & management accountability	63%		
					Fraud	55%	Corporate financial transparency	47%		
	Fraud	43%					Tax compliance and mandatory information exchange, incl FATCA	42%		
Most common partnerships	Corporates	71%	Corporates	55%	Corporates	55%	Professional services firm	79%	Corporates	87%
			Professional services firm	52%	Professional services firm	64%			Professional services firm	60%

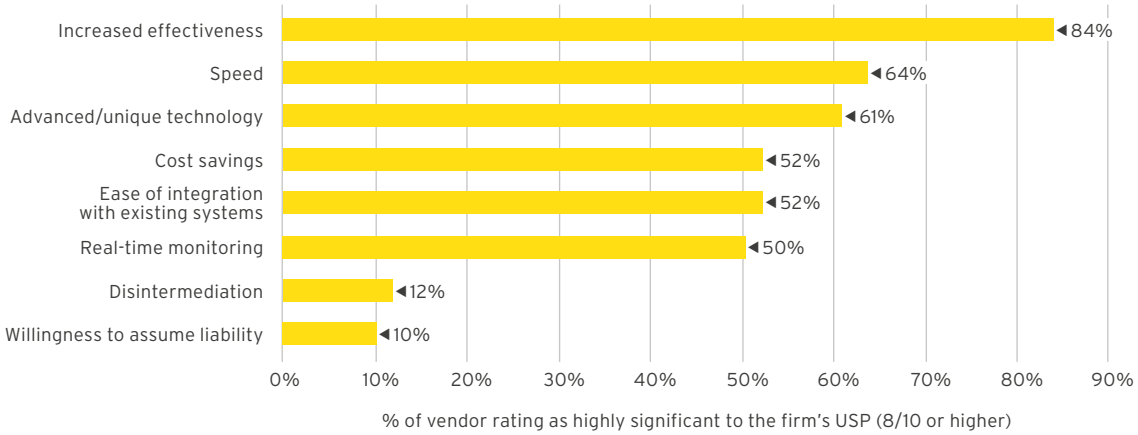
8. Enablers and impediments

What is the RegTech sector's unique selling proposition?

Survey respondents were asked to rate the importance of various potential sources of competitive advantage on a scale of 1 to 10, where 10 would be the most significant source. Many vendors tend to see their potential for increasing the effectiveness of compliance processes or enhancing the speed of service as their most important selling point (Figure 8.1). Those USPs tended to rank highly across market segments – only firms in the Profiling and Due Diligence segment ranked the use of advanced proprietary technology higher.

These findings point to an interesting aspect of the relationship between investors in RegTech firms and their founders. Looking at the amount of funding raised by firms, vendors which had attracted the most funding were much more likely to consider advanced, proprietary technologies to be their USP. Of the other potential USPs, only the ability to speed up compliance processes correlated to a similar degree with funding. The fact that proprietary technology might rank lower as a USP than other aspects of the RegTech proposition that are not correlated with funding success can be explained if, for instance, investors are more focused than entrepreneurs on exit strategies involving a potential acquisition.

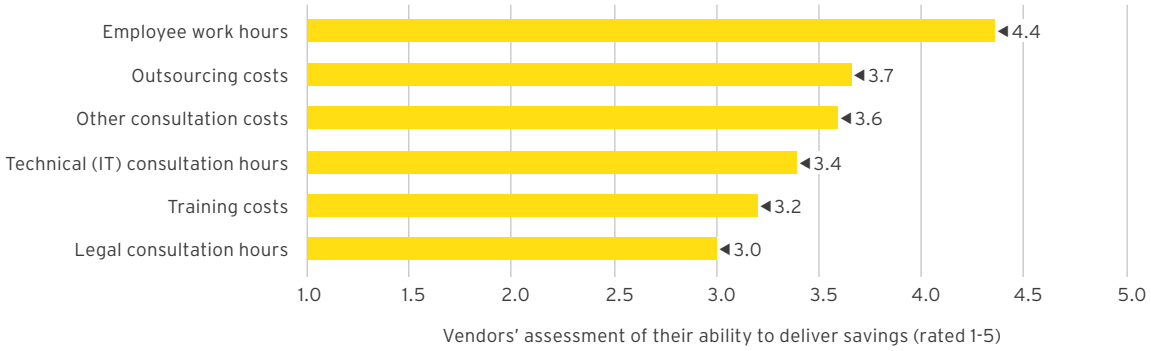
Figure 8.1: Most commonly cited USPs



The ability to save users time or headcount was not as central to firms' competitive positioning as the above, and in any case not all firms were confident they could quantify the savings they could achieve for clients. Indeed, as firms became larger and more experienced, they also became less likely to claim direct cost savings as their USP. Among the market segments identified for this study, Risk Analytics firms emphasised the cost savings available through their offering the most.

Those that could quantify savings, were usually able to demonstrate reductions in employee work hours and those best placed to calculate payroll savings tended to also be able to calculate training savings (Figure 8.2). Those vendors that applied AI in its various forms (factor A1) or had built their offerings around risk analytics use cases (factor B1) were usually more confident in making these claims.

Figure 8.2: Relative magnitude of savings from RegTech implementation, as reported by vendors



Vendors were least confident in their ability to save users money on legal advice, although vendors with an emphasis on dynamic compliance use cases and disintermediation (factors B2 and B4; see Annex for details) felt more confident in this area. Nevertheless, it appears that vendors become more confident of their ability to reduce the cost of expert (legal or technical) consultation as they mature, suggesting that that ability to displace legal advice entails significant trial and error, as well as investment.

In addition to the options detailed in Figure 8.2, firms were also able to 'write in' any significant savings that they were able to quantify. A significant number of those vendors that did so felt that their solutions might primarily save clients money by avoiding fines and non-compliance costs more generally.

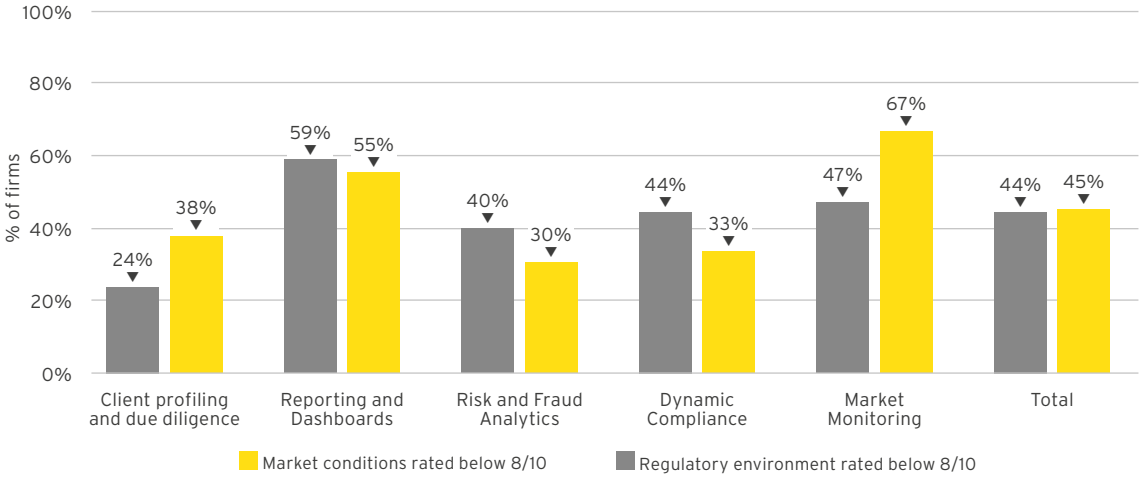
As impressive as the savings projected by vendors might be, they must be seen alongside the significant onboarding costs for users. For one interviewee with experience of RegTech procurement, restructuring the firm's databases ahead of the implementation of a new RegTech platform was a very costly - if ultimately successful - initiative. Data cleaning, that interviewee suggested, proved to be a considerable and costly challenge, even with a team of AI data scientists devoted to the task.

RegTech – the regulatory and market outlook

The RegTech sector is dominated by start-ups, with 70% of firms in the survey sample aged below five years. Most firms consequently report a reasonable amount of pressure on their business models, both from the marketplace and from regulators. Taking an average of the market outlook in each firm's top three markets,[45] just under half of the firms in the sample reported an average score below 8/10, indicating a moderate level of market challenge (see Figure 8.3).[46]

Firms facing market pressure appear slightly more likely to respond through pricing changes, although the difference is not statistically significant. More significant is the response to regulatory pressure, which generally tends to impede, rather than cause, business model change; 50% of firms facing a challenging regulatory environment reported marginal or no changes across the various aspects of their business models, compared to 31% of those not under such pressures. Vendors in the Reporting and Dashboards and Market Monitoring segments reported the most pressure on average both on the regulatory and market fronts, whereas those in the Profiling and Due Diligence segment reported more benign conditions. Given the relative abundance of funding going into the latter, the results appear reasonable. However, the differences between market segments are not statistically significant.

Figure 8.3: Market and regulatory conditions facing RegTech firms, by market segment



45 The market in which a firm was headquartered was assumed to be their top market, and the first two markets spontaneously named by the firm were assumed to be their second and third most prominent markets.

46 The choice of cut-off point materially affects this estimate; a cut-off point of 5/10 would result in very few observations of firms reporting market pressure. 8/10 may appear to be a high cut-off point but it is in line with common practice in other areas, such as e.g. the 'promoter' cut-off for the purposes of calculating net promoter scores. It also reflects the researchers' expectation that entrepreneurs in a fast-growing sector would be naturally optimistic about the prospects of their firms.

What drives vendors' market and regulatory outlook?

Given the limitations of the survey sample, it was difficult to establish statistically significant links between business model features and market or regulatory pressures while allowing for appropriate controls. Nevertheless, simple decision tree analysis[47] suggests some possible influences on vendors' market and regulatory outlook:

Source of advantage: Vendors who emphasised speed as their USP, such as real-time risk assessment applications, reported more benign market and regulatory conditions than those that did not, although this effect reversed with subsequent funding rounds. Such firms were particularly likely to report supportive market conditions if they had engaged with a regulatory sandbox, or if they were able to demonstrate significant cost savings. Additionally, firms with a real-time transaction monitoring offering also reported a more favourable regulatory environment.

Nature of offering: Vendors whose offering centred on risk management (except real-time risk analytics) faced more market pressure than those that did not, whereas those focusing their offering on dynamic compliance, e.g. automating regulatory audits and gap analyses, were likely to report a more favourable regulatory environment. Vendors covering a broader range of client use cases,[48] potentially enabling the end-to-end processing of regulatory requirements, were also more likely to report a benign regulatory environment. There were, however, also type of offerings that regulators appeared to treat with more caution. For example, vendors incorporating DLT in their offering were likely to report a more adverse regulatory environment.

Regulatory fragmentation: Vendors operating in multiple jurisdictions were more likely to report an adverse regulatory environment than those who were focused on a single market, likely due to regulatory fragmentation.

Sources of funding: Self-funded firms were more likely to report adverse market conditions. As a result of the much smaller amounts of funding they have received or of their limited access to the advice and assistance of experienced investors, such firms might find both product and business development much more challenging.

These results are based on a limited sample are should be treated with caution. However, if replicated in a larger sample, they would imply a significant premium for technologies able to produce real-time insights or decisions, for instance in the areas of customer onboarding and due diligence, and a strong interest from regulators in supporting such technologies. They would also

47 Four CHAID analyses were used to assess potential associations with market and regulatory outcomes, both as binary variables (stress v no stress) and as continuous variables (i.e. scores out of 10). Although a quantitative method was used, due to the small sample size employed these findings are indicative only. To further guard against spurious results, only significant results up to two levels down from the origin node are reported.

48 The proxy used for this was a sum of the absolute values of factors A1 through A6 and B1 though B9, as presented in the Annex. As factor loadings were generally positive, this was interpreted as a measure of business model breadth or the range of use cases targeted, and technologies employed.

imply at least some degree of regulatory support for applications that aim to facilitate machine-executable regulation and dynamic compliance. However, they might also indicate that the regulatory response to RegTech has been fragmented to date, and that vendors working across borders are at a relative disadvantage.

The Sandbox Effect

One unexpected finding from the survey was the sheer number of RegTech vendors who have applied to a regulatory sandbox.[49] About one in five firms in the survey sample claimed to have applied to a regulatory sandbox at some point in the past, with Dynamic Compliance firms marginally more likely than others to follow that route. More than half of all sandbox applicants applied to join a sandbox in the United Kingdom, while Luxembourg was a distant second. In the case of the United Kingdom, vendors are likely to have been attracted by the FCA's series of TechSprints, launched in 2016. At the time of publication, three of the six TechSprints in this series were aimed at RegTech applications, in the areas of reporting, machine-executable regulation, AML and financial crime.[50]

Survey responses suggest that access to a sandbox facility might improve perceptions of the market or regulatory environment among some vendors; it was not possible to assess whether this translates to market performance solely from the survey data. The case for live testing of RegTech solutions might be strongest where supervisors' treatment of innovative compliance solutions or their requirements around compliance outsourcing are under review. Such selective use is more likely to make good use of the resource-intensive sandbox environment,[51] while still allowing regulators to support innovators through alternative arrangements where the degree of regulatory uncertainty is lower.

49 Although the survey question explicitly discussed sandboxes, it is possible that respondents interpreted the term loosely, including, e.g. interactions with a regulator's innovation office.
50 https://www.fca.org.uk/firms/regtech/techsprints Accessed 12 June 2019
51 A more in-depth discussion can be found at https://www.unsgsa.org/files/2915/5016/4448/Early_Lessons_on_Regulatory_Innovations_to_Enable_Inclusive_FinTech.pdf

Figure 8.4: Examples of regulatory sandbox initiatives by jurisdiction

Sandboxes in operation as of June 2019

Abu Dhabi
Australia
Bahrain
Brunei
Canada
Columbia
Ireland
Isle of Man
Japan
Jersey
Kazakhstan
Kenya
Kuwait
Lithuania
Malaysia
Mexico
Mozambique
Mauritius
Serbia
Russia
Saudi Arabia
South Korea
Taiwan
Thailand
Uganda
UK
United States
Vanuatu
Zimbabwe

Forthcoming Sandboxes

Austria
Brazil
Chile
Congo
Estonia
Fiji
Malta
Mauritania
Nigeria
Norway
Qatar
Tajikistan
Romania
Spain

Proposed Sandboxes

Bulgaria
China
Guinea
India
Italy
Madagascar
Morocco
Papua New Guinea
Paraguay
Peru
Portugal
Rwanda
Samoa
South Africa
Tanzania
Trinidad and Tobago

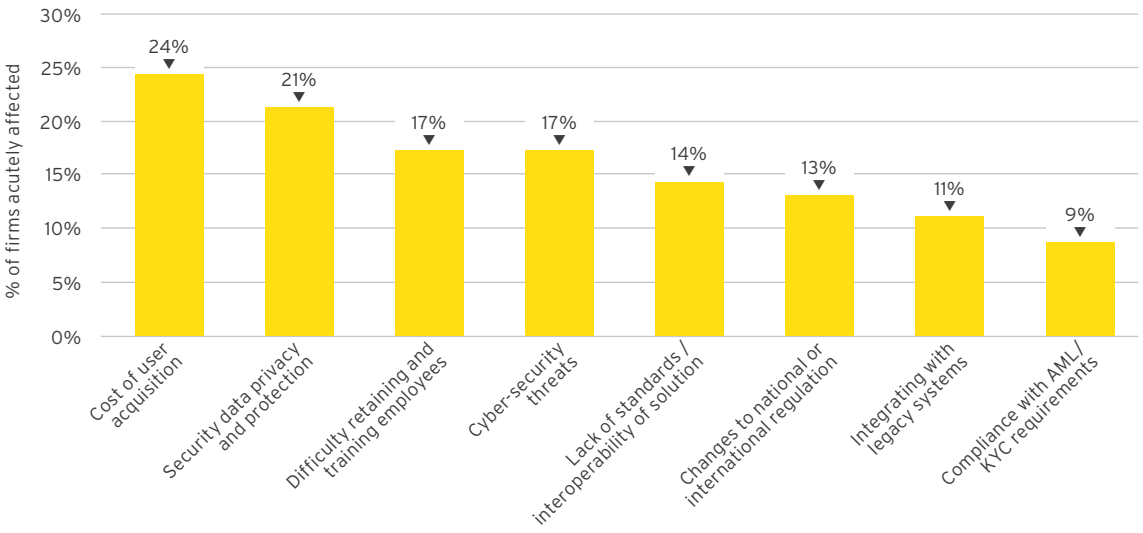
A Sandbox is considered to be 'Forthcoming' if the decision to operate it has already been made but it is not yet operational. If a decision has not yet been formally announced than its status is 'proposed'.

Weaknesses and threats

Acquiring clients, which are typically large and complex firms, is a long-winded and costly process. For a firm that has raised the average first funding round of $1.5m, a sales cycle that lasts between 12 and 18 months can be prohibitively expensive. Consistent with this, about a quarter of RegTech firms pointed to client acquisition as an acute risk, with younger and smaller firms particularly concerned (Figure 8.5). As one angel investor interviewed for this report explained, "when an organisation deals with any major regulation, the primary challenge is to bring stakeholders around one table to determine its impact"; a new RegTech vendor must have buy-in from everyone on that table. One major bank freely admitted that "competing technology priorities" were an internal obstacle to investing in compliance, with sponsors needing approval "from various layers of compliance management, IT management and overall finance budget." Even where consensus existed internally, the bank was explicit

that they "[...] [w]ill only deal with well-established vendors [and] try not to customize the package." Vendors had no option other than to navigate the bank's Third Party Risk Management (TPRM) program.

Figure 8.5: Self-reported ratings of threats to firms' business models



But it was those firms in the Dynamic Compliance and Market Monitoring segments of the market that were most affected; their offering relies on aligning multiple stakeholders within clients' organisations, making sales much slower and raising the stakes for vendors' business development to the point where pursuing the wrong leads can threaten the viability of a small business.

Dealing with clients' data exposes vendors to risks in the event of cyber-attacks and data leaks. Cyber-security fears are greater among younger vendors, but rise with the amount of funding a firm has raised. Particularly exposed are vendors in the Dynamic Compliance segment of the market, whose deeper integration with client systems makes them a more likely target for cyber-attacks. Unsurprisingly, firms in the Profiling and Due Diligence segment were most concerned about privacy and data protection risks, while those dealing mostly in aggregate data were less concerned.

The lack of shared standards and interoperability is often discussed as a major obstacle to industry growth. Two of the experts interviewed for the present study noted the importance of semantic convergence, and one pointed to the creation of the Financial Industry Business Ontology (FIBO)[52] as an example of good practice. In both interviewees' view, the potential of regulatory technology cannot be fully realised without such convergence.

52 https://edmcouncil.org/page/aboutfiboreview

Despite this, standardisation was not ranked accordingly highly by survey participants among the other risks and challenges facing their businesses and the sector. Only about one in seven across the sector saw this as a major issue, although firms in the Risk Analytics and Dynamic Compliance segments of the market were clearly much more concerned. Firms in the reporting and dashboards segment, on the other hand, typically benefit from some level of convergence among regulators, and were much less likely to cite a lack of common standards as a concern.

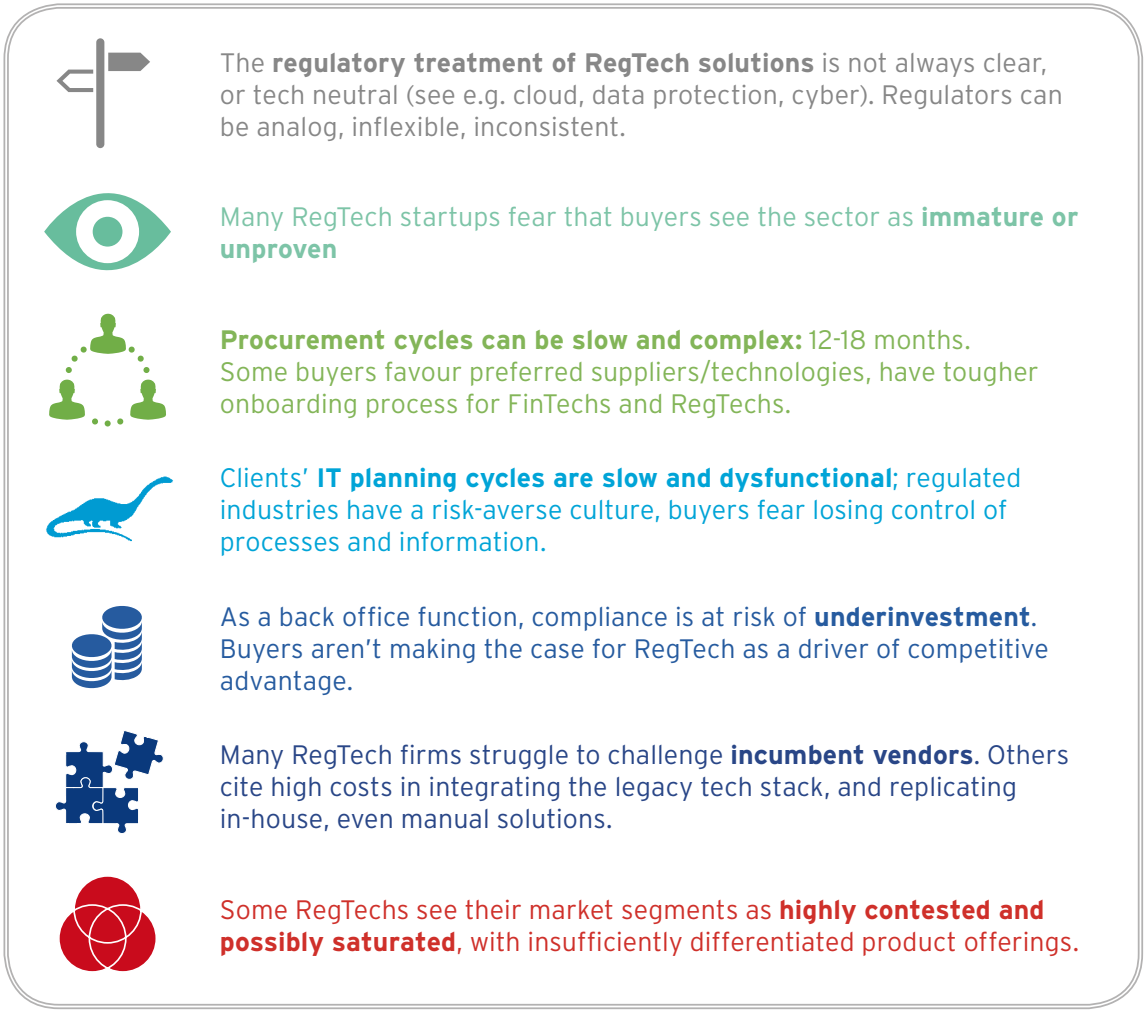
Integrating with legacy systems was much less of a concern for most firms, with under one in ten citing it as a major problem. Nevertheless, it was a major concern for businesses that had recently changed their business models to target new or different target users, likely because of the requirement to deal with unfamiliar architectures and vendors. One RegTech firm interviewed for our study, for example, noted how thin the line can be between supplying a RegTech solution and consulting or performing risk assessments following the purchase. This typically requires a different type of professional expertise, which firms must recruit or retain at significant cost.

Perhaps unsurprisingly, most firms had idiosyncratic concerns that could not be easily summarised, and some that had not been anticipated in the design of the survey. Respondents volunteered 255 qualitative responses to four questions, discussing the principal barriers to sector growth and elaborating on what they saw as the top risks to their own firms. These are summarised in Figure 8.6.

Overall, respondents painted a picture of a sector that must sometimes still fight for credibility, in part because the business case for investment has not been made internally by client firms, and in part because of the nature and low level of awareness of its offering. In interviews, for example, one vendor offering advanced risk analytics described a 'catch-22' situation whereby clients would ask for details of previous implementations, only to find that key outcomes could not be discussed in meaningful detail, or, worse, that the insights derived in real-life applications made senior stakeholders uncomfortable.

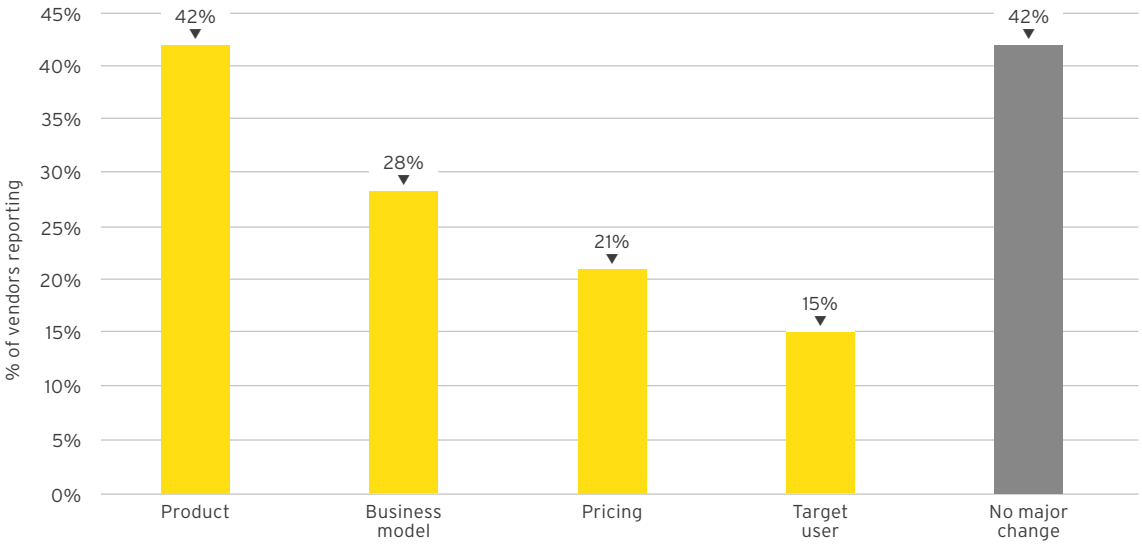
Vendors also spoke of problematic procurement and IT planning cycles within clients that frustrate both sales and implementation at the expense of vendors. Finally, some raised concerns about the dynamics of the sector, worried that some segments are becoming saturated, with too many undifferentiated firms fighting for the same limited pool of business.

Figure 8.6: Risks and obstacles for RegTech firms: A summary of verbatim responses



Dealing with change

Figure 8.7: Firms reporting a 'complete overhaul' since 2015, by focus of change



Over half of the survey sample reported that at least one aspect of their business had been subject to a major overhaul over the last five years (see Figure 8.7), with no significant difference between firms from different age cohorts. Given the young age of most vendors responding to the survey, such responses are best interpreted as stating that the firm had redirected its business model, product offering, client acquisition strategy and pricing, away from what had been originally planned.

Changes to a vendor's product were the most common, whereas switching to a new group of target users or new use cases was comparatively atypical. The latter finding should be read in context, as firms reporting changes in the users they targeted tended to be better capitalised than those who reported other types of change, or none.

It is possible to guess at some of the drivers of change by comparing vendors that experienced radical change against those that did not. This analysis is not conclusive, but it suggests that the most significant and more challenging changes might be correlated with firms' move towards dynamic compliance use cases (automated audits and gap analysis) and offerings aimed at oversight functions and supervisors. What most of the above have in common is that they extend a vendor's focus to multiple parts of the compliance journey, taking firms closer to machine-executable regulation. In particular, the need to integrate with different parts of a client's operations and match data to the firm's information taxonomies is most likely what justifies the significant cost implications of shifting to a new set of target users.

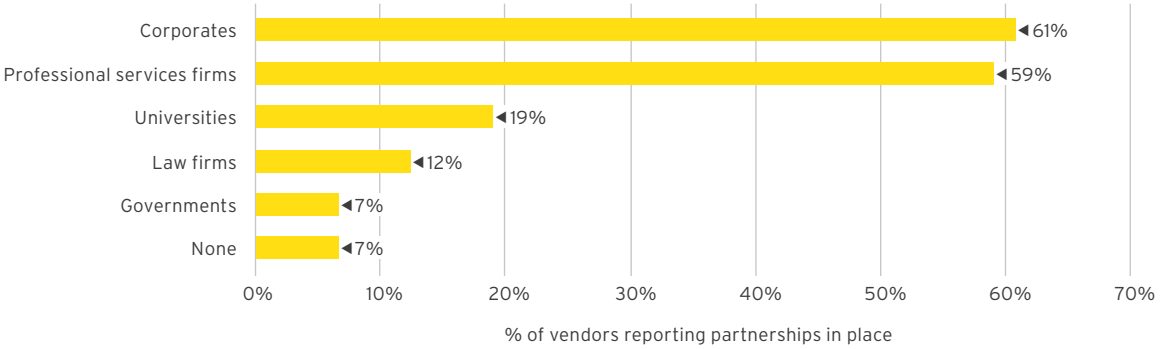
Leveraging partnerships to unlock RegTech growth

Although RegTechs are likely to start out relatively large compared to businesses in more traditional industries, most of the firms in this sector are still of modest size and have no guaranteed access to finance, which makes it hard for them to risk dealing with the procurement process of a major financial institution. The result is often to partner with another organisation that might expand the vendor's reach or resources, and perhaps provide a route to market.

Fewer than one in ten RegTech firms reported having no external partnerships in place, and more than half of the sample had partnered at some point with either a corporate or a professional services firm[53] (Figure 8.8). Universities were a less obvious partner for RegTech vendors, usually complementing commercial partnerships with other organisations, such as law and professional services firms. Verbatim responses suggest that software companies, FinTechs, NGOs and industry associations are also likely partners for vendors.

The scope of such partnerships can vary significantly, from a purely commercial white-label or distribution agreement, to product co-creation, to applied research. However, one type of collaboration may be the most important. A simple decision tree analysis suggests that partnerships with corporates (usually their own clients) might help smaller RegTech firms secure early-stage funding. Proofs of concept (PoCs) and co-creation agreements can provide modest amounts of funding to early stage start-ups, support them through the procurement process and produce due diligence that will encourage investors in a subsequent funding round. That said, corporate partnerships are more common among larger and older RegTech firms, where the aforementioned effect will be much weaker.

Figure 8.8: Share of RegTech firms engaging selected partners



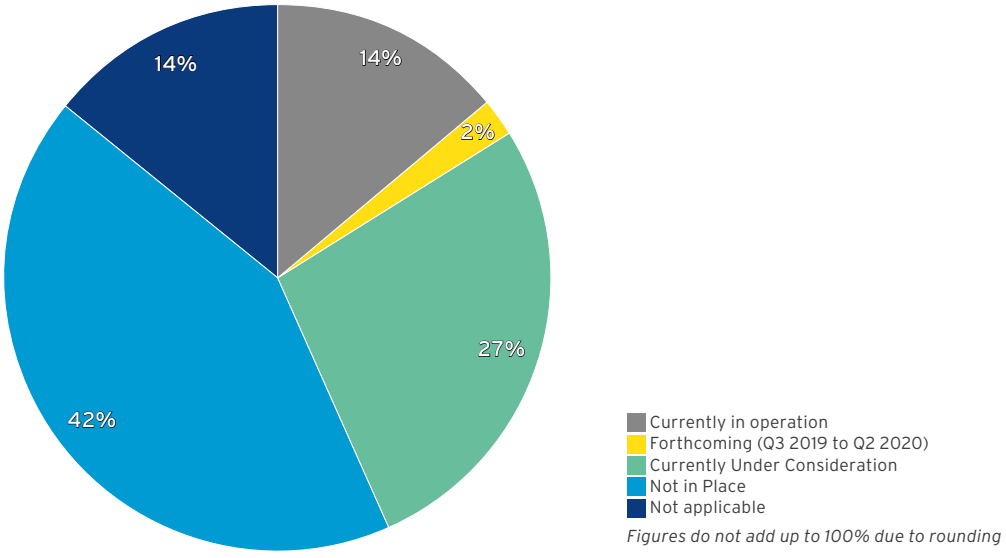
53 Verbatim responses suggest that the headline figure for professional services firms underestimates the true total, as firms also mentioned partnering with audit firms and consultancies when prompted to explain what other types of partners they had engaged.

9. RegTech: The regulators' perspective

Regulators sit at the heart of the RegTech ecosystem, as the source of rules, the arbiters of compliance, and the most powerful conveners of market participants. Ever since the term 'RegTech' was popularised (by a regulator) in 2015, many have taken it upon themselves to set the tone and level for ambition in their respective jurisdictions.

Evidence is beginning to emerge on the extent and nature of regulators' engagement with RegTech. Between May and June 2019, CCAF and the World Bank jointly surveyed regulators from 111 jurisdictions, asking among other things whether they had RegTech or SupTech initiatives in place, what technologies they used and what their impact had been. As Figure 9.1 demonstrates, about one in six (16%) jurisdictions will have such an initiative in place by mid-2020, and another 27% could potentially come to operate one in the future. This suggests that RegTech and Suptech programmes are still uncommon, and less prevalent than other regulatory innovation initiatives, such as innovation offices or sandboxes.

Figure 9.1: Share of jurisdictions globally in which regulators have RegTech/SupTech initiatives in place

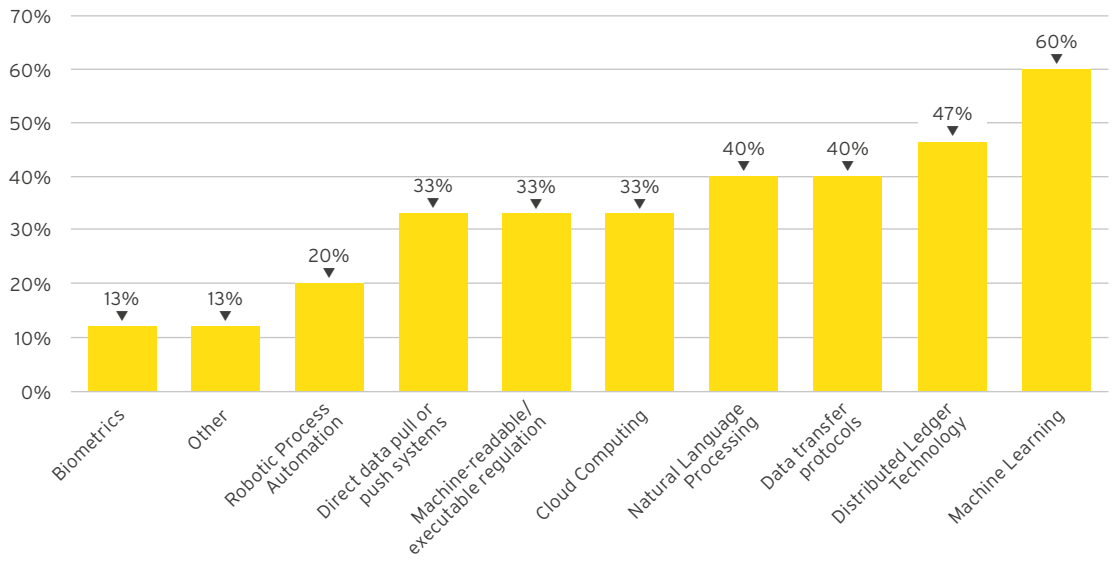


Source: CCAF & World Bank (forthcoming)

Although the final sample of regulators with an active RegTech or SupTech programme is small, their respective jurisdictions account for a significant share of total financial services activity and it is thus reasonable to discuss the technologies employed. Contrasting Figure 9.2 with Figure 6.1, it appears that DLT is more prevalent in the applications tested by supervisors than in the overall product offering of the industry. Regulators might additionally

have a more pronounced preference for on-premises deployment of RegTech solutions, as opposed to cloud instances, than corporate users do. Otherwise, the broad technology mix in SupTech solutions seems to be comparable to that for the broader RegTech industry.

Figure 9.2: Technologies developed or employed by regulators with an active RegTech or Suptech programme



Source: CCAF & World Bank (forthcoming)

To further understand regulators' motivations and distil the lessons they have learned, CCAF researchers interviewed regulators at the Monetary Authority of Singapore (MAS), the United Kingdom's FCA and the Bank of England (BoE), the Japanese Financial Services Agency (JFSA) and the Bank of Japan (BoJ), the National Bank of Rwanda (NBR) and the Central Bank of the Philippines (Bangko Sentral ng Pilipinas; BSP).

All original input[54] from the regulators was obtained through semi-structured interviews. Several common themes were identified in the regulators' responses, and this chapter is organised according to those themes.

Risk-based supervision, complexity and resource constraints drive regulators' RegTech agenda

Regulators' early engagement with RegTech solutions has tended to center on regulatory reporting use cases. Adoption at this level, for instance at the BSP or the BoE, has been driven by a trend towards more focused, risk based supervision. To this, the experience of the GFC has added a growing

54 FCA interview material was repurposed, with permission, for this purpose, from a previous interview conducted in the summer of 2018 and materials in the public domain. Interviews with Japanese regulators were conducted by EY Japan, using the same interview schedule developed and used by CCAF to ensure consistency.

unease with the lag between data submissions and actionable data. Finally, siloed and fragmented data collections built by the competing demands of diverse stakeholders are still common, contrary to both IT estate management principles and regulatory good practice. The NBR's Data Warehouse is a response to precisely this problem, bridging the Bank's diverse databases as opposed to integrating them.

Some regulators, such as the BoE, are clear they have crossed a threshold where they can no longer assume that growth in supervisory resource can keep up with the growing volume and complexity of financial information. Effectively, regulators risk hoarding data, particularly unstructured data such as management reports, which they cannot hope to process effectively. This risk has given rise to a second generation of use cases, focused on the use of predictive analytics and real-time supervision, drawing primarily on unstructured and Big Data – cited as current priorities, for example, by the BoJ and MAS. These might include simulation, network analysis and visualization applications to support market oversight or prudential and macroprudential policy, or they might involve the integration of public data and supervisory intelligence to power predictive analytics at the firm level and thus help refine supervisory priorities. The BoJ, for example, focuses on interactions between the financial system and the real economy, which it considers critical to financial stability. The bank developed an empirical model to bridge the two systems and uses it for a range of analyses in their regular Financial System Reports. It has also examined simulation studies of shock propagation involving large value payment systems, using Big Data related to payment transactions.

It is possible to corroborate some of the interview findings by focusing on statistically significant differences between the offerings of those vendors who reported that they catered to SupTech use cases and those of vendors who did not. Examined in this way, SupTech solutions were more likely to employ deep learning, graph analysis, NLP and data transfer protocols. From a functional perspective, SupTech offerings were more likely to incorporate management information tools, automated control audits and documentation, and to be aimed at end-to-end, machine executable regulation. Finally, from a thematic perspective, SupTech use cases are particularly likely to be focused on reporting, governance and accountability.

The convening power of regulators is a catalyst for industry solutions…

Perhaps the most striking effect of the regulators' RegTech agenda has been to bring competing firms and regulators together, not merely to the table but on the same side. Most regulators reported that larger firms were engaging them and each other as they could see the benefits to their own processes and bottom line – and many treated SupTech initiatives as a prompt to upgrade their own systems. Most regulators, however, also pointed to a need for firms to make the positive case for RegTech as a driver of value, not savings,

and invest accordingly. Many of the necessary commercial incentives are in place: for example, growing demand for personalised FinTech solutions drives investment in identity-related RegTech solutions.

While regulators might stop short of making the business case for RegTech, their convening power allows them to create spaces where partnerships might form spontaneously. The FCA's TechSprints, for example, bring market participants together to tackle a common compliance challenge, while the BoJ's FinTech Centre is tasked with helping firms gain exposure to advanced technologies. More mature firm-vendor partnerships have also benefited from Sandboxes, which one in five RegTech vendors have applied to (see Chapter 8).

Overall, it is clear that firms are willing to work with vendors and with each other, under the auspices of a regulator, to address industry-wide problems. Such sharing of insights need not risk collusion. This is because compliance applies across the industry and much of it[55] does not confer competitive advantage to participating firms.

… but to build a RegTech ecosystem requires a fine balance of public and private goods

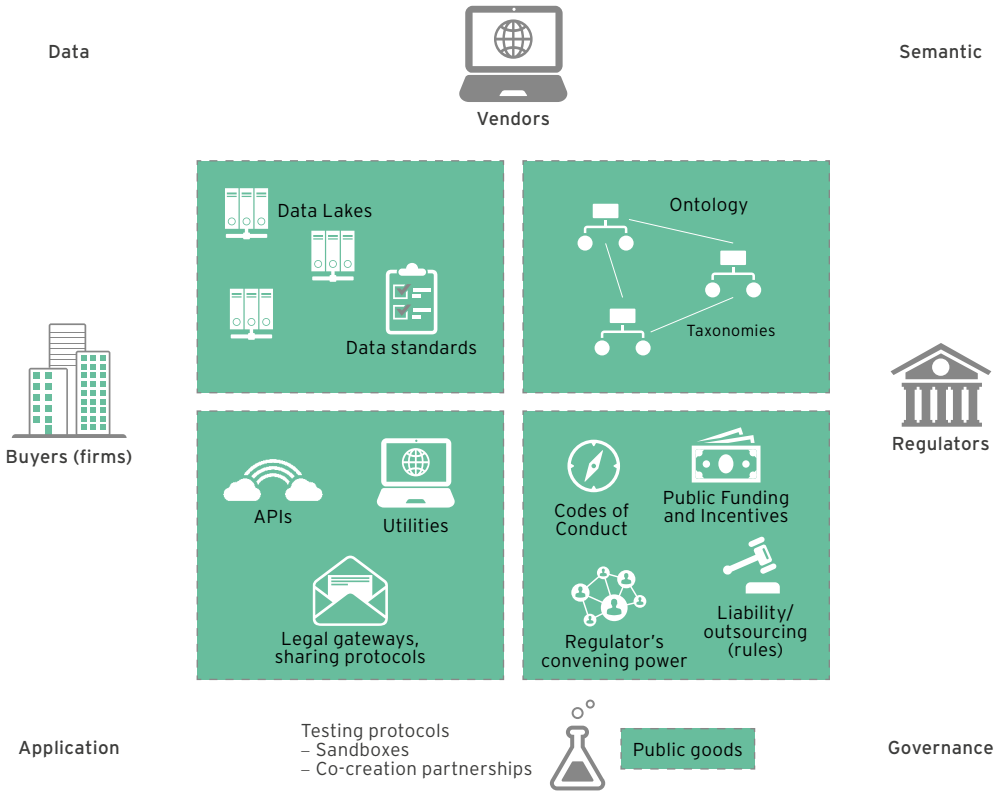
Many regulators spoke of a RegTech ecosystem, their own place in it or, in the case of the JFSA, of their intent to support its development. To describe such an ecosystem beyond listing market participants, it helps to consider the public goods on which firms might rely in order to automate and improve compliance (see Figure 9.3). Regulators were willing to consider investments (financial and reputational) where they could leverage the most public value and have a transformative impact on regulated industries. Public goods mentioned by interviewees included:

1. Shared ontologies, or at least shared glossaries and data taxonomies;[56]
2. Shared, standardised data formats and legal gateways for sharing data between firms;
3. Shared norms, such as MAS' FEAT (Fairness, Ethics, Accountability and Transparency) Principles for the use of AI and data analytics;[57] and
4. Shared utilities and data lakes (e.g. Singapore's MyInfo).

The latter are particularly important to the health of an ecosystem by driving broad adoption and maintaining a level playing field between firms. Financial regulators such as the BSP and JFSA stressed that for every major regulated firm with the resources and capabilities to invest in RegTech, there are many more, smaller and/or less well-resourced firms that are too thinly stretched. Shared utilities can keep such firms engaged and improve their compliance capabilities without demanding a prohibitive up-front investment.

55 Although by no means all. See e.g. 'Small is Beautiful', Chapter 5
56 An ontology differs from a taxonomy in that it represents not merely the concepts in a single domain such as compliance but also their properties and the relationships between them.
57 http://www.mas.gov.sg/~/media/resource/news_room/press_releases/2018/Annex%20A%20Summary%20of%20the%20FEAT%20Principles.pdf

Figure 9.3: Public goods in the context of a RegTech ecosystem, by layer of the ecosystem (data, semantic, application, governance)



This view echoes findings from the qualitative practitioner interviews. One such interviewee noted that mid-tier banks in particular must move fast to compete with larger providers while also keeping FinTech and challengers at bay. Compliance automation for these firms could be a source of competitive advantage if they can execute the attendant digital transformation correctly. It might allow them to build greater ownership of compliance among customer service and operations staff, thus freeing up internal risk and compliance departments' resources.

Regulators are clear that the industry needs to meet them halfway in funding such shared resources. One regulator, for example, was keen that the private sector own their own ecosystem, bearing the cost of application development in most cases, and look to the regulator primarily for data standards and taxonomies. To the regulator in question, the use of taxpayer money should be restricted to applications with industry-wide and whole-institution application. Even then, other government agencies may well need to share ownership and outputs with the regulator to make a robust business case for investment. Conversely in Singapore the public good element of shared RegTech platforms tends to be exclusively government-funded, and financial technology innovation grants are even available to local firms developing and testing new technologies. In the Philippines, international development

partner organisations take a greater role in providing such funding. However, all regulators stressed that it is for firms themselves to fund any additions layered on top of a shared utility to optimise or tailor it for private sector use, such as connectivity, adjustments and additional application development. Most importantly though, it is for firms to take on the cost of organizational change.

This is far from trivial. The JFSA pointed to the difficulty financial institutions had sharing data between the back/middle and front office and observed that functional separation introduced by legislation often contributed to information being siloed. In this regard, FinTechs may be better prepared to work with the regulator than larger incumbents. The BoE notes a significant contrast in culture between the two groups, with FinTechs markedly more willing and able to share data directly with a third party or even a regulator. The JFSA also found that the case for engaging FinTechs and challengers was greater in the early stages of building a RegTech ecosystem. One major bank countered that it is the regulators and government who should shoulder the cost of building common platforms, and who should take care to clearly define what their needs are. Firms might then be responsible for design and delivery.

A senior bank manager interviewed for the present study confirmed the regulators' views in this regard. They noted that banks are highly concerned about commercially sensitive and confidential information, and their concern is an important hurdle that must be overcome in the development of utility services. In this regard, the involvement of a regulator is highly comforting to regulated firms.

Fortunately, there are large parts of the financial services sector where the commercial case for RegTech is already made; MAS officials, for example, have seen a change over the last few years, with financial institutions that had previously lagged behind picking up pace and exploring how they can improve compliance through technology.

Regulators have taken on the capacity building challenge of SupTech implementation

Regulators have, for the most part, approached the task of onboarding RegTech and SupTech solutions with constructive curiosity, learning from industry and their peers, but early adopters found this more difficult than others did. For example, while the BoE was able to find parallels to its supervisory use cases in the United Kingdom's legal services sector, the NBR was particularly limited in its choice of comparators when setting out in 2015; it wasn't until late in the lifetime of its SupTech initiative that the Bank was able to benchmark against the Central Bank of Austria's (OeNB) automated data collection initiative.

As part of their work, it was common for regulators to work with their IT and Procurement departments to rethink or streamline their procurement processes, so that onboarding relatively untested vendors might become a more realistic option. External consultants provided additional support; the BSP, for example, was able to rely on the RegTech for Regulators Accelerator for targeted support, from drawing up requirements to reviewing onboarding processes.

As regulators move from primarily reporting-based use cases to predictive and real-time supervision, the demand for new supervisory skillsets will grow. Larger regulators such as the BoE or MAS have to date been able to build centres of excellence by drawing on existing talent across their organisations. Others are actively upskilling to make use of more complex data: the NBR has recently engaged the UK Office for National Statistics' (ONS) Data Science Campus to explore the potential of more advanced data analytics.

Machine-executable regulation might have to wait

More than one regulator was keen to digitise their rulebook, but other than the joint BoE/FCA Digital Regulatory Reporting (DRR) pilot[58] there was limited mention among them of concrete steps towards machine executable regulation.

As MAS officials pointed out, regulated firms' pursuit of end-to-end solutions may be unhelpful to user and vendor alike. Elsewhere in this report (Chapter 8) we find some support for this, in that end-to-end offerings are associated with higher levels of disruption for vendors and are more commonly attempted by the best-funded ones. Regulators engaged in previous CCAF research[59] suggested that small wins, not major milestones, might be more conducive to success in a regulator's SupTech agenda, and recent trials, such as the BoE/FCA DDR Pilot[60] have continued to take this proven, piecemeal approach.

In particular, the first DRR pilot report offers tentative evidence that significant savings are possible in regulatory reporting by centralizing the origination of business rules and information taxonomies used in compliance and reducing duplication. However the pilot has also underscored the key obstacles along the way to machine-readable regulation, namely:

- Existing options for parsing regulations are still too reliant on manual input to be scalable;
- A trade-off exists between the cost of changing the policymaking process in order to develop machine-readable regulation, and the loss of accuracy when relying on natural language;
- Further progress relies on the development of standardised industry

58 https://www.fca.org.uk/publication/discussion/digital-regulatory-reporting-pilot-phase-1-report.pdf
59 https://www.unsgsa.org/files/2915/5016/4448/Early_Lessons_on_Regulatory_Innovations_to_Enable_Inclusive_FinTech.pdf
60 https://www.fca.org.uk/publication/discussion/digital-regulatory-reporting-pilot-phase-1-report.pdf

data formats, taxonomies and definitions that can be applied across multiple reporting use cases; and

- A robust governance framework is needed to ensure centralized regulatory reporting utilities do not have adverse impact. This would determine the ownership of reporting requirements as code; the parties' liability for errors in reporting; the process of establishing common standards including internationally; and the means and principles for funding the above.

Annex – Factor analysis

The two tables below show how the two sets of factors were associated with the actual questions asked of respondents. Only loadings above .4 are reported below, and questions are ranked according to their loadings of the most relevant factors for readability.

Table A1.1: Technologies Factor Analysis: Rotated Component Matrix

	Component					
	A1. Artificial/ Augmented Intelligence	**A2. DLT**	**A3. Biometrics**	**A4. Data Lakes**	**A5. Location mapping**	**A6. Data automation**
Factor's share of total variance (%)	13.9	13.6	13.2	11.2	7.8	7.7
Uses machine learning	.842					
Uses deep learning	.836					
Uses NLP	.738					
Uses predictive data analytics						
Uses crypto-tokens		.839				
Uses Smart Contracts		.804				
Uses any DLT other than crypto-tokens		.682			.462	
Uses image recognition			.900			
Uses Biometrics			.819			
Uses speech recognition			.731			
Uses semantics/graph analysis				.692		
Uses Data Transfer Protocols				.656		
Uses Cloud Computing				.656		
Uses some other technology				.489		-.478
Uses GIS mapping					.875	
Uses RPA						.817

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Loadings below 0.4 have been suppressed on this table. a. Rotation converged in 7 iterations.

Table A1.2: Use cases Factor Analysis: Rotated Component Matrix

	Component								
	B1. Risk analytics	**B2. Dynamic compliance**	**B3. Reporting**	**B4. Disintermediation**	**B5. Client engagement**	**B6. Market surveillance**	**B7. Risk management**	**B8. Change management**	**B9. Focus on existing regulation**
Factor's share of total variance	10.227	8.977	7.996	7.749	6.372	6.187	5.722	5.648	5.415
Predictive analysis for frauds, conduct risks, and compliance violations	.877								
Detective analysis for frauds, conduct risks, and compliance violations	.788								
Transaction monitoring and surveillance	.619								
Replacing legacy systems with micro services	.410		.408					.405	
Legislation and regulatory gap analysis		.664							
Machine-executable regulation / legislation		.655							
Supervision technology for Regulators (SupTech)		.637							
Automated audits and documentation		.502							
Applying technologies to the testing of internal and other controls									
Data collection / reporting			.714						
Main user challenge is reporting data			.641						
Data analysis / decisioning			.591						
Main user challenge is processing large quantities of data									
Disintermediating incumbent service providers				.769					
Streamlined licensing				.660					
Agent based modelling					.819				
Consumer engagement / analysis					.575				
Market monitoring and surveillance						.803			
Main user challenge is navigating existing regulations			-.405			.698			
Other							-.775		
Risk identification, aggregation and management							.405		
Main user challenge is implementing an internal compliance programme								.761	
Main user challenge is organising complex information								-.475	
Regulatory management information tools									
Main user challenge is implementing new regulations									-.887

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 10 iterations.

Table A1.3: Correlations between functional and technology related factors

Pearson Correlation	A1. Artificial/ Augmented Intelligence	A2. DLT	A3. Biometrics	A4. Data Lakes	A5. Location mapping	A6. Data automation
B1. Risk analytics	.266**	.085	.176	.312**	-.080	.269**
B2. Dynamic compliance	.192*	.104	-.188*	.237*	-.092	.021
B3. Reporting	-.005	.025	-.082	.092	-.051	-.036
B4. Disintermediation	.006	-.013	.139	.276**	.179	-.087
B5. Client engagement	.083	.095	.112	.094	-.131	.079
B6. Market surveillance	-.107	.081	-.019	.001	.068	.090
B7. Risk management	-.064	.059	-.155	-.013	-.024	.157
B8. Change management	-.060	-.105	-.212*	.073	.123	-.053
B9. Focus on existing regulation	.084	.055	-.183	.084	-.005	-.007

***. Correlation is significant at the 0.01 level (2-tailed).*
**. Correlation is significant at the 0.05 level (2-tailed).*
By design, factors within the same family (e.g. B1 and B3) are uncorrelated.

Table A1.4: Average factor scores across market segments

	Profiling and Due Diligence	Reporting and Dashboards	Risk Analytics	Dynamic Compliance	Market Monitoring
Artificial / Augmented Intelligence	Medium		High	High	
DLT					
Biometrics	High				
Data Lakes			High	Medium	
Location mapping					
Data automation			Medium		
Risk analytics			High		
Dynamic compliance and oversight			Medium	High	
Reporting		Medium			
Disintermediation					Medium
Client engagement					
Market surveillance					High
Risk management					
Change management				High	
Focus on existing regulation				Medium	Medium

Note: 'High' loadings correspond to a median loading of 0.5 or greater, 'medium' loadings to a median loading of 0.3 to 0.5

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