

Regtech, Fintech, Compliance,
Innovation, Oversight, Automata-
tion, Big Data, Research Agenda,
Machine Learning, Cyber security

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We present a research agenda for secure and intelligent regulatory technology (“regtech”). This encompasses an overview of the conceptual, theoretical, and practical challenges that arise when using digital technologies to comply with regulatory regimes. Intelligent regtech “solutions” are often tailor-made to achieve better oversight and compliance outcomes. Such tools can make regulation and compliance easier and more efficient. Their use poses security challenges in respect of data, cyber security, and the consumer. Regtech also raises competition issues, as well as commercial and operational ones. We explore the research and policy implications by a targeted review of the literature. In doing this, we deliver new insights and highlight considerations for scholars and regulators alike. We articulate the concepts requiring further investigation. Our contribution is in defining regtech and establishing an interdisciplinary roadmap for further scholarly study.

1. Introduction

‘Regulatory technology’, also known by the neologism ‘regtech’, has recently attracted increasing academic attention. There are several pressing and emergent challenges that have arisen as a result of the increased use of digital techniques in regulation, particularly with regard to privacy, identity and ethics and the changing legal landscape.¹ At the same time, the role and importance of computational methods and data security in regtech is evolving. As a result, technology is altering the nature of oversight and compliance with regulation, a theme that runs throughout this journal. Regtech can be used to enhance societal goals, such as crime detection, and help reduce loss from errors and fraud. That said, the benefits and dangers of replacing human oversight must be considered. Acknowledging the scholarly need, we seek to establish a research agenda for evaluating the phenomenon which has received increasing attention and investment.²

- 1 Ross P. Buckley and others, ‘The road to Regtech: the (astonishing) example of the European Union’ (2020) 21 *Journal of Banking Regulation* 26.
- 2 Kari S. Larsen and Shariq Gilani, ‘Regtech is the New Black—The Growth of Regtech Demand and Investment’ (2017) 45 *The CAPCO Institute Journal of Financial Transformation* 27

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Received 4 Aug 2022, Accepted 6 Oct 2022, Published: 27 Oct 2022.

To address the theoretical gaps in what is understood about regtech, we explore how application and innovation in information communication technologies (ICT), especially through digital automation, impact both public and private regulatory stakeholders. We do this with specific reference to regulation and compliance in the financial sector. We then identify the lessons learnt which may be of use for other regulated industries. We conclude by proposing a research agenda to evaluate and understand the phenomenon in a deeper and more thorough way. This roadmap, which should be used to support a more dynamic policy agenda, includes the identification of a regtech taxonomy, the addressing of legal uncertainty, the identification of technological solutions, the development of preventive regulatory algorithms, and the criteria for measuring the success of regtech implementation.

In 2021, the global revenue from the regtech sector was estimated at around USD 2.87bn.³ Its adoption involves the implementation of new technology and automation techniques, and this is being driven by digital innovation especially in the private sector. Regtech is also increasingly being referenced by regulatory agencies to enhance oversight and enforcement activities.

- 3 Pavle Avramonic, Gergana Tomova and John Yeo, ‘The future of RegTech – what do firms really want?’ (*Insight: Opinion and Analysis Hosted by the FCA*, 2 June 2021) <https://www.fca.org.uk/insight/future-regtech-what-do-firms-really-want> (accessed 22 September 2022).

In order to assist regulators to learn from one another and facilitate the development of cross-industry best practice, we offer an initial mapping of existing regtech applications against regulatory pathways both within and outside of the financial sector. In doing so we establish a preliminary evidence base detailing where regtech has been employed effectively, where it could be employed effectively and where its use may be unsuitable or inefficient.

Innovation and advances in regtech by the private sector are being driven by technology's perceived ability to improve business practices, regulatory outcomes and help with the internal governance and oversight of companies. Arner and others suggest the widespread application of technology for this purpose may ultimately change the relationship between regulators and regulated.⁴ Aside from this long view, the adoption of regtech tools can improve the day-to-day lives of both these parties by automating the manual workload associated with compliance. Theoretical research, in contrast, is lagging technological innovation. It is for this reason that Wayne described regtech as a new frontier in legal scholarship, but it is also a new frontier in interdisciplinary scholarship on regulation and governance more widely.⁵

Regtech adoption results in more than just cost reduction. The direction of travel is towards greater integration of systems that have predictive analytics and are made more effective through continuous innovation. This extends its scholarly reach to statistical and computational methods. At the same time regtech is raising new and challenging questions concerning the relationship between regulation, technology, and innovation. The relationship has often been characterised as one in which technology leads and regulation follows.⁶ It could be argued that the development of regtech is indicative of the opposite: regulation leading, and technology following to better implement and comply with that regulation; or at least a more complex relation between technology and regulation than much of the existing literature identifies. This relationship has implications for broader questions about the use of automation in our societies and economies, as well as social, ethical and governance oversight, as acknowledged by Ulbricht and Yeung in their discussion of 'algorithmic regulation'.⁷

We argue here that regtech is in the process of transforming the relationship and dynamics between the regulator and regulated. It is extending oversight to the identification of fraud, scams and other illegal activity, rather than just their prevention. In finance, this includes accounting fraud.⁸ In the regulated utilities, it includes meter tampering and scams that persuade consumers to buy phone-related products/services.⁹ Regtech is also evolving. We suggest that transformation may

also extend to the compliance and oversight of new rules and standards in environmental, social and governance related areas.

The direction of travel in regtech research will depend on these over-reaching socio-economic questions (theory) as well as the ongoing relationship between regulation and innovation (practice). Although regulators in the UK, for instance, are encouraged to be "agile" in responding to technological change,¹⁰ the beliefs that technological innovation is inherently good and that "regulation stifles innovation" carry considerably less weight than they have previously both in the UK and elsewhere. We suggest that claims such as these should be treated with caution and scholars should focus on ethical as well as functional questions.

In summary, our proposed research roadmap aims to address gaps we identify in the literature in both theory and practice. We contribute to that literature by exploring the emergence of regtech as a field of study in the financial sector. Integral to this, we consider the emerging definitions of regtech and its evolution from fintech. Drawing on this experience, we consider opportunities and risks for regtech deployment in other sectors, especially those of other forms of critical infrastructure beyond finance, namely networked utilities, which we consider as being most ripe for digitalisation and automation of supervision and compliance.

2. Definitional Issues

Current definitions of the term regtech can be split into two broad schools of thought. Firstly, those scholars that identify regtech as a sub-division of financial technology or "fintech".¹¹ Secondly, those scholars that view it as a distinct sector, having evolved beyond its origins in the financial sector.¹²

What is clear is that regtech describes a broad spectrum of activities related to the use of digital technologies in compliance activities, be it in finance, the regulated utilities or indeed any sector.¹³ The term covers digital technology use by regulated entities, regulators, and third-party vendors. It especially refers to digital services and encompasses the regulatory user and compliance journey. The latter requires work-stream mapping and a proactive data approach which encompasses web scraping, digital reporting, process robotics, trend analysis, natural language processing, and cyber security. These all

4 Douglas W. Arner, János Barberis and Ross P. Buckley, 'FinTech, RegTech, and the reconceptualization of financial regulation' (2017) 37(3) *North-western Journal of International Law & Business* 371.

5 Vicki Wayne, 'Regtech: A new frontier in legal scholarship' (2019) 40 *Adelaide Law Review* 363.

6 Lyria Bennett Moses, 'Recurring dilemmas: The law's race to keep up with technological change' (2007) 2 *University of Illinois Journal of Law, Technology and Policy* 239.

7 Lena Ulbricht and Karen Yeung, 'Algorithmic regulation: A maturing concept for investigating regulation of and through algorithms' (2022) 16 *Regulation & Governance* 3; see also Karen Yeung, "'Hypernudge': Big Data as a mode of regulation by design' (2016) 20(1) *Information, Communication & Society* 118.

8 Shay Segal, 'Accounting frauds—review of advanced technologies to detect and prevent frauds' (2016) 2(4) *Economics and Business Review* 45.

9 Madalina Mihaela Buzau and others, 'Detection of non-technical losses using smart meter data and supervised learning' (2018) 10(3) *IEEE Transactions on Smart Grid* 2661.

10 HM Government, *Regulation for the Fourth Industrial Revolution* (2018 CP111) White Paper, 10.

11 Ioannis Anagnostopoulos, 'Fintech and regtech: Impact on regulators and banks' (2018) 100 *Journal of Economics and Business* 7; Lawrence G. Baxter, 'Adaptive financial regulation and Regtech: a concept article on realistic protection for victims of bank failures' (2016) 66 *Duke Law Journal* 567; Jamie Evans and Steve Browning, *Fintech: a guide to financial technology* (2021 Briefing Paper Number 9150); Larsen and Gilani (n 2); Bernardo Nicoletti, 'Regulations' in Bernardo Nicoletti, *The Future of FinTech* (Palgrave Macmillan, 2017); John Hill, *Fintech and the Remaking of Financial Institutions* (Academic Press, 2018).

12 Arner, Barberis and Buckley (n 4); Tom Butler and Leona O'Brien, 'Understanding Regtech for Digital Regulatory Compliance' in Theo Lynn, John Mooney, Pierangelo Rosati and Mark Cummins (eds), *Disrupting Finance: FinTech and Strategy in the 21st Century* (Palgrave Pivot, 2019); Ellinor Johansson, 'Regtech—a necessary tool to keep up with compliance and regulatory changes' (2019) 8 *ACRN Journal of Finance and Risk Perspectives, Special Issue Digital Accounting* 71; Dong Yang and Min Li, 'Evolutionary Approaches and the Construction of Technology-Driven Regulations' (2018) 54 (14) *Emerging Markets Finance and Trade* 3256.

13 The word "regtech" was first used in a UK Government report: UK Government Office for Science, *FinTech Futures: The UK as a World Leader in Financial Technologies* (2015).

must take account the fact that the data involved may be highly sensitive and difficult to access, such as personal data and/or confidential data in finance, which necessitates the use of privacy enhancing technologies.

Prior to defining regtech, we first define information communication technologies (ICT):

Definition 1 (Information communication technologies). A diverse set of technology and resources that can be used to transmit, store, create, share, or exchange information. These technological tools and resources include computers, servers, the Internet, storage, and telecommunication devices.

We then suggest regtech can be defined more usefully as:

Definition 2 (Regtech). Information communication technologies and automated approaches that fulfil key regulatory requirements and activities, that allow for the extraction, processing, and analysis of business and supervisory generated data to manage complexity, identify rule breaches, on-board clients, and promote efficiency.

This definition extends beyond finance and promotes the understanding of regtech as an umbrella term. It separates contemporary ICT based regtech from earlier forms of technology or technologies used for a regulatory purpose.¹⁴ It is also broad enough to cover all industries, not just finance. We argue this definition captures the numerous ICTs used to comply, enforce and understand regulation. Though falling short of explaining the phenomenon by its potential to shape the future of regulation, our definition acknowledges the potentially transformational nature of technology. It defines regtech by what it does rather than what it could do. Importantly, it also covers the new perspective that incorporates the direction of movement to more secure and intelligent solutions.

Our approach captures the view that a definition of regtech should encompass the increased efficiency and improved customer outcomes that are associated with it. Our addition of the concept of “automated approaches” to the definition widens its scope to include data cleansing, extraction of information from unstructured documents, automated intelligence gathering and dataset search capabilities. In this way, regtech can be seen as more than reducing the need for manual review. We argue this extends the scholarly remit to understanding and enabling better cognitive services. Our definition can also be used to frame ethical and societal questions arising from the use and application of the technology.

3. Literature

We undertook a targeted literature review using Scopus, JSTOR, Web of Science, IEEE xplora and Google Scholar with the help of two research assistants. There were 7,550 papers with “regtech” in the title, 2690 of them since 2020. When the terms “regulation” and “technology” were searched, there were 189,000 papers with both words in the title. We narrowed this down to 50 papers by quality of publication, with preference for SJR discipline rankings Q1 and Q2. We prefer that approach to citations due to the large numbers of new papers. We further looked for papers on compliance and oversight in finance, cross referenced against terms like risk, identity,

reporting, transaction monitoring and privacy, giving us another 50 papers. The latter terms are all areas in which automated regtech has been applied.

There are several fields in the literature where regtech is applied. These include: compliance, identity and risk management; regulatory reporting; transaction monitoring and fraud detection. Compliance with the rules is largely a checking process, and as such can be automated. Although identity verification can be also automated, it is necessary to check for fraudulent documentation. This requires text and other visualisation tools. Risk management, meanwhile, relies on algorithms and instrument pricing feeds. Statistical and computational methods can be applied in all areas. For example, transaction monitoring and fraud detection can all be done with predictive analytics. These all have applications in, but also beyond, finance.

Within the selected papers, we looked specifically for any evidence of successful and/or unsuccessful examples of regtech being used by either regulators or regulated companies. We also looked for any litigation or regulatory enforcement against finance sector companies specifically for using regtech. We extracted insights from the following questions:

- What is regtech?
- Is regtech different/new?
- How is regtech being used in the finance sector by both regulators and the regulated?
- What specific legal/regulatory frameworks are being implemented/complied with using regtech?
- What have been the benefits/disadvantages of using regtech?
- What have been the interaction with data protection and cyber security law?
- What have been bigger/broader/longer term trends in data and regulation? Digitalization and regulation?
- Regulatory theories and practices – how does regtech fit into this?

We have already addressed our findings from the first two questions. The uses of regtech are less well covered in the literature as they are by necessity practical issues. As a result, we note that many of the techniques used to address regulatory issues are only examined as single use cases: a case in point would be predictive analytics.¹⁵ For example, the use of machine learning to predict fraud or the use of random forest, a statistical technique, to evaluate credit risk. We confine our focus on regulatory framework to the United Kingdom, however we caution that this jurisdiction is more focused on supporting innovation than others (or at least claims to be).

As to advantages (benefits) and disadvantages, we note that the majority of the literature is centered on the former. The cost benefits of regtech are documented by most of the papers. Johansson and others make the point that it is also useful to keep up with regulatory changes.¹⁶ Arner and others go further than this and suggest that there is an emergence of what they call “regtech 2.0”, where the emphasis changes from knowing your customer to knowing your

¹⁵ Daniel Broby, ‘Financial technology and the future of banking’ (2021) 7 *Financial Innovation* 47.

¹⁶ Johansson and others (n 12).

¹⁴ Arner, Barberis and Buckley (n 4).

data.¹⁷ Disadvantages, such as bias in artificial intelligence, no human fail-safes, false positives on screening and the fact that risk as proxied by standard deviation is not additive, are poorly covered. Research into the need for human judgment in compliance and oversight is especially needed.

We observe that the extant academic literature addresses the phenomenon of regtech through two broad themes, namely: (1) how regulatory data is being digitalized; and (2) how regtech represents a paradigm shift from previous regulatory and compliance practices. An example of the latter from the financial sector is the increasingly automated “know your client” process. An example of the former includes the use of artificial intelligence in the evaluation of credit risk.¹⁸ The data science that is applied in such examples is based on interdisciplinary scientific methods, processes, algorithms and systems, all equally applicable to the networked industries. These allow the extraction of relevant information and insights using such tools as data mining, and machine learning.¹⁹ Despite this, there is not a cohesive body of scholarly thought on regtech. We suggest it is more a “field of study” that benefits from interdisciplinary insights.

There is a broad consensus within the literature that the demand for regtech adoption is being driven by two key interlinked factors: the growing complexity of regulation and the mounting cost of compliance. Despite once being described as a “niche market”,²⁰ investment in regtech has remained in the billions since 2017 and reached new heights in 2020, totaling USD 10.6 billion.²¹ This is a level of investment indicative of a widespread belief in the “transformational potential” of the sector. In this respect, the use of technology to aid regulatory processes is well established.²²

In addition to the literature, we reviewed what financial regulators in the UK, EU and internationally had written about regtech. We critically looked at the companies they regulate and their use of regtech, including whether they had policies and whether they used “regulatory sandboxes”.²³ These are set up by the regulator to support organisations that are developing innovative products and services in a safe environment. Given the pioneering of what has evolved into regtech from developments in the financial sector, we considered it pertinent to focus on it. The key insights from this literature review are as follows.

Firstly, the wide application of technology and algorithms used in regtech is echoed by many authors including Brand, who states that regtech has “assumed a much wider relevance across a range

of markets and sectors”.²⁴ Indeed, the use of technology in order to meet regulatory requirements across all sectors has been described as “definitively unavoidable” due to the mounting emphasis on data and reporting.²⁵ This is also, in our view, facilitated by the increasing complexity of systems and society, and the pervasiveness of digital technologies in everyday life for at least the last 15 years.²⁶

Secondly, academic enquiry into innovation in the regtech context, in contrast, focuses on the development of automated reporting capabilities, risk management and analytical tools, which have been spearheaded by the private sector, whether the regulatees themselves or third party regtech suppliers. We observe that there is a belief in some circles that regtech can enhance the public interest by addressing inefficiencies in compliance and oversight and their participants and also by ensuring good and effective regulation. Enriques, who documents this, however, points out that there are also risks. He identifies human resources as the weak link, particularly internal governance.²⁷ For example, employees might become overly confident about the output of algorithms and/or an automated approach. Likewise, regtech comes with cyber security risk as it is facilitated by protocols that expose an organisation to further data generation, networking and ICTs, including increased Internet use, which can give rise to cyber security threats.

Thirdly, there is some semblance of a taxonomy but it is as yet largely undefined. Buckley and others suggest that regtech is built on four unconnected pillars.²⁸ These are: the reporting requirements of (financial) companies; the data protection rules on privacy and confidentiality; the open banking and finance initiatives; and the digitalisation of identity. Application programming interfaces are a new regulatory tool.²⁹ They provide a set of functions or procedures that allow communication and interface in an automated way. In practice they allow data to be transferred without manual interaction. They therefore provide an economising solution for use in regulation where there are reporting requirements. Such an approach requires secure data transfer and has implications in respect of privacy, cyber security and third party permissioning.

In summary, the literature is nascent, growing rapidly and diverse. Determining a research agenda based on its evaluation requires that fundamental unanswered questions be addressed. Most important of these is an understanding of what both regulation and technology are. Only by understanding existing regulatory practices and technology paradigms can we then determine whether regtech

17 Douglas Arner, Dirk A. Zetzsche, Ross P. Buckley and Janos Barberis, ‘FinTech and RegTech: Enabling Innovation While Preserving Financial Stability’ (2017) 18(3) *Georgetown Journal of International Affairs* 47.

18 Anagnostopoulos (n 11).

19 Chikio Hayashi, ‘What is Data Science? Fundamental Concepts and a Heuristic Example’ in Chikio Hayashi and others (eds), *Data Science, Classification, and Related Methods. Studies in Classification, Data Analysis, and Knowledge Organization* (Springer 1998).

20 Institute of International Finance, *Regtech in Financial Services* (2016).

21 KPMG, ‘Pulse of Fintech H1’20 – Regtech’ <https://home.kpmg/xx/en/home/insights/2020/09/pulse-of-fintech-h1-20-regtech.html> accessed 22 September 2022.

22 Arner and others (n 17).

23 Stefan Philipsen, Evert Stamhuis and Martin de Jong, ‘Legal enclaves as a test environment for innovative products: Toward legally resilient experimentation policies’ (2021) 15(4) *Regulation and Governance* 1128.

24 Vivienne Brand, ‘Corporate Whistleblowing, Smart Regulation and Regtech: The Coming of the Whistlebot?’ (2020) 43(3) *UNSW Law Journal* 801.

25 Carla Stamegna and Cemal Karakas, *Fintech (financial technology) and the European Union: State of play and outlook* (2019) European Parliamentary Research Service (EPRS) Briefing, PE 635_513 [https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/635513/EPRS_BRI\(2019\)635513_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/635513/EPRS_BRI(2019)635513_EN.pdf) accessed 22 September 2022.

26 Bharat Dave, ‘Space, sociality and pervasive computing’ (2007) 34(3) *Environment and Planning B: Planning and Design* 381; Emmanouil Tranos and Yannis M. Ioannides, ‘Ubiquitous digital technologies and spatial structure; an update’ (2021) 16(4) *PLoS ONE* e0248982.

27 Luca Enriques, ‘Financial Supervisors and Regtech: Four Roles and Four Challenges’ (2017) 53 *Revue Trimestrielle de Droit Financier*.

28 Buckley and others (n 1).

29 Christopher C. Nicholls, ‘Open Banking and the Rise of FinTech: Innovative Finance and Functional Regulation’ (2019) 35(1) *Banking & Finance Law Review* 121.

represents a paradigm shift. So far, the scarce extant literature on regtech has not addressed this. The question of what the “technology” in regtech refers to has been addressed. It is either implicitly or explicitly based on ICT and some form of digital automation. The question of what “regulation” is, though, is more complex. We now look to regulatory studies to understand this. Three questions guided this: First, what is meant by regulation from a technology perspective? (section 3.1). Second, are there a set of procedures shared by regulators and the regulated that would benefit from the use of technologies? Also, do ICTs introduce technology specifications that merit distinction from other forms of compliance and oversight? (section 3.2). Finally, we investigate the role of the Internet and whether it represents a paradigm shift (section 3.3).

3.1. Technology and Regulation

There are numerous lines of scholarly thought on the role of regulation, although less so on technology and regulation. A selection of the former is referenced in this paper. The latter include the welfare-theoretic or public interest theory of regulation associated with Pigou, the contracting theory associated with Coase, and the capture theory of Stigler.³⁰ Peltzman argued the public interest school of thought is grounded in the assumption that unregulated markets can fail, and the belief that the state knows and can act in the public interest, which is preferable to group or self-interest.³¹ This view builds on the insights made by Stigler and Friedman on electricity regulation and subsequent contribution into the economics of information, and suggests that governments are able to correct failures in markets through regulation.³² Within the context of the State, regulation refers to deliberate Government intervention in cases of perceived market failure, ostensibly in the public interest. Instances of these failures through a neo-classical lens include, but are not limited to, anti-competitive behavior, externalities, information inadequacies, monopolies, and windfall profits.

As its name implies, regulation is core to regtech. Baldwin, Cave and Lodge suggest regulation can be understood in any or all of the following senses: as a specific set of commands; as deliberate state influence; as all forms of social or economic influence, whether this stems from the state or the market.³³ Under this broad understanding, regtech could refer to the application of technology in any or all of the following circumstances: a social media site monitoring its content for inappropriate or illegal material such as the controversial “upload filters” seemingly required by the new EU Copyright in the Digital Single Market Directive;³⁴ a mobile gambling app which prevents players exceeding certain time;³⁵ or an electronic entry system which requires users scan their ID. These diverse examples illustrate that any move

towards a definitive definition of “regtech” must provide a clear definition of what is meant by regulation in order to reduce the number of instances to which it applies (lest it become a term so broad and vague as to be meaningless) and justify why those activities which fall outside of this definition have been excluded.

One means of incorporating this broad collection of themes and addressing the scope of regulation at the same time is by focusing on shared procedures in cases of deliberate state influence. According to this line of thought, regtech can be defined as the use of ICTs, especially automation, AI and algorithms, to assist the regulator and/or the regulated in managing “sustained and focused control exercised by a public agency over activities that are socially valued”.³⁶ Focusing on the core procedures within this scope such as compliance, oversight and enforcement provides a systematic method for excluding technologies which could be deemed “regulatory” but are not regtech, such as the use of Microsoft Word or Excel by a regulator’s staff.

The adoption of this approach raises two immediate issues. First, it can be seen to exclude industry self-regulation (ISR), in which the regulated are also the regulator. For example, in the UK, the advertising, newspaper and film industries are partially or wholly self-regulated.³⁷ While these bodies may not have a legislative mandate, self-regulation as a form of “soft law”, may be a “viable source of the normative framework governing society”³⁸ as evidenced by the many self-regulatory bodies who hold considerable reputational power and punitive power within their respective industries. For instance, the independent industry funded Committee of Advertising Practice (CAP) and Advertising Standards Authority (ASA) are responsible for setting advertising standards and monitoring adherence to these standards in the UK. Focus on deliberate state action in this regard can be seen as neglecting many important regulators which monitor adherence to ethical, legal and safety standards, and, moreover, may benefit from the use of ICTs and automation in doing so.

That said, while some regulators may not always have a legislative mandate, the process of self-regulation is nonetheless shaped by the wider legal environment created and maintained by the State. The act of self-regulation in this light can be viewed as an effort to work within the law to avoid direct state action, such as new, more intrusive legislation for the industry (as has been threatened at various points in the past for the UK newspaper industry). Moreover, self-regulated industries are still subject to direct regulation in a number of cases, especially vis-a-vis generally applicable laws such as data protection or corporate governance law in the UK and EU. Thus, while the State is not acting directly in these instances, self-regulatory bodies can still be seen to be working within a framework of deliberate state influence.

Another issue is that by evoking the state and by extension legislation, the line is blurred between regtech, legal technology or “legaltech”/“lawtech”, and government technology or “govtech”.

30 Nahid Aslanbeigui and Guy Oakes, *Arthur Cecil Pigou* (Great Thinkers of Economics Series, Palgrave Macmillan 2015); Francesco Parisi, ‘Coase Theorem’ in Steven Durlauf and Lawrence Blume (eds), *New Palgrave Dictionary of Economics* (2nd ed, Palgrave Macmillan 2008); George J. Stigler and Claire Friedland, ‘What can regulators regulate? The case of electricity’ (1962) 5 *The Journal of Law and Economics* 1.
31 Sam Peltzman, ‘Toward a More General Theory of Regulation’ (1976) 19(2) *The Journal of Law and Economics* 211.
32 Stigler and Friedland (n 30).
33 Robert Baldwin, Martin Cave and Martin Lodge, *Understanding Regulation: Theory, Strategy, and Practice* (Oxford University Press 2012).
34 Felipe Romero Moreno, ‘“Upload filters” and human rights: implementing Article 17 of the Directive on Copyright in the Digital Single Market’ (2020) 34(2) *International Review of Law, Computers and Technology* 153.
35 Adrian Parke and others, ‘Facilitating Player Control in Gambling’ (2014) 8(3) *The Journal of Gambling Business and Economics* 36.

36 Philip Selznick, ‘Focusing Organizational Research on Regulation’ in Roger Noll (ed), *Regulatory Policy and the Social Sciences* (University of California Press 1985).
37 Binakuromo Ogbebor, ‘British Press System: Press Regulation and Accountability’ in Binakuromo Ogbebor, *British Media Coverage of the Press Reform Debate* (Palgrave Macmillan 2020).
38 Rolf H. Weber, ‘Sectoral Self-Regulation as Viable Tool’ in Klaus Mathis and Avshalom Tor (eds), *Law and Economics of Regulation: Economic Analysis of Law in European Legal Scholarship* (Springer 2021).

It is necessary therefore to differentiate between these. Like regtech, both legal/lawtech and govtech have multiple definitions. Broadly speaking, legaltech “refers to the application of new technologies to the world of law, to carry out tasks that, until recently, were performed by lawyers or other personnel working in law firms”.³⁹ Govtech is an umbrella term for various “new technologies applied to public services and specifically designed for government purposes”.⁴⁰ It is clear that there is some overlap among these categories: a lawyer using automated compliance tools to ensure that a client complies with regulatory obligations may be using both legaltech and regtech; a public regulator providing an automated complaints service to the public vis-a-vis companies it regulates may be providing both regtech and govtech. However, there are many circumstances in which there are clear differences in how a particular automated ICT is used in a particular situation, which would make it exclusively regtech and not legaltech or govtech. Legaltech and govtech aside, regtech also has various subcategories including “compliance-tech”, “supervisory-tech” and “policy-tech”. Though Buckley and others view regtech as an umbrella term for these classifications, further research is required to certify this status and verify that the role of these applications for a regulatory purpose is not better understood in isolation.⁴¹ To use an analogy, while each part of an engine performs a different function, together they function for a singular purpose and can be understood as an object in and of itself.

Regtech must achieve a similar level of cohesiveness to establish itself as a distinct sector and evidence that it is not simply “tech for reg” or an “opportunity for fintech firms to develop new regulatory tools”.⁴² An important first step towards doing so is to understand whether there is a set of procedures shared by regulators and the regulated that would benefit from the use of technologies. A more difficult future step is to aid the convergence of regtech platforms across industries and countries, a difficulty which reflects non-technological barriers such as divergent regulatory regimes in different jurisdictions, for example, with the Internet itself being a case in point.⁴³

A recurrent discussion in the literature is on the question of self-regulation, and whether rules are better suited to automation than principle-based regulation.⁴⁴ Regtech has the ability to go beyond individual externalities and prove helpful in the trend towards responsive regulation, extending even to environmental issues. In Friedman and Friesen’s view, business compliance is a cost to society and the approach to regulation needs to change.⁴⁵ In response to the deregulation debate, Ayres and Braithwaite proposed a principled way

in which governments can be responsive to their self-interest as well as normative and social motivations.⁴⁶ They contentiously argue for third parties, particularly NGOs, to be directly involved in regulatory oversight. Technology has advanced to a level where such responsiveness becomes possible for corporate entities. However, the creation of additional digital data and networking via regtech, like any digital technology use, also comes with its own environmental costs.⁴⁷ Yet the automation that regtech brings may help with mitigating costs and improving regulation. We now turn our attention to the literature on whether and how that is being done.

3.2. Procedures, processes and systems using ICT

Compliance procedures, processes and systems require guidance, templates and reporting protocols. These all have to be delivered in a secure way. Within finance, these concepts cover the duty of care and conduct of business requirements and are used in both monitoring and oversight. They are often elaborate and complex, covering the individual, the organisation and the marketplace. The use of technology to aid procedures, processes and systems is well established.⁴⁸ We illustrate the interaction in Figure 1 which depicts how automation and data analysis can be incorporated into the compliance environment. These link to the development of supervisory technology or “suptech”, the use of innovative technology in financial supervision.

There is a broad consensus within the finance related literature that demand for regtech is being driven by the growing complexity of regulation and the mounting cost for businesses of compliance using technology. The growing complexity of regulatory procedures, processes and systems require that we differentiate between the notions of “complex” and “complicated”. While both notions necessitate understanding of a high number of component elements, complicated systems can be understood in isolation. If on the other hand, the system in figure 1 cannot be explained without reference to its interactions with other systems, rules, controls and/or regulators then it can be said to be complex. Regulation is a complex system. Whilst one can describe the contents of an individual regulation it cannot be fully understood without knowing who it concerns and in which circumstances. Thus, to fully understand a regulation one must understand how it relates to the broader regulatory environment: an environment which has become “transboundary and cross sectoral”.⁴⁹

We suggest that while this growth in complexity is often framed within the regtech literature with reference to the Global Financial Crisis (GFC), the complexity of current regulatory systems cannot be fully attributed to the GFC alone.⁵⁰ Instead, it should be understood through the broader lenses of the shift to regulatory capitalism from the 1990s, and the shift to digitalisation.⁵¹ To this end,

39 Esther Salmerón-Manzano, ‘Legaltech and Lawtech: Global Perspectives, Challenges, and Opportunities’ (2021) 10(2) *Laws* 24.

40 Justine Desmond and Bhavin Kotecha, *State of the UK GovTech Market* (Public 2017) <https://www.productivity.govt.nz/assets/Submission-Documents/5f89275e79/DR031-GovTech-World-Attachment-Two-1225Kb.pdf> accessed 22 September 2022.

41 Buckley and others (n 1).

42 UK Parliamentary Office of Science and Technology, ‘Financial Technologies POSTnote’ (Medium, 24 May 2016) https://medium.com/@POST_UK/financial-technologies-postnote-e244af93e667 accessed 22 September 2022.

43 William Drake, Vinton Cerf and Wolfgang Kleinwachter, *Internet Fragmentation: An Overview*. Davos: World Economic Forum (2016) https://www.zora.uzh.ch/id/eprint/121102/1/WEF_FII_Internet_Fragmentation_An_Overview_2016.pdf accessed 22 September 2022.

44 Darren Sinclair, ‘Self-Regulation Versus Command and Control? Beyond False Dichotomies’ (2002) 19(4) *Law & Policy* 529.

45 Stephen J. Friedman and Connie M. Friesen, ‘A New Paradigm for Financial Regulation: Getting from Here to There’ (1984) 43(3) *Maryland Law Review* 413.

46 Ian Ayres and John Braithwaite, *Responsive regulation: Transcending the deregulation debate* (Oxford University Press 1992).

47 Tanya Notley, ‘The environmental costs of the global digital economy in Asia and the urgent need for better policy’ (2019) 173(1) *Media International Australia* 125; Benedetta Brevini, *Is AI good for the Planet?* (Polity Press 2021).

48 Arner and others (n 17).

49 Eva Thomann and Fritz Sager, ‘Moving beyond legal compliance: Innovative approaches to EU multilevel implementation’ (2017) 24(9) *Journal of European Public Policy* 1253.

50 Esman Kurum, ‘Regtech solutions and AML compliance: what future for financial crime?’ (2020) *Journal of Financial Crime*.

51 Christine Parker and Vibeke Nielsen, ‘The Challenge of Empirical

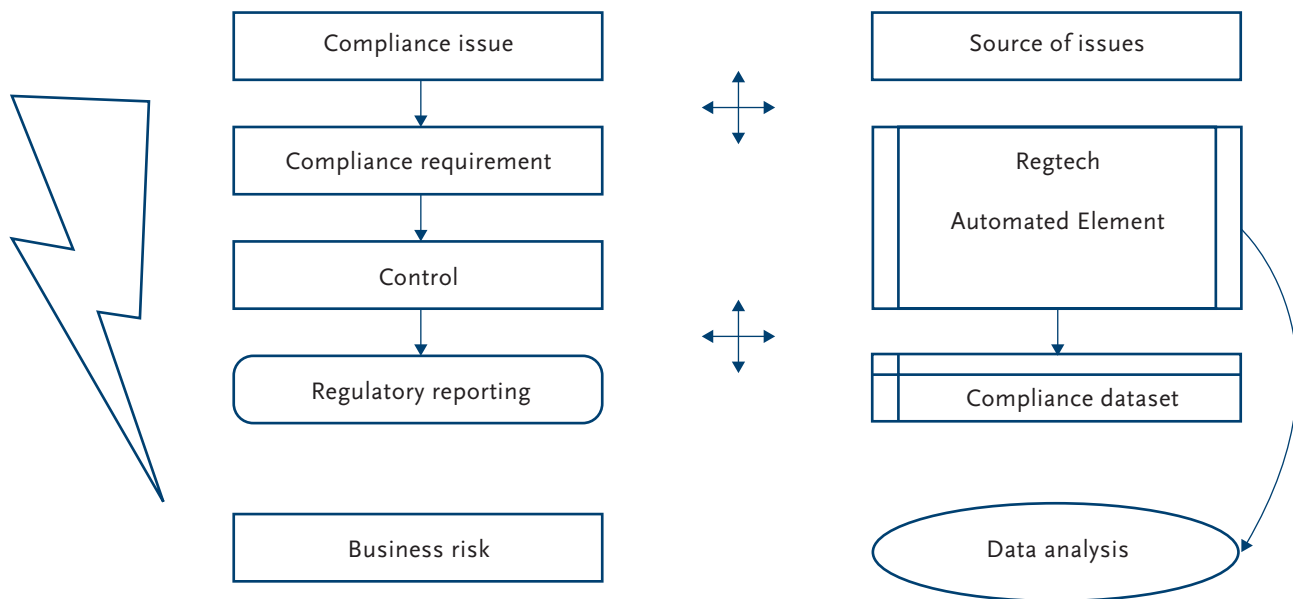


Figure 1. This figure shows how regtech can be embedded in the compliance architecture. Data analysis and automated procedures run alongside the traditional control and reporting environment.

Buckley and others provide a useful framework for understanding the significant developments in digitisation and its regulation in the form of regulatory instruments which have led to the emergence of a regtech sector in the European Union, namely: AIFMD and MiFID II (financial regulation); GDPR (data-protection); PSD 2 (payments) and eIDAS (digital ID).⁵² This is because the role of identity has become more important and digital payments have been separately defined. We argue that similar lessons can be learnt by the regulated utilities, although these have other regulatory issues such as price control and service reliability.

Taken together, the emphasis on data and reporting established by these regulations has made the use of technology to understand and comply with regulation “definitively unavoidable”.⁵³ This is evidenced by a survey of executive risk managers and compliance officers in German financial institutions which found that 89 percent of those surveyed saw a strong need for technological solutions to manage complexity and increase efficiency.⁵⁴

For the regulated and regulators alike, this growth in complexity has led to a parallel growth in costs as they seek to understand and comply with regulatory requirements. That said, to date regtech investment has primarily been driven by the financial sector’s interest in increasing efficiency and reducing compliance costs.⁵⁵ This is largely due to the high cost of non-compliance in this sector as Shizas and others note, “adoption has been strongest where it has been sup-

ported by legislative initiatives that punish non-compliance with large fines or criminal sanctions”.⁵⁶

Penalties notwithstanding, the growing complexity of regulation has also raised compliance costs in terms of: experts’ time; wages; and general processing costs. While regtech has traditionally been associated within the financial sector, these applications can be viewed as regtech’s “low-hanging fruit”.⁵⁷ The growing emphasis on data and reporting in the wider regulatory environment means that similar complexity problems and costs exist, but efficiency gains are also there to be made, across all sectors.

For the regulator, regtech offers a similar means of decreasing complexity and its subsequent costs as they seek to interpret their remit and monitor compliance in addition to supporting growth and innovation amongst the regulated.⁵⁸ Fines for non-compliance with data protection regulation have become significant, prompting more investment in regtech solutions that avoid such eventualities.⁵⁹ Having said that, regtech utilisation amongst regulators is necessitated by its use amongst the regulated. Failure to adopt these technologies could result in technology-based power asymmetries. In this light, regulator investment in regtech is necessary to prevent situations in which the regulated are able to utilise technology

Research on Business Compliance in Regulatory Capitalism’ (2009) 5 Annual Review of Law and Social Science 45.

52 Buckley and others (n 1).

53 Stamegna and Karakas (n.25) 3.

54 Michael Becker and Rüdiger Buchkremer, ‘Implementierung einer Regulatory Technology Lösung bei Finanzinstituten unter Berücksichtigung agiler Vorgehensmodelle’ in M Mikuzs and others (eds) *Projektmanagement und Vorgehensmodelle 2018 - Der Einfluss der Digitalisierung auf Projektmanagementmethoden und Entwicklungsprozesse*. (Gesellschaft für Informatik 2018).

55 Arner and others (n 4) 14.

56 Emmanuel Schizas and others, *The Global RegTech Industry Benchmark Report* (Cambridge Centre for Alternative Finance 2020) https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3560811 accessed 22 September 2022.

57 Robin Lee and Sharifah Isha, ‘Regtech Applicability Outside the Financial Services Industry’ in Janos Barberis, Douglas W. Arner and Ross P. Buckley (eds), *The REGTECH Book* (Wiley 2019).

58 Eva Micheler and Anna Whaley, ‘Regulatory technology: replacing law with computer code’ (2020) 21 *European Business Organization Law Review* 349.

59 Paul Ryan, Martin Crane, and Rob Brennan, ‘GDPR Compliance tools: best practice from RegTech’ in J Filipe and others (eds), *Enterprise Information Systems. ICEIS 2020. Lecture Notes in Business Information Processing*, (Springer 2021).

to circumvent their responsibilities, as was seen in the case of Volkswagen's emission scandal.⁶⁰ The literature suggests that there is a view that regulators are lagging behind industry in the adoption of innovation.

Many of the regtech applications are built on statistical analysis of the internal corporate data and aggregated regulatory filings. Financial fraud, for example, is identified using a combination of statistical, data visualisation, data mining, and filtering tools. Bankruptcy predictions can be made using machine learning. Similarly, credit defaults are predicted using decision tree regressions. The monitoring of text has also added new regtech avenues such as the oversight of social media activity using Natural Language Processing, information retrieval to undertake structured and unstructured data mining. Cyber crime can also be detected using statistical techniques, for example combining a set of reputation blacklists with machine learning algorithms.

The compliance process has also been transformed. Customer segmentation can be enhanced using data mining and decision trees. For example, customer life cycle and product appropriateness can be modelled using hybrid data mining, Markov chains, optimisation and analytical hierarchy. All of this suggests there is room for further research on data bias and optimal algorithms. In financial services, the concept of an oversight regulator exists. This is a slightly different approach to that taken in the regulated utilities. The latter approach has the regulator and the utilities interacting in a process focused on the market price, namely price determination, its oversight and compliance. Oversight in financial markets is more focused on behaviour, an area where regtech could potentially remove human bias. The financial sector has been at the forefront of the adoption of data science methods and lessons can be learnt from that. This learning process is illustrated by the increase in the dimension and weight of finance and economics literature mentioning big data from 2015 to 2019.⁶¹ This occurred in parallel with the migration of many financial platforms to the Internet which, in turn, led to the development of innovative regtech start-ups. These provided ICT solutions to regulatory, compliance and oversight problems based on the same broad innovations.

Much regtech scholarship to date examines regtech's use within the financial sector and is linked to discussions and applications of financial technology or "fintech". To illustrate, the Philippines Central Bank developed an Application Programming Interface (API) for their prudential reporting system.⁶² This use case shows how the central bank moved the previous reporting regime from Excel-based spreadsheets to an automated approach. It now incorporates transmission, processing, warehousing, and analysis in a seamless way.

Given the varied applications and co-creation, it is unsurprising that regtech is sometimes viewed as a subset of fintech. In this interpretation, it facilitates the execution of regulatory requirements more

efficiently than human based interventions.⁶³ Where regtech and fintech differ can be attributed to whether the application of these technologies is either for a regulatory purpose within finance, or instead also has the ability to perform a regulatory purpose outside of the finance sector.

3.3. The role of the Internet - A paradigm shift?

We also investigate how regtech interacts with previous or predecessor themes in regulation and technology, especially the Internet. This includes, more recently, automation and algorithms. Within fintech, Broby makes the case that the Internet fundamentally changes the nature of financial mediation.⁶⁴ This is because it allows peer to peer interaction linking borrowers with lenders and investors with entrepreneurs. Similarly, the Internet and associated and successor Internet-enabled technologies are a major driver of innovation in regtech. They alter the way data is created, disseminated and processed, creating a focus on digital reporting. Without them, there would be no regtech. In this respect, scope is important as is whether something very fundamental is happening to the way we regulate because of the Internet and ICTs.

Indeed, the increased scope of regulatory oversight suggests something fundamental is occurring. Many sectors of the economy, like all other aspects of society, have undergone a significant digitalisation of processes and practices over the last twenty years. This has been accelerated due to the widespread availability of, and developments in, digital technologies and the Internet. While the pace and shape of digitalisation may differ from industry to industry, and from country to country, the use and integration of digital technologies in regtech is following a similar trajectory. Houdek observes that regtech solutions should incorporate efficiency, intelligence, assurance, availability, and enjoyment.⁶⁵

The digitalisation associated with the Internet in regtech is viewed by us as potentially disruptive. It changes the relationship between businesses and their customers, and hence by extension the regulatory oversight of this relationship. Indeed, digital transformation is an important theme in academic research.⁶⁶ That said, another important theme is that the Internet and its successor technologies and applications also bring with them new techniques and procedures to settle transactions. The Internet is enabling compliance in currently less regulated areas such as environmental compliance, labour rights and governance issues. However, digitalisation is a two-edged sword, as there are environmental costs to using the Internet as mentioned earlier, and the Internet has facilitated an erosion of labour rights in some areas through gig work.⁶⁷

There are several new technologies such as blockchain, an immutable distributed ledger, that are being used by regtech companies. Blockchain is open-source technology and its role in regtech is as an alternative to the traditional intermediary process. In this respect, the

60 Ben Wagner, 'Algorithmic regulation and the global default: Shifting norms in Internet technology' (2016) 1 *Etikk i Praksis-Nordic Journal of Applied Ethics* 5.

61 José López-Roble and others, 'The last five years of Big Data Research in Economics, Econometrics and Finance: Identification and conceptual analysis' (2019) 162 *Procedia Computer Science* 729.

62 Simone Di Castri, Matt Grasser and Arend Kulenkampff, *An API-based Prudential Reporting System for the Bangko Sentral ng Pilipinas (BSP): R2A Project Retrospective and Lessons Learned* https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3596276 accessed 22 September 2022.

63 Anagnostopoulos (n 11).

64 Broby (n 15).

65 Tobias Houdek, 'Introducing the RegTech Quality Compass: The Five Factors of RegTech Quality' in Janos Barberis, Douglas W. Arner and Ross P. Buckley (eds), *The REGTECH Book* (Wiley 2019).

66 Anandhi Bharadwaj and others, 'Digital Business Strategy: Toward a Next Generation of Insights' (2013) 37(2) *MIS Quarterly* 471.

67 Mark Graham and others, *The Risks and Rewards of Online Gig Work At The Global Margins* (Oxford Internet Institute 2017); Nikos Koutsimpogorgos and others, 'Conceptualizing the Gig Economy and Its Regulatory Problems' (2020) 12(4) *Policy @ Internet* 525.

intermediary is replaced by the collective verification of the ecosystem offering a huge degree of traceability, security and speed. The blockchain can be used to handle collateral, making settlement more efficient, cost effective and secure. This use case allows for an expansion on the use of collateral and therefore increase firms' access to capital.⁶⁸ Once again, we see evidence of a paradigm shift for financial regulation. Yet blockchain has fierce critics including those who question whether it can do what its proponents claim.⁶⁹ This demonstrates the differing perspectives on and complex nature of technology use and implementation in regulation.

From a research gap perspective, the evolving role of the Internet is presenting significant challenges to regtech due to ambiguities in legal frameworks, and inconsistencies across national jurisdictions, while the Internet is a global, transnational technology. Yet the Internet is also an enabler of regtech since without it, regtech would not exist as we know it. The Internet also reduces the cost of many transactions and the cost of their transmission. It enables different forms of communication and at faster speeds. This benefit extends to regtech. Yet we caveat our observations because the Internet also causes compliance issues in respect of cyber security, data protection and intellectual property among others and is still evolving.

Alongside the phenomenon of digitalisation and digital transitions, the regulation and governance of digital technologies has been a prominent topic in regulation and governance research over the last two decades.⁷⁰ With the advent of the Internet, and the increasing digitalisation of society and the economy, issues regarding compliance with legal and regulatory frameworks have arisen. These include the regulation of digital information, computational law and the convergence of technology “super convergence” and business models. These issues are compounded by the fact that there is limited harmonisation of Internet regulation at the international level.

Innovative technologies, including new ways of automation and better algorithms, are also presenting ways of facilitating more, cheaper and better regulation. These give rise to regulatory problems around the need to regulate these technologies too.⁷¹ We can see the development of regulatory regimes around the Internet and ICTs, such as data protection and cyber security, becoming key issues for regtech as well. Other issues related to algorithms, AI and automation include discrimination and bias regarding protected characteristics including gender and race, which may be present in training datasets, how these technologies operate and how they are deployed.⁷² Such biases and discrimination should not be imple-

mented through regtech applications, and so is another area of research which must inform regtech.

We suggest that regtech upends the previous paradigm of concentration on the regulation of ICTs and the Internet by focusing on the integration of these technologies in regulatory processes. As mentioned earlier, received wisdom is that regulation lags behind technological development, even if in reality the picture is more complex, particular in the context of deregulatory trends from the 1970s-1990s.⁷³ Regtech shows instead technology enabling regulation and possibly changing the nature of regulation and how technology is used. This, coupled with the more pro-active “regulatory turn” towards the Internet and related technologies and applications, particularly in the UK and EU, suggests a paradigm shift in how the relationship between the Internet, ICTs and regulation is conceptualized.⁷⁴ Regulation is no longer lagging behind technology, but enabling it and even shaping it. However, this may not always be a desirable and positive process: on the topic of governance by algorithms, Gritsenko and Wood conclude:

In sum, algorithmic tools have an impact on the ways actors communicate, build, and maintain relationships, which results in declining interdependence of their choices, but an increasing dependence on technical systems for the capacity to coordinate actions. In particular, with the advent of machine learning, past interactions have an impact on the future, yet, in an opaque, invisible manner.⁷⁵

4. Towards a Research Agenda

Having identified that regtech may enable more efficient and predictive compliance and oversight through the use of intelligence, we now address how scholars can support its adoption and evolution over time through addressing the identified research gaps. We illustrate the proposed roadmap in Figure 2 for this research agenda. It covers a number of disciplines, including finance, law, computing, management science and statistics. The legal issues are particularly challenging due to the evolving nature of the technology. These include data security, enforceability and the problem of multiple jurisdictions.

In setting out the research agenda it is important to recognise that regtech is dependent on third party providers. These include software, cloud computing, programmers and data services. These providers may fall outside of the regulatory remit. It is also important to understand the role of cyber security and threats to an organisation's data. It is also important to understand its role as a system wide change force following for example Omarova's discussion on “Technology vs Technocracy”.⁷⁶

Firstly, we identified the need to create a taxonomy so that there is a common set of definitions and understanding. We believe his first step will ensure scholarly consistency, which some of our observations in section two will support. Such a taxonomy should then be supported by a mapping of what is known and what is not known

68 Juan Antonio Ketterer, *Digital Finance: New Times, New Challenges, New Opportunities* (2017) IDB-Inter American Development Bank Discussion Paper No IDB-DP-501.

69 Robert Herian, 'Taking Blockchain Seriously' (2018) 29 *Law and Critique* 163; Jannice Käll, 'Blockchain Control' (2018) 29 *Law and Critique* 133.

70 See e.g. Robert Hahn, Robert Litan and Hal Singer, 'Addressing the next wave of Internet regulation: Toward a workable principle for nondiscrimination' (2010) 4(3) *Regulation & Governance* 365; Alexander Kharlamov and Ganna Pogrebna, 'Using human values-based approach to understand cross-cultural commitment toward regulation and governance of cybersecurity' (2021) 15(3) *Regulation & Governance* 709; Karen Yeung and Lee Bygrave, 'Demystifying the modernized European data protection regime: Cross-disciplinary insights from legal and regulatory governance scholarship' (2022) 16(1) *Regulation & Governance* 137.

71 Ulbricht and Yeung (n 7).

72 Timnit Gebru, 'Race and Gender' In Markus D. Dubber, Frank Pasquale and Sunit Das (eds), *The Oxford Handbook of Ethics of AI* (Oxford University Press 2020).

73 Angela Daly, *Private Power, Online Information Flows and EU Law: Mind the Gap* (Hart 2016).

74 Terry Flew, Fiona Martin, and Nic Suzor, 'Internet regulation as media policy: Rethinking the question of digital communication platform governance' (2019) 10(1) *Journal of Digital Media and Policy* 33.

75 Daria Gritsenko and Matthew Wood, 'Algorithmic governance: A modes of governance approach' (2022) 16(1) *Regulation & Governance* 45.

76 Saule T. Omarova, 'Technology vs Technocracy: Fintech as a Regulatory Challenge' (2020) 6(1) *Journal of Financial Regulation* 75.

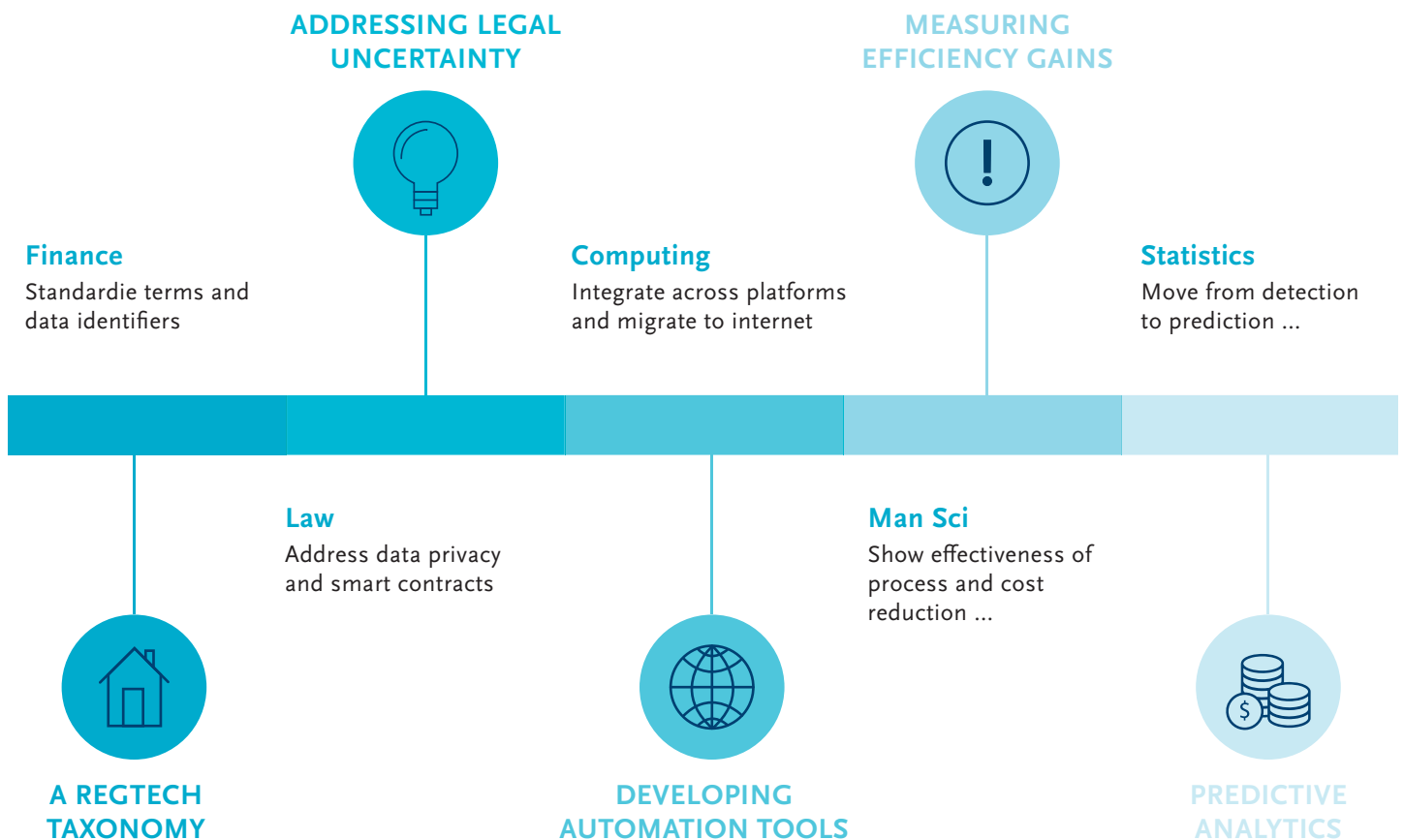


Figure 2. This figure shows how the identified gaps in the regtech literature might be visualised in a roadmap. Although research can be conducted in parallel, it illustrates the logical steps in developing regtech by building on past precedents.

about regtech use in different sectors and in different countries and regions. This would give better insights into data and rules. Further to this taxonomy, we would suggest it makes sense to develop a regtech pedagogical curriculum. This could then be used for certification under the various competence regimes. This will also help address some areas of ambiguity arising from understanding of terms and technologies.

Secondly, there is the need to address the relationship between regtech and other legal frameworks to ensure regtech itself is compliant. While regtech as noted can help regulation be administered and compliance be demonstrated more efficiently, here are also potential clashes between regtech and other aspects of legal and regulatory frameworks including data protection, cyber security, and anti-discrimination law. Clarifying this relationship can ensure regtech is developed and implemented in compliant ways of its own. Understanding this relationship better may also involve providing clarity on other issues such as the liability of outsourced and automated compliance. Several areas of legal ambiguity need to be addressed. This is particularly important for smart contracts, an area which regtech is embracing. Where does the liability arise where a regtech based digital algorithm fails? The traditional approach in finance would be to hold the corporation accountable for failure by a human employee. The legal framework for corporate liability may therefore be revised to reflect the shift in corporate function. Specifically, intent to benefit is not a liability defense under “respondeat superior” because algorithms do not have intent and do not make contracts.

Thirdly, the road map requires further technological input. The paradigm shift mentioned in section three needs further work to assess its implications and computing scholars need to provide more robust and inter-operable code as this would make regtech more efficient and universal. Further research also needs to be done to investigate the issue of trust and automated procedures. This includes the nature of trust in the choice of outsourced provider. Allied to this, more research needs to be done on how blockchain and decentralised technologies can be used in regtech applications where there are untrusted parties involved. This is desirable as more and more confidential data is being placed on blockchains.

Fourthly, management science scholars should assist with the development of preventative oversight. This can be achieved through the use of predictive analytics. The success of such techniques needs to be empirically evaluated. The risks in predictive analytics also need to be fully understood, including bias and discrimination. Creating an evidence base for appropriate and inappropriate uses of analytics accounting for risks and benefits may foster responsible innovation and the uptake of ethical methods. The backbone of regtech also needs to be further developed and strengthened. This implies research to address the technology challenges of systems integration. Business schools could also help navigate this paradigm shift, with a research informed approach (for example, by helping companies with the buy (outsource) versus build (internal) decision).

Finally, the fifth leg of our proposed roadmap is the provision of statistical output and analysis. As we have shown, automation is at the core of regtech. Research should therefore be conducted to

measure the efficiency gains. Similarly, computer science academics can develop data identifiers to promote further automation. Other disciplines could develop natural language text corpus and weighting schemes to support oversight of text in regtech applications. Business schools could help companies with the buy versus build decision, perhaps using a horizon scanning approach to understand relevant technology trends.

5. Lessons for other regulated industries

We now turn our attention to other regulated industries. The lessons learnt in the financial sector are, in our opinion, most useful for the regulated utilities: electricity, telecommunications, water and gas. These are regulated sectors in which data can be optimally stored and categorised, so the regulator can provide a safe collaborative environment in which to innovate and costs can be reduced through automation. This is because the utilities can benefit from better use of data analytics and process automation in regulation and compliance. The nature of oversight of these entities is, however, very different. Utilities are not subject to the extensive financial anti money laundering, know your client and stress testing rules. Yet, there are still reporting requirements in the regulation of utilities. Other common denominators, as observed by Arner and others are the under-resourced nature of the regulators, the increasing data they generate, and the need for data protection.⁷⁷

The regulation of utilities in the United Kingdom, and elsewhere, is complicated by the cross sectoral importance of data protection compliance, as well as price cap regulation, profitability and delivering a return on investment.⁷⁸ In this context, Stenzel and Frenzel suggest that such companies in these regulated industries manage their technological change in a strategic way in response to subsidies.⁷⁹ We suggest that such financial metrics can be embedded into smart contracts, thereby making their implementation easier by the regulated. These are automated programs that avoid ambiguity, thereby making compliance more straightforward.

While ICTs can be applied in many different regulatory contexts outside of finance,⁸⁰ the financial data produced by some regulatory process may muddy the proverbial water. For example, non-financial regulated sectors may still report in financial terms. This lends credit to the argument that regtech should be defined as a vertical of fintech. With that said, there are a high number of regulatory activities that do not utilise fiscal measures or produce financial outputs: the question is whether these processes require a level of ICT specification that merits distinction from other applications.

For the regulated and regulators alike, the aforementioned growth in complexity in all of these sectors has led to a parallel growth in costs as they seek to understand and comply with regulatory requirements. That said, to date regtech investment has primarily been driven by the financial sector's interest in increasing efficiency and reducing compliance costs. This is largely due to the high cost of non-compliance in this sector as Shizas and others note, "adop-

tion has been strongest where it has been supported by legislative initiatives that punish non-compliance with large fines or criminal sanctions".⁸¹

Penalties notwithstanding, the growing complexity of financial regulation has also raised compliance costs in terms of experts' time, wages and general processing costs and this will most likely also occur at the regulated utilities. While regtech has traditionally been associated within the financial sector, these applications can be viewed as regtech's "low-hanging fruit", as previously mentioned. The growing emphasis on data and reporting in the wider regulatory environment means that efficiency gains are there to be made across all sectors. Yet each regulated sector and framework in the utilities has its own features and complexities, as well as potentially differing attitudes towards ICT integration and digital transformation including the inevitable earlier take-up of ICTS in telecoms regulation compared to some other sectors.⁸² This may influence the extent to which regtech is implemented and valued in particular networked utilities, or the extent to which pre-existing implementations of ICTs for regulatory functions in these sectors may be considered ex post as regtech applications.

6. Conclusion

In this paper, we presented a research roadmap and some policy issues for secure and intelligent regtech that includes developing clearer definitions, taxonomy, legal framework, algorithms, and success criteria. We defined regtech in the context of ICT and the automated approaches that fulfill key regulatory requirements and activities. Our review of the literature on the subject identified three broad themes associated with regtech: automated regulation, ICT procedures, process and systems and the role of the Internet. The latter represents a paradigm shift in the way regulatory oversight is moving, from enforcement towards a more predictive model.

Our roadmap is relevant because regtech is seeing a great deal of investment to drive efficiency and the scope of regulation is increasing. We presented an overview of this. Our definition of regtech based on ICT approaches that fulfill key regulatory requirements and activities, extends the scope of regtech to identity and verification, key areas not captured by other definitions. Regtech has the potential to change the relationship between regulators and the regulated in the networked utilities. It is yet unclear in what form this transformation will manifest itself, but we believe valuable lessons can be learnt from the financial sector's regtech roll out. We observe the law and regulation are no longer trailing technological change, if ever this was indeed the case. We have suggested ways forward for further interdisciplinary research on regtech, in which finance, law, computing, management science and statistics scholars can evaluate its success or otherwise.

Our review revealed a diverse nature of the research questions which need to be addressed. These range from the issues of trust through to the interdisciplinary adaption of predictive and analytical techniques, the most important being the addressing of legal ambiguity as it

77 Arner, Barberis, and Buckley (n 4).

78 David Parker, 'Price cap regulation, profitability and returns to investors in the UK regulated industries' (1997) 6(4) *Utilities Policy* 303.

79 Till Stenzel and Alexander Frenzel, 'Regulating technological change—The strategic reactions of utility companies towards subsidy policies in the German, Spanish and UK electricity markets' (2008) 36(7) *Energy Policy* 2645.

80 Arner and others (n 17) 10.

81 Schizas and others (n 56).

82 See e.g. Peter Humphreys and Stephen Padgett, 'Globalization, the European Union, and Domestic Governance in Telecoms and Electricity' (2006) 1(3) *Governance* 383; Rajiv Kohli and Shawn Johnson, 'Digital Transformation in Latecomer Industries: CIO and CEO Leadership Lessons from Encana Oil Gas (USA) Inc.' (2011) 10(4) *MIS Quarterly Executive* 141.

relates to data and privacy. There are also a number of allied practical issues. Firstly, we suggest that as regtech streamlines compliance and oversight, it is important to make the process proportionate in the context of business outcomes. Secondly, the regulators and the regulated need to address legacy IT and adopt a responsible technology-embracing approach. This includes the development of skills and the need to educate management and the consumers. Awareness of the risks posed by regtech (and regtech's basis in the Internet and automation) and the need to address and mitigate those risks in any roll-out will contribute to an appropriate and responsible development and implementation of regtech.

We showed how the financial sector led the way in embracing regtech and showed how the regulated utilities can learn valuable lessons from the state of the art. We conclude that this can lead the activities of the regulators to become more predictive, efficient, and automated. It will lead the regulated to reduce costs and hopefully make less mistakes, if implemented in an evidence-based and responsible manner.

In conclusion, the regtech phenomena is likely to be here to stay. It is moving towards more secure and intelligent solutions. We therefore propose a research roadmap that captures this theme and a policy agenda that recognises the changing landscape. It begins with the need to establish a taxonomy and extends to the need for standardisation of data classifiers. We suggest scholars address any legal ambiguity and compliance issues with regtech itself. We propose more research into privacy and anti-discrimination issues. This extends to a realistic and practical appraisal of new techniques, such as blockchain and distributed ledgers. Overall, we see a continuance of the development of automated techniques and propose more work on predictive analytics to support this, as well as greater empirical and better statistical measurement of the regtech phenomena. Our roadmap points to a greater focus by academics on security and intelligence, which both have real world implications for crime detection and prevention.

Acknowledgements

We would like to thank Catalina Velandia Quimbayo for her research assistance. We would also like to thank the University of Strathclyde Faculty of Humanities and Social Sciences Grant Support Scheme for funding this research.

Abbreviations

Regtech, regulatory technologies
 AI, artificial Intelligence
 ML, machine learning
 ICT, information and communication technologies
 GFC, global financial crisis
 AIFMD, Alternative Investment Fund Managers Directive
 MiFID, Markets in Financial Instruments Directive
 GDPR, Global Data Protection Regulations
 PSD2, Payment Services Directive

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