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The Regulatory Future of Emerging Technologies – A Scoping Paper on Gaps and Opportunities

19th meeting of the Regulatory Policy Committee

28-29 November 2018
OECD Conference Centre
Paris, France

This paper identifies the current challenges for regulating disruptive/emerging technologies and documenting emerging approaches to address them, and scans the current work being undertaken to enable and leverage the use of disruptive/emerging technologies in improving the efficiency and effectiveness of delivering regulatory services and the characteristics of such practices.

It will serve as a background paper for the Roundtable discussion (Item 2) during the 19th RPC meeting on Wednesday 28 November.

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1. Introduction

"It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change."

Charles Darwin

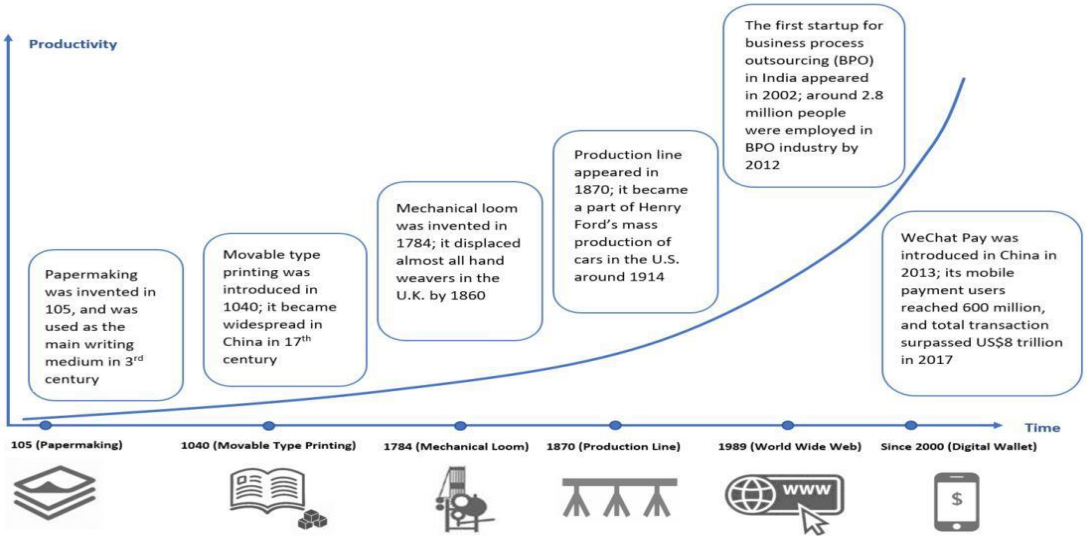
1.1. Overview

1. We live in an era of near unprecedented technological change, rivalled by only the industrial revolutions of the 18th and 19th centuries. Emerging disruptive technologies are transforming the way we conduct business and live at a rapid pace and have given rise to new industries and products that were not conceived of even a decade ago. These range from digital technologies (e.g. Artificial Intelligence, 3D printing, the Internet of Things, drones, advanced robotics), new materials (nano particles, biofuels, GMOs), to new processes (e.g. data driven production, artificial intelligence, synthetic biology).

2. Given the rapid advances in telecommunications and connectivity, mobility, computing and data handling capacity, the majority of modern disruptive technologies are the direct result of or have essentially utilised digitalisation. Other areas of innovation including new materials and processes also occur through the advances in computing and data analytics.

3. Digitalisation is fundamentally disrupting status quo across many markets and business categories. For example, the world's largest taxi company owns no taxis and has an operating model that primarily involves Mobile Applications (e.g., Uber), the largest accommodation provider owns no real estate (e.g., Airbnb), the fastest growing banks have no actual money (e.g., Society One), and the list goes on and is increasing. The time for technological diffusion is also exponential as can be seen in Figure 1.

Figure 1. Time for Technological Diffusion



Source: World Bank.

4. As these technologies transform businesses and societies, they will have far-reaching consequences for productivity, employment, skills, income distribution, trade, well-being and the environment. Governments in general and regulators in particular have a major role to play in ensuring a balance between encouraging innovation and incentivising the development of such technologies while protecting broad public and consumer interests and potential unintended negative consequences of these disruptions.

5. Governments set the frameworks within which businesses function, through broad regulation such as competition policy and consumer law, and through specific legislation that governs the conduct of particular activities, firms, industries or workers (North 1991). Government action can also directly influence the development of certain technologies over others, while taxes, subsidies and transfers can incentivize firms and consumers to develop and/or adopt new technologies and to adapt as they become widespread.

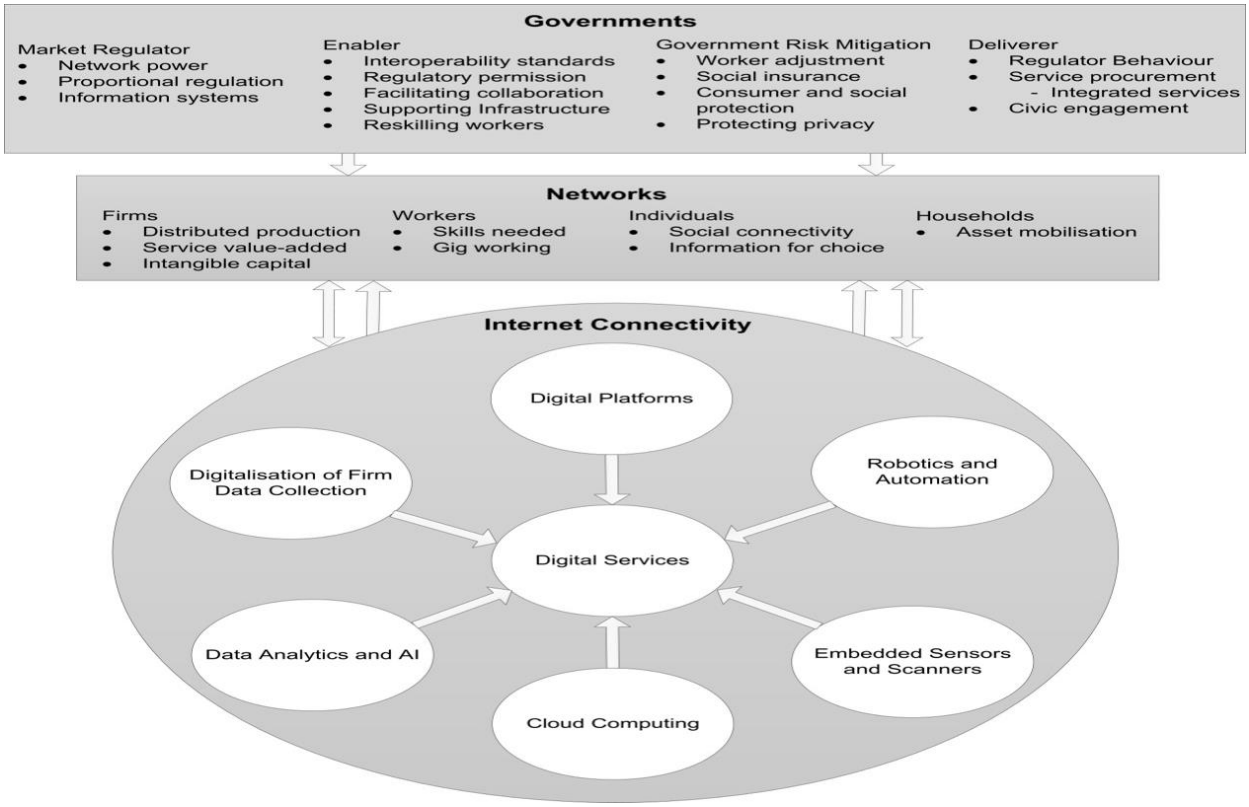
1.2. Role of Government

6. Government may need to evolve their roles as they respond to disruptive technologies. As outlined in Australian Productivity Commission (2015) these roles include:

- Market regulator
- Enabler including possibly financing/supporting the growth of the technology sector through public investments and subsidies
- Risk Mitigator
- Deliverer of Services

7. These roles are reflected in Figure 1.2.

Figure 1.2. Disruptive technologies and Role of governments



Source: *Australian Government Productivity Commission: Digital Disruption – What do Governments need to do? (2015)*

8. It is becoming increasingly apparent that governments have to evolve their policymaking frameworks and paradigms to "regulate" emerging technologies and consider new and innovative approaches in that regard. What is less apparent is that there appears to be a prospective role for emerging technologies as an enabler for more efficient and effective regulatory policy, both for design and delivery. Preliminary research carried out by the OECD (OECD, 2017), institutions such as the World Bank (World Bank, 2017) and government agencies such as Transport Canada (Prism Institute, 2018) provide glimpses into the opportunities and possibility to take regulatory policy into the 21st century.

1.3. Scoping Paper Objective

9. The objective of this scoping paper[1] is two-fold:

[1] This paper has been prepared in cooperation with the Prism Institute with additional support from University of Queensland's Centre for Policy Futures. They have undertaken a review of published academic and non-academic literature on topics related to policies, regulations and regulatory models associated with emerging and disruptive technologies.

1. identify the current challenges for regulating disruptive/emerging technologies and documenting emerging approaches to address them, and;
2. scan the current work being undertaken to enable and leverage the use of disruptive/emerging technologies in improving the efficiency and effectiveness of delivering regulatory services and the characteristics of such practices.

10. In addition to laying out the future regulatory landscape, the paper aims to identify current knowledge gaps and areas for further investigation. In this context, the paper does not aim to provide a comprehensive overview of the current literature that exists and that describe the challenges and solutions but is to be seen as purely scoping the opportunities for research themes and priorities that the Regulatory Policy Committee may want further delved into and explore.

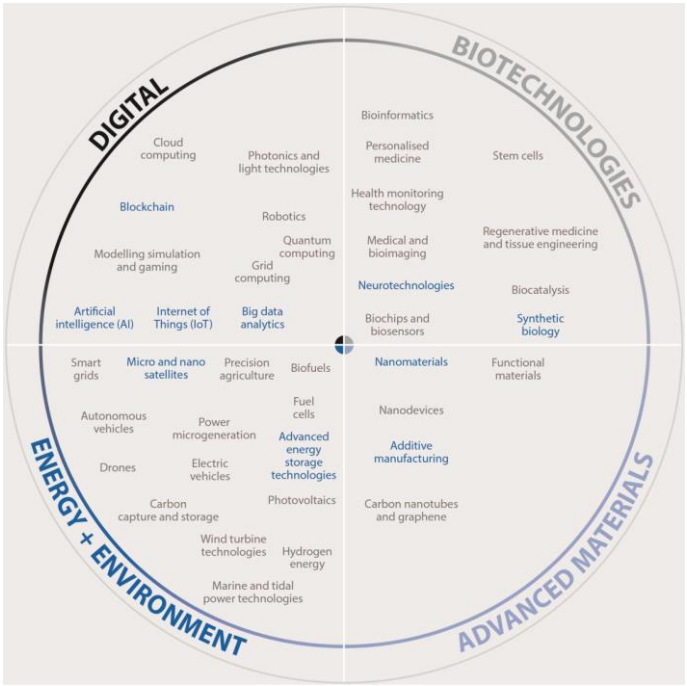
2. Characterising Emerging/Disruptive Technologies

12. Undoubtedly the pace and generation of new technologies is relentless and unfolding at incredible speed. It also seems to be the pattern to label almost any advance as being a breakthrough, and the list of "next big things" grows ever longer (Mckinsey Institute). However, it is evident from a historical perspective that the current wave of technologies do in fact have the potential to disrupt the status quo, alter the way people live and work, rearrange value pools, and lead to entirely new products and services.

13. For policy-makers and regulators to prepare for and "manage" future technology it is important for them to have a clear understanding of what technologies might shape the global economy and society over a sustainable period and for which their "intervention" may be necessary. As they take on the different roles of enabling and regulating markets, mitigating risks to society and delivering services effectively, they will need to make informed decisions based on a comprehensive knowledge of the types and nature of these technologies.

14. The OECD in its Science, Technology and Innovation Outlook (OECD, 2016) identifies 40 key and emerging technologies of the future as shown in Figure 2.1. In addition, it discusses 10 of these technologies (highlighted in blue in Figure 2.1) in detail as being potentially the most disruptive and carry significant risks that may require the most policy attention.

Figure 2.1. 40 Key and Emerging Technologies for the Future



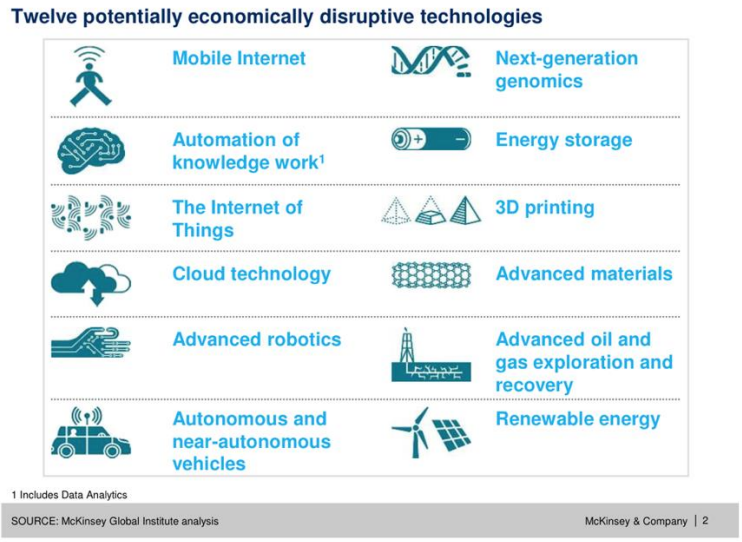
Source: OECD 2016.

15. In another of its publications, "The Next Production Revolution: Implications for Governments and Business" (OECD, 2017) the OECD examines the opportunities and

challenges, for business and government, associated with technologies bringing about the "next production revolution". These include a variety of digital technologies (e.g. the Internet of Things and advanced robotics), industrial biotechnology, 3D printing, new materials and nanotechnology. The report suggests that as these technologies transform the production and the distribution of goods and services, they will have far-reaching consequences for productivity, skills, income distribution, well-being and the environment.

16. Similarly, the McKinsey Global Institute ("Disruptive technologies: "Advances that will transform life, business, and the global economy") attempts to sort through the many claims to identify the technologies that have the greatest potential to drive substantial economic impact and disruption by 2025. The report states that, while important technologies can come in any field or emerge from any scientific discipline, they share four characteristics: high rate of technology change, broad potential scope of impact, large economic value that could be affected, and substantial potential for disruptive economic impact. It identifies the technologies shown in the figure below to have significant potential to drive economic impact and disruption by 2025.

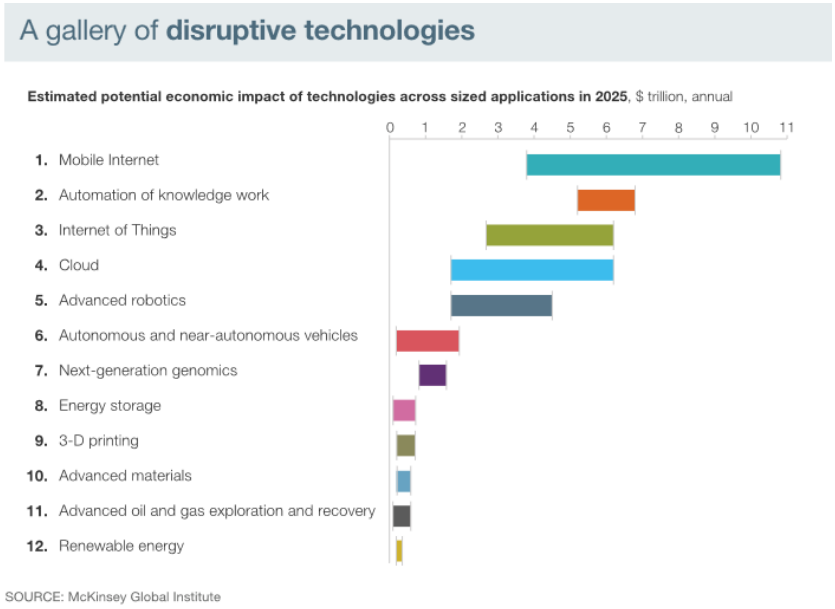
Figure 2.2. Potentially Disruptive Technologies



Source: Mckinsey Institute.

17. Mckinsey estimates that, collectively, these technologies have the potential to drive direct economic impact on the order of $14 trillion to $33 trillion per year in 2025 with estimates of the potential economic impact of each technology shown in the figure below.

Figure 2.3. Economic Impacts of Disruptive Technologies



Source: Mckinsey Institute.

18. The innovative disruptive or emerging technologies that are considered for the purpose of this paper and are categorised[2] as follows:

1. Information/Platforms
   - Monitoring/Surveys (in-situ sensors/IoT, Earth Observation, UAVs); Digitisation
   - Data Management (open data, Blockchain)
   - Data Analysis (Big data, Geospatial/AI/Machine Learning, modeling)
   - Data Access (APIs, data visualisation, mixed reality-AR/VR)
   - Platforms/Social Media/Portals/Apps
2. Institutional/Social Interactions
   - Crowdsourcing, gamification, competitions
   - Mobile money, Fintech
   - Maker movement/DIY/Tech Incubators
   - Sharing economy.

19. While the application of these technologies can revolutionize sectors and have a multiplier effect on economic growth and productivity of a country, and well-being of its citizens, governments have a mandate to focus on overall policy impact and enablers such as open data mechanisms, digital ID and experience at citizen, business, community and

[2] While the paper acknowledges the existence of a 3rd category involving production (3D printing/additive manufacturing, Advanced materials, nanotech, biotech, distributed energy etc.), the scope is limited largely to the digital technologies described in the first two categories.

jurisdictional levels. They can create the necessary environment for building the enabling architecture, set data standards and protection, and attend to risks such as ethics, data privacy and cyber-resilience.

20. What remains relatively unexplored is that, governments and regulators in particular can also be active users of many of the emerging technologies to become more efficient, reliable and outcome-focused, especially as demands on their capacity and infrastructure continue to be challenged. Regulators continue to face pressure to become more innovative, evidence-based, and collaborative. Properly harnessed, these technologies offer regulators the opportunities to make improvements that reduce the burden on business and increase compliance, ensure competitiveness and innovation amongst businesses and enable greater consumer protection and social welfare.

21. Section 3 of this paper examines the challenges the governments and regulators face with respect to regulating the emerging technologies, Section 4 surveys the regulatory solutions that are being developed or conceived to address them. Section 5, on the other hand, examines the potential areas and opportunities for policy-makers and regulators to explore the use of emerging technologies in their endeavour of reforming their policies and services through the entire regulatory cycle.

3. Regulating Emerging Technologies

3.1. Challenges and Considerations for Regulatory Responses

22. Emerging technologies hold great and unprecedented opportunities. As described in the previous section, their impacts will range from the economic to the societal, cultural, environmental and geopolitical. However, there always will be a great deal of uncertainty with the evolution of emerging technologies. Their potential immediate and tertiary risks cannot easily be anticipated and even if some of the risks could be foreseen as they emerge, trade-offs would still need to be considered. Both foreseen and unforeseen risks are amplified by the accelerating speed and complexity of technological development.

23. The growing complexity of new technologies, combined with a lack of scientific knowledge about their future evolution and often a lack of transparency, makes them harder for both individuals and regulatory bodies to understand (Global Risks Report 2015, WEF). The experience of the past, if anything, serves only to foreshadow the disruptive and destabilising effects that rapid technological change, especially if poorly regulated, may have on societies. Governments and regulators should, as a first step, have an understanding of the broad regulatory challenges that these emerging technologies pose when considering their approach to regulate them.

24. This section of the paper identifies five major regulatory challenges which are being encountered today, some are novel innovations while others are general characteristics of rapid technological change. They can be captured under the following themes:

1. Pacing problem
2. Disruptive business models
3. Socio-Ethical challenges with Artificial Intelligence
4. Online platforms with natural monopoly characteristics
5. Data privacy and security

25. For each ‘challenge’, the section defines the problem and indicates the current or potential adverse consequences of the ‘challenge’. After outlining the challenge, the paper describes the current thinking on possible solutions or pathways to resolution and highlight any gaps or opportunities in the current discourse and knowledge. These gaps or opportunities may be areas of insufficient understanding requiring further research or they may be issues that have been overlooked by current attempts to regulate. It is hoped that this will facilitate wider discussion of the disruptive and adverse potential of emerging technology while also highlighting that these challenges are manageable if proper action is taken now.

3.2. Pacing Problem

26. As suggested above, it is not only the types of emerging technology that are challenging contemporary regulation but also the sheer pace of technological change. More specifically the pacing problem is the tendency for technology to advance faster than regulation or social structures governing that technology (Marchant, et al., 2011). The disconnect between the pace of technology and the pace of regulation has always been a concern. There is a growing consensus, however, that the current manifestation of the pacing problem is particularly challenging. Marchant, et al. (2011) elaborates a number of reasons for this:

1. Humanity's growing scientific prowess may lead to emerging technologies that have the capacity to create changes with widespread and/or not easily reversible consequences (e.g. gene drives, or solar irradiance geoengineering). The complexity of emerging technology means that the potential for unforeseen adverse outcomes is higher as there is greater capacity for change wedded to lower human involvement (e.g. lethal autonomous weapons systems). The cost of regulatory failure therefore is high and potentially profound (Marchant, et al., 2011).
2. The complexity of some emerging technologies makes it hard for non-experts such as policy makers and regulators to enact and enforce effective regulation (e.g. artificial intelligence). This invariably slows the pace of regulation.
3. Potentially revolutionary technological change is occurring across a wide (globalised) range of sectors and jurisdictions (e.g. CRISPR). Failure to regulate the pacing problem in a coordinated way at the global level may create a perverse incentive for individual states to not regulate responsibly and seek a competitive advantage in the global economy (e.g. regulation of stem cell research in China Jiang, (2017)). Thus, the scale and scope of technological change and transfer is magnified in the global economy.

27. The major obstacle to developing regulatory solutions for the pacing problem is that the problem appears to be an intractable one faced by many societies undergoing a period of rapid technological change. Nonetheless, current thinking in managing the pacing problem has focused on the idea of 'flexible' regulatory or governance approaches (Marchant, et al., 2013). The suggestion being that the pacing problem emerges because regulation is designed on an issue-by-issue, sector-by-sector, technology-by-technology basis. Thus, when a new technology or application emerges there is a lag time while regulators and legislatures perform their respective roles in developing new regulation. Hence the regulatory cycle is slow and by the time regulation is in place, the 'regulatory target' has moved again. Flexibility offers an alternative by suggesting that regulation should be broad enough to preemptively encompass most emerging technologies in a particular field (such as biotechnology) and specific regulations could then be tailored to specific technologies, such as CRISPR (Marchant, et al., 2013). One mechanism suggested for flexible regulation is codes of conduct for technological sectors and this is a potential starting point (Marchant, et al., 2013).

3.3. Disruptive Business Models

28. Interest in disruptive innovation has grown rapidly over the past 10 years, such that disruption is now arguably one of the most influential ideas of the early 21st century, especially in the business and economic work. There is no exact definition of disruptive

innovation. However, two main features seem to be relevant: 1) disruptive innovations have the potential to drastically alter markets and their functioning; and 2) they not only involve a new product or process but can also involve the emergence of a new business model.

29. Disruption, like the pacing problem, is not a new phenomenon but is an intrinsic facet of certain types of innovation. OECD (2015) makes the following observations on disruptive innovation:

- Disruption can come either from an existing firm or from a new market entrant.
- Disruption generally occurs on "large" markets which are dominated by entrenched and often inefficient incumbents.
- Disruptors scale up very quickly due to the fact that their services and products are mainly provided through the Internet or mobile technologies.
- Disruptors offer customers new ways to satisfy an unmet (e.g. by introducing a new product) or poorly met (e.g. by introducing a new distribution channel) demand.
- Disruptions generally bring substantial consumer benefit through enhanced competition.
- Disruptions challenge - and sometimes bypass - existing products and business models.
- Disruptions threaten incumbent firms and business models by reducing or destroying their market shares.
- Disruptions not only raise challenge for firms, business models and products, but also for regulators and enforcement agencies.

30. Another challenge of disruptive innovation is that existing markets and market-dominant practices are socially and economically embedded within wider society. Disruptive innovation while potentially creating new value for some also has the potential to drive adverse economic consequences for firms and individuals linked to the previous system (Dorrell, 2018). For example, just as the mass-produced automobile caused a decline in urban horse-related businesses, the growth of the ride-sharing service Uber has led to a decline in the taxi-cab industry (Berger, et al., 2018). Without adequate regulation of disruptive innovation, there will be economic 'collateral damage' from their growth and subsequent redistribution in equity across society. This will become more prevalent as technological growth spreads disruptive innovation into new sectors and jurisdictions.

31. Another key factor is that disruptions can significantly transform labour markets globally. The OECD in its 2017 Economic Outlook (OECD, 2017) analyses the impact of technological progress in OECD countries, over the past two decades. A key finding of its analysis suggests that with the growing use of technology over the past two decades, all regions considered have experienced a process of polarisation away from middle-skill jobs to low- and high-skill employment. The increasing ability of disruptive technology to perform easy-to-codify routine tasks has led to de-industrialisation (the reallocation of employment from manufacturing to services) causing this polarisation.

32. Analyses carried out illustrate that the tasks most at risk of being substituted by technology are those involving basic exchange of information, buying and selling and simple manual dexterity. The risk of automation is particularly severe for workers from the most disadvantaged socio- demographic groups, who are most likely to be in low-

skill occupations. Policy makers should pay particular attention to these differences, as automation could reinforce existing disadvantages faced by some workers (OECD, 2017). Policymakers need to ensure that future policies and regulations have strategies that help workers to withstand the disruption while allowing them to reap the benefits of technological change.

33. Disruptive innovations can also have an impact on (and may be drive by) larger community goals or consumer satisfaction needs and may need to consider welfare redistribution patterns. They may also empower new segments of the population. For example, there are many innovations today that are not accomplished by businesses but by users seeking to satisfy their own needs, such as the real-time glucose monitor initially developed by a private community of diabetes patients and developers. This kind of "free innovation" raises interesting questions on how to regulate people who are not innovating for profits (Zhoudan Xie & Mark Febrizio , 2018).

34. If there is significant history of disruptive innovations causing social and economic change, there is an equally poor history of attempts to manage and regulate disruption. Historically these approaches fall into two categories. The first seeks to preserve or protect existing markets or practices through regulation. Some jurisdictions have taken this approach, for instance, responding to ride-sharing platforms with an outright ban (Barnett & Barnett, 2016). These jurisdictions often had strongly regulated or monopolised taxi industries and thus strong pressure from interest groups to preserve existing markets. At the same time, preventing disruption - especially from an online platform – may well be futile due to pressures of consumer choice. In a number of jurisdictions where this regulatory approach was first attempted, governments have been forced to relent and change the approach after failing to achieve meaningful compliance (Department of Transport and Main Roads, 2018).

35. The second approach takes the opposite view. Market logic and "creative destruction" drives this regulatory approach. It favors allowing disruption to alter markets with little regulatory oversight (Lepore, 2014). The reasoning here is that disruptive innovation represents a form of progress and thus is inevitable (Lepore, 2014). From this perspective, those who suffer the economic 'collateral damage' are simply an unfortunate consequence of the survival of the fittest in a competitive market and should seek to adapt to the new market paradigm or exit the marker all together.

36. A successful regulatory approach likely lies somewhere in the middle of these two extremes. There is value in preserving some aspects of existing markets and this would include forcing disruptive firms to 'play by the same rules' such as taxation, employee rights, and health & safety (Productivity Commission, 2016). These regulations perform an important public good and should be considered when disruptive firms attempt to evade regulation in the name of progress. Moreover, the case can be made that some firms may label themselves 'disruptive' while not being particularly innovative in an attempt to circumvent regulation (e.g. the position of Deliveroo on employee rights (Tims, 2017)). Regulators should aim to vigorously resister this type of circumvention sin order to avoid spreading non-compliance with public good regulation under the name of innovation.

37. There is a reasonable argument that certain forms of disruptive change are inevitable or at least impossible to prevent once on the market, hence protectionist responses are unlikely to be effective. Instead regulators should acknowledge the potentially corrosive impacts of disruptive innovation and take a transitionary perspective

towards existing markets (and individuals) likely to be affected. Thus, the middle ground approach must consist of three aspects:

1. Preserving and enforcing the public good aspects of existing regulation for both disruptive and traditional firms (e.g. taxation, employee rights, health & safety).
2. Recognising that disruptive innovation is happening and encouraging it in an orderly and well-regulated way.
3. Recognising that disruptive innovation creates 'collateral damage' and that unchecked, this can be highly societally corrosive. This can be responded to by a transitionary approach in affected sectors.

38. Besides the obvious gap in solutions highlighted above there is another key limitation in the literature on disruptive innovation. The term innovation refers to changes in existing markets or practices and this can be both due to new technology but also novel forms of behavior and organisation. Thus, it is important to distinguish in regulatory discussions, disruptive firms using new technologies (such as mass-produced automobiles) and disruptive firms using novel forms of organisation (Uber and Airbnb) (Lepore, 2014). Regulatory approaches suited to one may not be suited to the other and this distinction seems underdeveloped in current thinking.

39. Many if not most markets with network externalities are two-sided. To succeed, platforms in industries such as software, portals and media, payment systems and the Internet, must "get both sides of the market on board." Accordingly, platforms devote much attention to their business model, that is, to how they court each side while making money overall (Rochet and Tirole, 2003).

40. Digital platforms have proven particularly disruptive to incumbent businesses in certain sectors of the economy, prominently highly regulated sectors such as finance or taxis, where there is ample scope for regulatory arbitrage. Where they succeed, it is because they deliver value to their users, on both the consumer side and the supplier side. The platform benefits buyers by assembling sellers and sellers by assembling buyers. Their observed rapid growth is explained by the fact that platforms enable interactions or exchanges that make all participants better off and the great the greater number of interaction or exchanges the great the network effect. Moreover, in the context of markets with increasingly varied types of goods and services, the increasing scope for customisation based on detailed understanding of consumer preferences always for greater value creation by more differentiated matching of buyers and sellers.

41. It is clear that competition authorities are currently grappling with the challenges these platforms pose in terms of market definition and analysing the cross-subsidy between the two sides of exchanges (see section on natural monopoly characteristics),. At the same time, the growth of digital platforms has focused not entirely on consumer gains and competition analysis but rather on possible demand side externalities (such as the negative impact of short-term travellers on residential neighbourhoods, micro generation in network stability or the "gig economy" on boarder labour market legislation.). From this perspective it is clear that disruptive innovation is an ever-present aspect of both technological changes and the regulatory frameworks that aim to manage them.

3.4. Socio-Ethical Challenges with Artificial Intelligence and AI Powered Devices

42. If there is one emerging technology which has gripped the popular imagination it is artificial intelligence (AI).As far back as 'HAL 9000' in *2001: A Space Odyssey* the fear of rogue AI has been part of the public discourse. This preoccupation was further heightened with Agent Smith and the cyborg assassins in the film series The Matrix and The Terminator respectively. Most of these popular ideas about AI relate to what is termed 'Artificial General Intelligence', that is a computer with fluid intelligence like that of a human and experiencing some form of consciousness/sentience (Bringsjord & Govindarajulu, 2018). Yet while 'Artificial General Intelligence' remains the ultimate (but distant) goal of many in the field, most AI is far more prosaic and already plays a major role in the daily lives of humans (i.e. narrow artificial intelligence) (Goertzel & Pennachin, 2007). At its core artificial intelligence is when machines (computers) are able to mimic cognitive functions associated with the human mind such as problem solving, perception, learning, or autonomous decision making (Bringsjord & Govindarajulu, 2018).

43. Existing applications for AI include driverless cars, financial monitoring, and virtual assistants (e.g. Siri or Amazon Echo). Thus, future growth in artificial intelligence is in the short term, to be in those types of application with machines that are specialised in performing a particular service or function (Goertzel & Pennachin, 2007). Examples of suggested near future technologies are the use of AI in surgery or the deployment of AI in military contexts (known as Lethal Autonomous Weapons Systems (LAWS)).

44. The major challenge of regulating AI is the question of the ethics and equity of autonomy. As machines become more competent (at their particular task) the need for human input decreases to the point where the machine may be considered to be acting autonomously or making autonomous decisions. Regulators should ask are a set of "first principle" questions when considering machine autonomy:

1. Should machines be allowed to make autonomous decisions?
2. If machines do make autonomous decisions what sorts of things can machines decide?
3. Who is responsible (legally, ethically, socially, financially) and liable for the outcomes of a machine's decision?
4. What level of human review or oversight is necessary when a machine makes an autonomous decision?

45. These questions are important to consider and naturally will relate differently to different AI applications. For example, the impacts of poor decisions made by an intelligent toaster are unlikely to be catastrophic. However, poor decisions by financial AI could cause serious economic damage, while poor decisions by surgical or military AI could be lethal. Thus, there are a number of other factors which have to be considered in responding to each of these questions, such as the reversibility of the decision, and seriousness of the consequences should the machine make the wrong decision, many of which can be answered on the basis of risk and a clear understanding of expected (or unaccepted) outcomes.

46. Furthermore, as AI systems develop increasing autonomy there is the potential for errors to occur on a semi-regular basis. When the results remain non-catastrophic it has the potential to create a situation known as 'normalisation of deviance'. In this situation,

errors which do not lead to adverse consequences become redefined from being problems to acceptable operating risks despite being outside of design specifications. As these errors continue to occur they eventually may lead to catastrophic outcomes which were foreseeable but not corrected due to habituation towards the errors (Vaughn, 2016). In the case of AI, it is important to remain aware of this potential as there will be errors in the early stages at least and in the absence of catastrophes, complacency may quickly set in.

47. Another well documented risk associated with AI is the potential for algorithms used in machine decision to reflect human biases (such as racism or sexism) due to these biases in the data inputs. This presents the danger of 'objective' decisions not really being objective and thus AI could perpetuate human inequalities. This risk has been extensively covered in literature (Buchanan & Miller, 2017).

48. Current solution thinking around autonomy suggests that the need for human oversight is key, this could take the form of human approval of proposed actions or a 'kill-switch' which would interrupt the actions of an autonomous system (Endsley, 2017). However, the current focus is on preventing or ameliorating the effects when AI does make poor decision rather than the regulation around either where AI should be used in the first place or what happens in terms of responsibility when a decision (even a non-error) is autonomously made. A considerable amount of philosophy and disciplinary research has studied this topic but there remains an urgent need for these to be incorporated in concrete regulatory and governance approaches, especially in a cross-sectorial way.

49. AI powered devices have the extraordinary potential to improve the health, economic, and personal welfare of underserved communities. Wearable devices, for example, can closely monitor a patient's health, which is critical for certain illnesses and predict patterns of health outcomes which can ultimately benefit health care providers. While these AI devices have the ability to improve the lives of consumers and citizens, a lack of access to the Internet, and thus many of these applications, could also make things worse for underserved communities. If policymakers do not implement policies to encourage equitable deployment, these technologies could exacerbate existing inequalities by providing the benefits of data-driven decision making only to some and placing already underserved communities at an even greater disadvantage (Department of Commerce, 2017).

50. Ethical issues range from process-related (e.g. the transparency of the algorithms) to outcome-related (e.g. discrimination, equity). Our legal system is currently insufficiently equipped to cope with all these issues, and the emergence of largely self-regulated governance schemes can only exacerbate the problem (Renda, 2018).

51. The complexity and breadth of the topic means that the gaps in knowledge and governance of AI are many. Nonetheless, the key task from a regulatory perspective will be regulating autonomy in a manner that integrates the scientific, ethical, legal and disciplinary perspectives on AI into a more general approach to the regulation and governance of autonomy. Bridging the science and regulation of AI is a complex task. For example, a small change in AI behavior from a technical perspective may represent a radical change from a regulatory or social perspective. Technically, it is only a small change to go from a military weapons system autonomously perceiving and suggesting targets to that system making the decision to fire itself. The change in autonomy is significant and so are the social and regulatory implications. Because of the complexity

of the scientific, philosophical, and sociopolitical/legal issues around AI, it is imperative to develop a more general regulatory perspective integrating these various insights.

3.5. Online Platforms with Natural Monopoly Characteristics

52. One of the major economic driving forces of the past two decades has been the growth in the digital economy, of which a key component is online platforms offering services to consumers (Hagan, 2018). Such online platforms prominently include search engines (Google), social media (Facebook, Twitter), and alternatives to bricks and mortar shops (Amazon, Alibaba). Past and current evidence suggests that the dynamics of the market for online platforms create conditions which promote natural monopoly behavior by the most successful or widely used platforms (Haucap & Heimeshoff, 2014). There are several reasons for this:

- Accessibility - Unlike physical firms, online platforms are accessible to all consumers with an internet connection. This creates fewer barriers to access for consumers.
- Cost of switching - Related to the accessibility, consumers also face a low cost for switching between online platforms. This enables rapid comparison and gravitation of consumers towards the most effective platforms.
- Tying – the ability of these platforms to link its proprietary vertical (or specialised) search platforms to its horizontal (or general) search platform through visual prominence fits within the legal boundaries of tying (Iacobucci, 2018)

53. Online platforms operate in a marketplace where conditions promote a 'winner-takes-all' outcome and the subsequent creation of monopolies by the most successful platforms (Haucap & Heimeshoff, 2014, Prufer & Schottmüller, 2017).

54. There is a growing awareness of these natural monopoly characteristics of online platforms, particularly the online domination by the five tech companies - Google, Apple, Microsoft, Amazon, Facebook (Manjoo, 2017). The European Commission has recently examined whether the market dominance by a small number of firms is encouraging anti-competitive behavior. In a different context, public discourse in the United States has questioned whether monopolies have the potential to bias public access to information.

55. On the contrary, some have challenged the claims that online platforms have secured permanent monopolies, protected by barriers to entry from network effects and stockpiles of data, and should be the focus of intense antitrust and regulatory scrutiny, to be inconsistent with the economics, technology, and history of online competition (Evans, 2017). These studies suggest that online platforms most certainly face dynamic competition as a result of:

- disruptive innovation that provides opportunities for entry;
- competition from online platforms that have secured a toehold in one area but compete across multiple areas;
- the fragility of category leadership resulting from the fact that network effects are reversible and entry costs are low; and,
- the prevalence of ad-supported models resulting in firms competing for consumer attention and advertising revenue.

56. The last two decades of online platform competition have seen the toppling of several business leaders (Yahoo, Internet Explorer, AOL). These were the result, at times unexpectedly, through some combination of technological change, business model innovations, and cross-platform rivalry. The threat of displacement may prevent online platforms from taking their customers for granted. Empirical research (Evans, 2017) suggests that the history of online platform competition also refutes the proposition that data on users protects platform leaders from competition or puts an insurmountable obstacle before entrants.

57. Some argue that in actual many digital platforms are three-sided and so can be characterised both as matching two sides that each generate positive externalities (users and content providers), whilst also providing an audience for a third side that might not deliver positive externalities, such as advertisers (OECD, 2018). The transactions between these three sides may all be observable or none of them might be. The nature and strength of the cross-platform network effects is therefore more important to the analysis than the category of platform. For example, the consequences of some platforms' actions can be much greater than they appear at first sight. For example, when a strong cross-platform network externality exists on more than one side of the market, this creates feedback loops. In these loops, an action can trigger a spiral of reactions, which, as in a multiplier effect, increase the magnitude of the consequences of the action. As an example, increasing the price that users pay might reduce the number of users, but this may also reduce the value of the platform to advertisers and hence reduce the amount that advertisers are willing to pay. In turn, this may reduce the return that content providers earn when their content is viewed on the platform, thereby reducing the amount or quality of content, which may reduce the number of users. Once again, this may then reduce the amount that advertisers are willing to pay, and so forth. Each action the platform takes can therefore create a series of reactions (a ripple effect). If these effects go far enough, they may tip the firm towards failure on the one hand, or dominance (monopoly) on the other (OECD, 2018).

58. One important and yet complex factor related to online platforms deals with the jurisdictional location of the firms rendering services vs their use by consumers residing all over the world. In addition to posing operational complexities including e-commerce taxation (US Wayfair Decision), it may be difficult to bring forward legal proceedings against these firms when disputes occur. An example of the problem is the recent refusal of Facebook Chairman and CEO Mark Zuckerberg to appear before the British Parliament Digital, Culture, Media and Sport Committee. While parliament does have the power to compel Zuckerberg's appearance while he is in the UK, they are effectively powerless while he remains outside their jurisdiction (Sabbagh, 2017).

59. Overall, the disproportionate power of certain online platforms resulting from their natural monopoly characteristics and the immaterial and trans-boundary nature of their services makes regulating large actors difficult and not as much with the small actors. This in turn creates not only ordinary competition problems but also problems of international regulatory co-operation, both in the design of common approaches likely to be effective to regulate on-line platforms and in the enforcement of regulations. It is an area where work of the OECD Regulatory Policy Committee[3] could usefully inform discussions on regulating on-line platforms.

[3] www.oecd.org/gov/regulatory-policy/irc.htm

60. The knowledge gap that exists with respect to evaluating the monopoly characteristics of online platforms creates an ambiguity and challenge when developing regulatory approaches. One regulatory approach similar to how utilities (telecom/power etc.) were addressed in the early 20th century, suggests online platforms be viewed like utilities with a public interest in their efficient and proper governance (Plantin, et al., 2016). This approach would involve online platforms and regulators recognising that these services (platforms) provide a public good and thus should be subject to more stringent control and regulation than most market sectors.

3.6. Data, Digital Privacy, & Security

61. Over the last three decades, personal data have come to play an increasingly important role in our economies, societies and everyday lives. Innovations, particularly in information and communication technologies, have impacted business operation, government administration, and the personal activities of individuals. New technologies and responsible data uses are yielding great societal and economic benefits. The volume of personal data being collected, used and stored is vast and continues to grow. Modern communications networks support global accessibility and continuous, multipoint data flows. The potential uses of personal data have increased tremendously as a result of the wide range of analytics that can provide comprehensive insights into individuals' movements, interests, and activities (OECD, 2013).

62. The preceding section of this report already highlighted the significant role of the digital revolution in the growth in prosperity over the past two decades (barring a global financial meltdown unrelated to the digital market in 2008). The fundamental building block of this digital economy (and incidentally the aforementioned AI) is data in all forms. This is reflected by the increasing capital value given to data and data gathering/processing (Buchanan & Miller, 2017). However, this data hungry economic model has created concerns over both privacy and security of data in the digital market. Everything done online generates data which can then be gathered, monitored, and stored. More importantly, using machine learning, data can then be used to develop and refine algorithms for everything from automated share market transactions to political advertising tailored to individuals (Buchanan & Miller, 2017). Although the pervasive spread of algorithms through society is an issue in itself, two key problems exist with the data itself:

a Privacy - Individuals and firms undertaking business transactions online assume their data is protected, however, there are concerns over sensitive information (medical records, seditious statements, financial record etc.) being potentially available online. The concern is that these may expose individuals to risks, not only from misuse, but also from discriminatory or inequitable actions based on private data

b Security - A second concern besides the sensitive nature of data itself is how firms which gather data protect that sensitive information. Although the popular image of data security is protection from external nefarious threats, a significant portion of data misuse occurs in the context of people with legitimate access misusing those privileges. (Hutchings & Jorna, 2015) Thus regulating the security and storage of data is a key problem which is not simply solved by better digital security, as some people will always need access.

63. Although the above section has touched on the adverse consequences of poor data privacy and security, it is worthwhile briefly discussing these in greater detail. An extreme example of poor data privacy is the social credit system currently being piloted in the People's Republic of China. Under this system a vast range of behaviors both criminal and non-criminal may affect an individual's social credit score, like a credit score, and this in turn impacts a range of outcomes from educational and job prospects to loan terms (Hoffman, 2018). This is an extreme case however it is both a clear affront to liberal democratic values and a potential warning of the socially destructive potential of data-driven smart cities.

64. Although the use of data for social engineering may appear positive to some, historical cases of surveillance-based societies clearly show that any public goods are offset by poor outcomes for citizens living under such a regime (Lichter, et al., 2015). Such systems have the potential to exacerbate existing inequities, for instance insurers in some states may deny insurance to those seen as high-risk. The social inequity effects of such market driven systems are already well documented in some places such as the United States and if the use of private data in making these determinations is not regulated to protect the vulnerable then this outcome may become more widespread.

65. The second concern regarding security is that even if private data is used in a responsible way it will create a vast data bank of sensitive personal information. Poor security practices may then allow actors with illegal or otherwise nefarious intentions to access this data placing citizens at risk of adverse outcomes. The risk is not only from third-party actors seeking to access a restricted system but also (or even more so) from those with legitimate access who may misuse the data (Hutchings & Jorna, 2015). Thus, solving the security problem is not simply a question of cybersecurity but also of regulatory and governance practices within organisations using data.

66. Due to the growth of the digital economy and the recognition of the risk associated with pervasive data collection and use, regulators in many states are already seeking to manage various aspects of digital privacy and security. Over many decades the OECD has played an important role in promoting respect for privacy as a fundamental value and a condition for the free flow of personal data across borders. Building on the original 1980 release of the Guidelines and arising out of a call by Ministers in the 2008 Seoul Declaration for the Future of the Internet Economy to assess the Guidelines in light of "changing technologies, markets and user behaviour, and the growing importance of digital identities", the OECD Council in 2013 adopted a revised Recommendation Concerning Guidelines Governing the Protection of Privacy and Transborder Flows of Personal Data ("Privacy Guidelines") (OECD, 2013).

67. The most comprehensive attempt so far has been the European Union's *General Data Protection Regulation* (GDPR) (Voiget & von dem Bussche. 2017). The GDPR has drawn mixed responses. From the consumer or citizen perspective it is highly effective and errs on the side of caution in protecting their interests (Blume, 2012). This is undeniably a positive for public confidence and trust in digital services. However, some commercial and research interests have raised concerns that compliance may be too onerous and that this will simply lead to actors choosing not to operate in the EU or avoiding compliance (McCall, 2018). Thus, the GDPR offers a good example of the need to strike the balance between data use and data privacy interests. The EU may not have the correct balance yet, however, as an early piece of regulation in an emerging field it is an important and positive step.

68. Outside of the balance between data use and privacy, the GDPR has also helped to highlight a secondary problem with data regulation and privacy. Attempts to regulate within jurisdictions may clash with the need to move data across jurisdictions or the super-jurisdictional nature of the digital economy itself. At present, there is a fundamental disconnect with respect to the regulatory priorities of individuals' data between the United State and Europe. In the former, commercial freedom and freedom of speech are favored while in the latter, European regulators favor the rights of the consumers and citizens (Geller, 2016). This disconnect in regulatory approaches not only affects the commercial sector but also can affect certain public goods such as medical research or financial intelligence. Thus, there is a need in the development of data regulations to address two problems:

a *Movement of data across jurisdictions* - in the course of the global digital economy data must regularly cross jurisdictions and to facilitate this it is important that regulators do not approach data as a purely domestic regulatory issue. It is an issue more similar to international trade and requires cooperation and alignment across jurisdictions.

b *Interoperability* - To facilitate regulatory cooperation or alignment it is important that data regulations are able to 'talk to each other' in that they use similar terms and take similar approaches to data, privacy, and security. Thus, even if each jurisdiction adopts their own regulations, international cooperation requires that data users, whether commercial or research, should be able to comply with multiple jurisdictions and modify data stored under one regulation to comply with other regulations with a minimum of effort.

69. Together these suggest that international co-operation will be necessary to develop effective regulatory approaches for data privacy and security. Moreover, these international aspects will be necessary even when regulators seek to develop regulation within their particular domestic jurisdiction, as data is unparalleled in its globalised movement.

4. Approaches to regulating emerging technologies

70. Policy-makers and regulators need to develop innovative policy and regulatory measures to respond to the changing landscape and to address the continued development and use of disruptive technologies. Although policy and regulatory frameworks are evolving across many sectors over the past years, research findings described in the previous section suggests there is an increasing interdependence between sectors. Technology developments are enabling effective global, regional and local development through knowledge management, sharing and collaboration between all sectors and at all levels of government as well as with business and users. There are clear opportunities to empower and include people around the world in a trusted, connected digital society.

71. As regulators begin contemplating the development of agile, flexible light-touch, multi-sectoral, forward-looking, neutral and transparent policy and regulatory approaches they have to respond to several key questions as they begin to tackle the regulatory challenges identified in the previous section.

Box 4.1. Four questions regulators need to ask themselves

1. What's the current state of regulation?

When answering this question, policy makers will have to consider aspects including the relevance of current regulations, barriers to innovation through prescriptiveness, overlapping or convergent regulations, and other impacted regulations such as employment, taxation etc.

2. What's the right time to regulate?

Typically empowered with mandates to protect citizens and society, promote economic growth and competition and protect national/regional interests, regulators have to make choices of the appropriate time to regulate. They cannot be found to be too slow in avoiding negative impacts to their mandate or too fast or overzealous in protecting their mandates while hampering innovation without understanding the true nature of their impacts.

3. What's the right regulatory approach?

When the decision has been made to regulate, regulators and policymakers now have a variety of tools to choose from ranging from traditional regulatory approaches to softer approaches including self-regulations.

4. What has changed since regulations were enacted?

Impact of enacted regulations using tools such as ex post evaluations developed by the OECD and others may be used to not only to monitor and evaluate the performance of the regulations but, more importantly, relate them to the state of emerging technologies and business models and determine their relevance.

Source: Deloitte 2017

This section looks at a range of regulatory approaches that are being used or should be considered when dealing with emerging technologies and the challenges posed by them. They are themed under the following categories:

- Traditional Regulations (Prescriptive, Performance/Outcome/Risk, Management)
- International Regulatory Cooperation
- Self-Regulation and Co-regulations
- Regulatory Experiments (Regulatory Sandboxes, Adaptive Regulations).

4.1. Traditional Regulations

72. As a tool of government, regulation consists of rules that identify permissible and impermissible activity on the part of individual or firms along with sanction or incentives to ensure compliance. Traditional approaches to regulating risks have been divided into prescriptive (e.g., technology based), performance or outcome-based and management based regulation (OECD, 2010, Roca, 2017). Each approach incentivises a different level of innovation at firms and addresses uncertainty in a different way.

4.1.1. Prescriptive or technology based regulations

73. Technology-based regulations tend to decrease uncertainty by prescribing the standards of use of certain technologies (Roca, 2017). Some of the advantages of technology-based approaches include the possibility of a higher-than-market valuation of non-market, the reduction of equity problems, the reduction of the needs for monitoring, ease of promulgation, and superior enforceability (Roca, 2017). However, a wide body of literature suggests that businesses may have less incentives to innovate and go beyond compliance.

74. While such prescriptive regulations may address the challenges associated with natural monopolies and to some extent issues with AI, so long as the evolution of technologies are reasonably stable and mature, they are inadequately suited to deal with the other regulatory challenges identified for the same reasons. They are not equipped to address the changing pace of technologies and business models.

Box 4.2. Example of Regulating Emerging Technologies (Department of Commerce, 2017)

The US National Telecommunications and Information Administration (NTIA) released a green paper discussing its proposed next steps on addressing regulatory aspects of Technology and more specifically the Internet of Things (IoT). In it, the Agency details its proposed next steps on the IoT and states it will:

> Continue to foster an enabling environment for IoT technology to grow and thrive, allow the private sector to lead, and promote technology-neutral standards and consensus-based multi-stakeholder approaches to policy making at local, tribal, state, federal, and international levels on issues ranging from U.S. security and competitiveness to cybersecurity, privacy, intellectual property, the free flow of information, digital inclusion, interoperability, and stability related to the IoT.

The Agency mentions "The 1997 Framework for Global Electronic Commerce" which focused on policy prescriptions that would allow the Internet, unencumbered by ex ante regulations, to flourish. These same principles can be equally effective in promoting the development of other emerging technologies. Trial and error experimentation drives innovation and technological progress, and the best environments for such experiments are those unencumbered by unnecessarily prescriptive rules. Fostering that level of dynamism

requires a recognition of the value of market-friendly environments in promoting high levels of innovation.

The International Telecommunication Union (ITU) as part of its Global Symposium of Regulators (GSR) has developed best practice guidelines that calls for regulatory frameworks that promote digital transformation by fostering the use of emerging technologies, encouraging investment-friendly business models, and eliminating barriers to continued innovation and progress. Some key callouts within these guidelines include:

- implementing an agile framework through flexible light-touch, multi-sectoral, forward-looking, neutral and transparent policy and regulatory approaches;
- encouraging policy and regulatory measures to facilitate deployment and use of emerging technologies for affordable digital infrastructure and services, including in the area of infrastructure sharing, interconnectivity, quality of service and effective use of spectrum;
- addressing the enabling environment for emerging technologies including issues such as intellectual property rights (IPR), artificial intelligence (AI), investment, job creation and cybersecurity, and technological neutrality
- creating innovation spaces to promote opportunities for youth, foster the development of innovative ICT solutions, and nurture a community of entrepreneurs and mentors;
- recognising that emerging technologies also require measures to continue building the digital skills of people not only as consumers but also as citizens;
- defining the appropriate response mechanisms to threats and cyberattacks including early warning service to enhance consumer confidence in the digital economy
- promote policies that encourage both innovation and effective competition among sector players in the ecosystem, and that also support the protection of consumers;
- enforce or collaborate in the enforcement of competition law to ensure that service providers comply with all the rules of fair and healthy competition
- support small and medium-sized enterprises (SMEs) by reducing barriers to entry related to licensing regimes and fiscal and taxation policies
- regulatory sandboxes for enterprises wishing to test an emerging technology or innovative service without being bound by all the regulations that would normally apply
- promote further public participation and consultation in the regulatory process through regulation by data.

Performance or outcome-based regulations

75. Performance or outcome-based regulations, which typically specify measurable outcomes (performance measures, risk thresholds etc.), allow businesses greater opportunities for innovation, as long it is easy to demonstrate that the desired performance has been achieved (Roca, 2017). They have had a long history dating back to the early 1980s particularly in the United States where the focus was to relieve the regulatory burden on governments and to limit its intervention. This shift was driven by a need to lessen the rigidity of regulations and compliance burdens, while promoting innovation and lowering compliance costs. It was thought that by creating more flexible

regulations businesses would have the opportunity to discover better technologies or processes that were more cost effective and complied with regulations. Various forms of outcome-based regulations have since been adopted in the United States and a number of other countries for the regulation of air and water quality, building and fire safety, energy efficiency, food safety, forest practices, nuclear power plants, pipeline safety, and work safety.

76. These types of regulations specify required outcomes or objectives, rather than the means by which they must be achieved. Firms and individuals are able to choose the process by which they will comply with the law. This allows them to identify processes that are more efficient and lower cost in relation to their circumstances, and also promotes innovation and the adoption of new technology on a broader scale. The focus of regulation is shifted to results or outputs, rather than inputs, and the degree of government intervention in markets is effectively reduced. Adoption of performance or outcome-based regulation can also simplify and clarify regulations, since they can be written in terms of underlying objectives, rather than requiring large amounts of detailed, prescriptive standards to be set out in legislative terms.

77. While performance objectives or results are clearly outlined, the industry is able to decide for itself how it will achieve these results. Performance-based regulations, by design, are therefore well suited to address the pacing problem as long as there is clarity and longevity on the type of outcomes. While, the expected thresholds on outcomes may change, the type of outcomes need to remain constant for these regulations to work in a fast-paced technology evolution. For example, outcome measures such as specifications for minimum flying heights to preventing endangering human life for remotely piloted aircraft systems such as drones can provide regulatory predictability and address the pacing problem. Transport Canada for example, is amending its aviation regulations for unmanned aircraft systems to becoming performance based in order to provide regulatory predictability to businesses and reducing burden on them. Many of the emerging technologies support the delivery of risk based regulations by providing reliable data that would help in reducing uncertainties in measuring risk estimates and outcomes.

Box 4.3. Outcome based regulation

Dame Judith Hackitt, in her independent review "Building a Safer Future," acknowledges that prescriptive regulation and guidance are not helpful in designing and building complex buildings, especially in an environment where building technology and practices continue to evolve (pacing problem) and will prevent those undertaking building work from taking responsibility for their actions. The report suggests that the new regulatory framework governing building safety must be outcomes- based (rather than based on prescriptive rules and complex guidance). Her belief is that, in addition to addressing the changing technologies and business models, this will create an environment where there are incentives to do the right thing and serious penalties for those who choose to game the system and as a result put the users of the 'product' at risk.

Source: UK, 2018

78. In the context of AI, the applicability of performance-based regulations is very evident in terms of setting achieving outcomes especially when setting and meeting risk thresholds. The technology, by its very nature, reduces uncertainty in risk predictions and helps demonstrate risk outcomes more reliably. However, the effectiveness of such

regulations in addressing the challenge described earlier relating to accountability and responsibility for decisions particularly when desired outcomes are not achieved is unclear and may need to be researched further. The challenges associated with movement of data across multiple jurisdictions, aspects of interoperability, and varied societal tolerance of issues such as privacy and security makes it harder to establish performance based regulations that addresses the security and privacy aspects.

79. The EU's General Data Protection Regulation (GDPR) adopts a risk-based, context-specific approach meant to ensure that appropriate data-protection measures are designed and implemented throughout the entirety of the processing activities (Marelli, 2018). This approach aims to provide a unified body of data protection law and a more harmonised administration within the EU while also introducing an entirely new set of obligations for companies looking to transfer personal data outside of the European Union (McCallister, 2017). At its core, the GDPR promotes the responsibility of data controllers (the persons, companies, associations, or other entities that are in control of personal-data processing) and it introduces new, decentralised modes of accountability. Controllers are required to adopt a proactive approach toward data protection and are responsible for the ex-ante assessment, the implementation, and the post hoc verification of appropriate measures to ensure and demonstrate that data processing complies with the GDPR. The GDPR, in Article 22, seems to prohibit automated decision making with the provision of strongly protecting the interests of individuals. However, it is being argued that this prohibition has several exceptions and limitations raising several queries in cases where decisions are taken using algorithms (Brkan, 2017).

80. With the exception of dealing with aspects such as cross-jurisdictional issues and AI, and in sectors where the expected societal outcomes can be well defined and measured, outcome based regulations can be an effective means of regulating emerging technologies when dealing with challenges such as the pacing problem, data privacy and security and AI.

4.1.2. Management-based regulations

81. Management-based regulation or "enforced self-regulation" (Ayres and Braithwaite, 1995) aims to shift the decision to businesses with the most information (Roca, 2017). Such actors have a better understanding of the risks and benefits of the technology. Such regulations would also work when the business's incentives are tied to regulatory incentives. Typically, such regulations require businesses to maintain a range of processes, systems, and internal management practices to achieve goals defined in the regulations which could be outcome based. Regulators generally do not need to check direct compliance with legislation, but rather to audit the corporate management systems, and in some cases to review documentation provided by businesses to show compliance.

82. Interestingly, the GDPR now also provides that an organisation's adherence to a code of conduct aimed at a specific sector that has been approved by the European Commission according to the processes set out in the GDPR, when paired with binding and enforceable commitments to apply the appropriate safeguards, constitute an independent justification allowing personal data to be transferred to that organisation. The central drawback to this approach is that no relevant code of conduct currently exists (Mark Phillips, 2018). Another limitation of the Code approach is that, although adherence with an approved Code of Conduct provides evidence of compliance with the GDPR generally, it does not provide *proof* of compliance. The role of such a Code cannot

be seen to supplant the GDPR's obligations, only to clarify and assist in interpreting them in a particular context.

83. Management-based regulation provides businesses with greater flexibility to respond to pace of changes in technology. However, in addition to not addressing cross-jurisdictional issues such as data privacy and security and AI, implementation requires a far more complex relationship between regulators and the private sector (Coglianese and Lazer, 2003), and there is higher danger of regulatory capture further compounding the natural monopoly characteristics.

4.2. International Regulatory Cooperation

84. Unlike traditional products and technologies, many emerging technologies span multiple industries and jurisdictions (Saner and Marchant, 2015), requiring coordinated approaches among regulators. The potential risks presented by emerging technologies are broader and more diverse than those presented by more commonly regulated markets and products. Future trajectories of these technologies are extremely uncertain. As a result, they create unique imperatives and opportunities for international regulatory cooperation.

85. As highlighted by previous work of the Regulatory Policy Committee (RPC), regulatory co-operation comes in many forms and types, and can differ in geographical scope – from bilateral to regional or multilateral (OECD, 2013). Forms of cooperation may range from the most binding through harmonisation of rules via joint institutions to the lightest through exchange of information among regulators. International treaties and other formal legal agreements can impose identical legal requirements on participating nations, but these instruments have become increasingly difficult to negotiate and implement and therefore are often foregone in favor of more informal coordination approaches (OECD, 2013 and Saner and Marchant, 2015).

86. Other initiatives may involve sharing of data and analysis among regulators to provide a common evidentiary foundation for national regulations typically through trans-governmental networks of regulators (Abbott, K., C. Kauffmann and J. Lee, 2018). RPC work on international regulatory cooperation also highlights the work of a variety of international organisations in offering platforms for continuous dialogue on regulatory issues; facilitating the comparability of approaches and practices; providing member countries with flexible mechanisms to identify and adapt to new and emerging regulatory areas or issues. This work aims to contribute to the development of a common regulatory language; and developing international legal and policy instruments (OECD, 2016).[4]

There is a number of examples of regulatory cooperation in relation to emerging technologies (see Box 3.2). These provide sporadic examples of existing regulatory cooperation in the fields of relevance to regulating emerging technologies. More needs to be done to analyse the relevance of different cooperation approaches to ensure the effectiveness, efficiency and fit for purpose of regulations of emerging technologies. Nevertheless, a number of trends in regulatory cooperation emerge from evidence that reflect the nature of emerging technologies.

Box 4.4. Examples of regulatory co-operation

[4] www.oecd.org/gov/regulatory-policy/international-organisations-and-role-in-irc.htm

EU's GDPR, discussed earlier, can be a considered an example of regulatory harmonisation in the area of data protection, within the broader EU regulatory framework. It provides a unified body of data protection law and a more harmonised administration within the EU while also introducing an entirely new set of obligations for companies looking to transfer personal data outside of the European Union (McCallister, 2017).

The OECD's Mutual Acceptance of Data (MAD) program designed to address chemical safety globally is another example of regulatory cooperation based on exchange of information and mutual recognition through an international organisation that may prove an interesting reference for emerging technologies (see the case study on Chemical Safety in OECD 2013). In the case of the MAD framework, member nations accept one another's test data for assessment of new chemicals as long as the data are generated following the OECD test guidelines and principles of good laboratory practice. The program facilitates testing harmonisation among countries, and enables burden sharing in both the generation and evaluation of chemical test data. By working together on technical and policy questions, members and observers alike gain understanding of one another's positions on issues and learn how to apply technical approaches and policies to regulation collectively. Similar applications can be considered while addressing issues and challenges concerning AI for example wherein the availability and exchange of data is critical to reduce AI related decision-making failures.

With regard to data privacy issues impacted by transboundary data flows, the OECD has also played an important role in promoting respect for privacy as a fundamental value and a condition for the free flow of personal data across borders since the mid-1970s. The cornerstone of OECD work on privacy is its Revised Guidelines on the Protection of Privacy and Transborder Flows of Personal Data (2013). The Asia-Pacific Economic Cooperation (APEC) forum's 2005 APEC Privacy Framework is another example of business-oriented data protection framework that adopts an accountability principle for data transfer, anchored in an inter-governmental process. In 2011, Cross-Border Privacy Rules (CBPRs) were announced as a mechanism to bring increased certainty to the APEC Privacy Framework's transfer rules (Mark Phillips, 2018). Instead of requiring senders to determine whether appropriate protection will be maintained with the data in the recipient's control, CBPRs are codes of conduct that businesses can be certified as conforming to, to demonstrate that they have implemented protections consistent with the APEC Privacy Framework for the purpose of acting as personal data transfer recipients. This arguably moves the model closer to an adequacy model in that each is effectively a self-certification regime driven by the business sector.

4.3. Self- Regulation and Co-Regulations

87. The spectrum of regulatory instruments ranges from those which involve no government intervention through to explicit traditional command and control regulation. Self-regulation and co-regulation are instruments with no or limited government involvement.

88. Self-regulation typically involves a group of economic agents, such as firms in a particular industry or a professional group voluntarily developing rules or codes of conduct that regulate or guide the behaviour, actions and standards of those within the group. The group is responsible for developing the self-regulatory instruments, monitoring compliance and ensuring enforcement. Examples of self-regulation include:

codes of practice; industry based accreditation arrangements; and voluntary adoption of standards.

89. Co-regulation entails explicit government involvement in the regulatory framework. Because this involvement can take many forms, it can sometimes be difficult to make a clear distinction between self-regulation and co-regulation. It is generally considered that co-regulation involves government giving explicit legislative backing in some form for the regulatory arrangements. The specific types of instruments or mechanisms, such as codes of practices, voluntary agreements, dispute resolution procedures that may be created under a self-regulatory regime are similar under a co-regulatory framework. It is the degree of government involvement and legislative backing that determines the difference between the two.

90. Confronted by the regulatory challenges posed by disruptive technologies, some academics note for example the emergence of an amorphous system of regulatory governance called “Soft law” (Hagemann, 2018). Soft law regimes are those that lack "the mandatory, enforceable character of hard law," and are "understood to shape expectations of appropriate behavior more strongly than mere political or social undertakings." (Hagemann, 2018). These may include a wide array of policy vehicles ranging from principles and codes of conduct, policy guidance documents, best practices and voluntary standards, white papers etc. Also, the flexible nature of soft law approaches makes them relatively easy to modify in response to changing circumstances (Marchant and Allenby, 2017). Please note, that “soft laws” may carry a different meaning when developed by International governmental organisations such as the OECD.

91. Box 4.5 provides some examples of the range of instruments or mechanisms which are types of self-regulation used in a range of emerging technologies.

Box 4.5. The use of “Soft Law” mechanisms in the Tech Industry

“Soft Law” Mechanisms	**Industry Example**
Company-NGO Partnership	Dupont-EDF Nano Risk Framework
Responsible Use Guidelines	Coalition for Responsible Gene Editing
Risk Mitigation Checklist	Ethical OS
Downstream Product Stewardship	Ginko Bioworks
Industry Best Practices .	Future of Privacy Forum
Public Engagement	Nantucket – Gene Drives
Request Government Regulation .	Microsoft – Facial Recognition
Corporate Principles	Google/AI
Data Sharing	IBM/Facial Recognition
Patent License Restrictions	Broad Institute/ Gene Drives
External Monitor	Volkswagen

Source: Developed by Prof. Gary Marchant, Arizona State University

When faced with governance of complex technologies that are constantly evolving, the current breed of self-regulation and co-regulation can serves as a foundational structure that can be built upon and the likes of which will continue to serve as new rules for emerging frontier.

4.4. Regulatory Experiments

92. Many scholars have suggested experimenting with available and new regulatory tools that may be useful in regulating new technologies such as AI, including the following (Michael Guihot, 2017):

- Enhancing flexibility through temporary regulation by using experimental legislation including sunset clauses to "define adaptable goals and enable the adjustment of laws and regulations according to the evolution of circumstances;
- Creating "regulatory sandboxes" to allow firms to "roll out and test new ideas . . . without being forced to comply with the applicable set of rules and regulations."
- Developing "anticipatory rulemaking" or adaptive regulations techniques that leverage feedback processes to enable "rule makers to adapt to regulatory contingencies if and when they arise because a feedback effect provides relevant, timely, decentralised, and institution-specific information ex-ante."
- Making increased use of data analysis to identify what, when, and how to regulate.
- Utilising the iterative development of the common law to adapt rules to new technological contexts where possible and developing new specialist regulatory agencies where they are particularly needed.
- Using "legal foresighting" to identify and explore possible future legal developments, in order to discover shared values, develop shared lexicons, forge a common vision of the future, and take steps to realize that vision.
- Creating new multi-stakeholder fora to help overcome information and uncertainty issues that stifle innovation or inhibit effective regulation.

93. A number of these approaches are discussed below.

4.4.1. Regulatory sandboxes

94. A regulatory sandbox generally refers to a regulatory "safe space" that creates an environment for businesses to test products with less risk of being "punished" by the regulator for non-compliance. In return, regulators require applicants to incorporate appropriate safeguards to insulate the market from risks of their innovative business (Dirk Zetsche, 2017). It typically involves a framework set up by a regulator to allow pilot testing of innovations by private firms in a controlled environment (e.g., exemptions, allowances, time-bound exceptions etc.) overseen by regulators. It was pioneered by the

UK's Financial Conduct Authority has provided a new way to test a new idea outside the constraints of the full regulatory system and gain data on how well it works when applied to real scenarios. Its application in fintech scenarios have been in place for a few years now and well documented (Dirk Zetsche, 2017).

95. As a non-financial sector example, Autonomous vehicle (AV) rules were introduced in Singapore in February 2017 providing rules for prospective trials of autonomous vehicles and automated vehicle technology, and prospective use of autonomous vehicles (Weilun, 2017). Parties announcing trials included businesses looking at autonomous bus and truck technology, ride hailing applications and tourist services. The AV Rules and broader legislative framework give the Singapore Land Transport Authority the ability to effectively implement a regulatory sandbox in relation to any such trial or use. This allows the LTA, for example, to create bespoke licensing conditions and demarcated trial areas. The discretion provided to the LTA leaves it open for an applicant to engage with the LTA on the solution to be authorised. However, there are certain overarching conditions to authorisation and duties of authorised operators prescribed under the Road Traffic Act and the AV Rules which have to be followed. A similar framework is also being adopted in Germany.

96. A regulatory sandbox introduces the potential to change the nature of the relationship between regulators and innovators toward a more open and active dialogue. It may also enable the regulator to revise and shape the regulatory and supervisory framework with agility. Regulators establish sandboxes to promote competition and efficiencies within markets through innovation. The success of a sandbox is dependent on how it is framed and, the effectiveness of the innovations amongst other factors. While the sandbox concept itself is easy to copy, its true value lies in the substance of the sandbox, which is the extent to which it can promote beneficial innovation based upon an in-depth knowledge exchange between innovator and regulator (Dirk Zetsche, 2017).

Truly smart regulation will pair the sandbox with a strong, fact-based, research-driven dispensation and licensing practice that furthers innovation while minimising risk. However, in markets where experienced regulators decide their cases, regulated entities already benefit from responsible dispensation practices, while avoiding the risks and uneven competition a sandbox creates. Some large and experienced regulators have therefore hesitated to adopt the sandbox approach and seek an efficient level of forbearance or dispensation by way of no-action letters, restricted licensing, piloting, and other tools (Dirk Zetsche, 2017). Risks and limitations with regulatory sandbox include sending negative signals to markets as the sandboxes are essentially "unregulated", lack of transparency and standardisation, and perceptions of not creating level playing fields.

4.4.2. Adaptive regulation

97. Adaptive regulation refers to design of institutions and processes to review and update policies in light of evolving scientific knowledge and changing technological, economic, social and political conditions (IRGC, 2015). The pace at which technologies and business models are changing and globally evolving as described earlier, adaptive regulation may pose challenges for regulators, regulated parties and other stakeholders as periodic re-evaluation and revision might reduce the stability and predictability of rules, which could have the effect of discouraging investment and innovation. In response, the Institute of Risk Governance (IRGC)proposes, planned adaptive regulation (PAR) as an enhancement to handle this change with greater agility and predictability, through planned review and revision, rather than through a purportedly final decision that

locks regulation in place and then grows increasingly out of step with the ongoing changes – yielding unintended consequences and rigid rules that inhibit innovation.

98. IRGC believes that PAR is reserved for cases such as regulating AI and digital aspects such as data privacy and security where:

1. There is a prior commitment, planned early in the policy's design, to subject the policy to periodic re-evaluation and potential revision, and
2. There is a systematic effort or mechanism, planned early in the policy's design, to monitor and synthesise new information for use in the re-evaluations.

99. In a similar example, the US Consumer Financial Protection Bureau (CFPB), recognising that its policies have interfered with technological innovations in the past, has tried of late a collaborative approach. In the past, firms resisted innovation because perceived violations of the rules brought punitive action. To overcome this problem, the CFPB has begun issuing what it calls "no-action letters." These offer innovative firms' freedom from fines and prosecution while the firm tries out new technologies. It does not guarantee approval, much less market success, but it does allow experimentation without fear of prosecution.

100. Technologies in collaborative platforms can perform some of the functions carried out by traditional regulatory frameworks. For example, many technologies embed effective feedback mechanisms through producer and consumer ratings. These feedback mechanisms generate trust among users in a more transparent, reliable and efficient manner than traditional regulation. That contributes to consumer protection and safety.

Additionally, the owners of these technologies collect an unprecedented amount of data in the markets in which they operate such as data on tax receipts, consumer habits, traffic patterns and driver safety, to name a few. These newly available insights are particularly important because they are surfacing in markets where data was traditionally scarce and may even have been nonexistent. Regulators and tax authorities can leverage the data to design policies, improve implementation, boost tax collection and achieve better regulatory outcomes.

4.5. Conclusions

101. The speed with which technological advancement is outpacing regulators' abilities to address emerging concerns clearly warrants a paradigm shift in thinking and conception of new approaches to regulating these innovations. Most twentieth century regulatory institutions globally are ill-equipped to effectively address the rapid progress driving 21st century technologies. This previous section of the report has described five significant challenges that they face in regulating these technologies namely; 1) Pace of change or the pacing problem, 2) Disruptive business models, 3) Natural monopoly characteristics especially of online platforms, 4) Autonomous decision-making using AI, and 5) Digital data privacy and security issues. Some of these challenges such as the pacing problem, data privacy and security issues and disruptive business models are better understood and better documented than the others. Some of these including AI and natural monopoly characteristics continue to evolve and morph into new and uncertain risks as the technologies themselves evolve and require greater attention.

102. This section examines some of the current regulatory (soft and hard) approaches that are being developed and contemplated to address these regulatory challenges. A

range of instruments spanning traditional regulations, regulatory cooperation, self-regulatory and regulatory experimentation frameworks are proposed. However, as the research suggests, no single methodology or framework seems to have all the necessary characteristics to tackle all the challenges warranting a more holistic and hybrid approach that provides a wide range of options as being a likely way forward. The Regulatory Policy Committee is well positioned to not only consolidate available literature but augment them with specific case studies and generate useful and practical guidance documents and toolkits for regulators' use along the lines of several such materials they have produced in the past. In doing so, it is important to develop them as living documents that are periodically reviewed and updated to keep pace with technological changes.

5. Regulating Better with Emerging Technologies

5.1. Introduction

103. In the previous sections, we have learnt about the challenges faced by governments as regulators and enablers of disruptive and emerging technologies and the approaches and trends in addressing some of these challenges. The body of literature describing these challenges and experiences is growing by the day and significantly reducing the knowledge gap while still being away from truly solving the issues in total. However, the same cannot be described about the amount of available knowledge on the use of emerging technologies by governments to render services to businesses and citizens including delivering regulations. This is not to say that governments have not embraced technologies to provide more efficient, effective and outcome-based services, it is just that not enough of such initiatives have been well documented to provide an opportunity to have a meaningful dialogue on the benefits, challenges and charting the future of public sector service delivery.

104. There is growing anecdotal evidence at the least to suggest that the advancements in digital information technology have had profound implications for governments and citizens alike, including many benefits but also heightened complexity and challenges. While digital technologies have already disrupted the B2B and B2C space, companies and policy makers alike are yet to understand the underlying business models and avenues to monetize digital in many other areas such as the G2B and G2C spaces. In government, digital seems to blend with discussions around open data, big data, broadband policy, digital inclusion or entrepreneurship, or government transformation, resulting in a lack of clarity (Falk, 2018). Nevertheless, enthusiasm about digital is high among politicians and policy makers alike.

105. The earliest form of digital governments may be traced back to the first wave of eGovernment that happened in most countries of the world in the 2000s, both in mature and emerging economies. A vast body of literature published by multilateral organisations, academia, think tanks or consulting companies documents the history of priorities and activities in eGovernment quite well. The OECD has developed a normative framework in this policy space (OECD, 2014). Likewise, the UN Public Administration Programme has published the comprehensive set of assessments and benchmarking since 2001. They looked at online presence and maturity of member states and assessed more than 50,000 features of eGovernment websites (Falk, 2018).

106. Cooperative projects between the government, business, and citizens began to emerge to help governments prioritize the development of more advanced information technology infrastructure . Estonia, for example, passed legislation that allowed the creation of infrastructure such as the national digital identity (ID Card) program and the data exchange platform X-Road both critical for developing the digital society systems that were to come (World Bank, 2017).

107. Being a smarter government seems to require having a more forward thinking approach to the use and integration of information, technology, and innovation in the activities of governing (Ramon Gill-Garcia, 2014). This would typically mean having the

following "smart" elements: openness and decision making, open information sharing and use, stakeholder participation and collaboration, and improving government operations and services, all through the use of intelligent technologies as they act as a facilitator of innovation, sustainability, competitiveness, and liveability.

108. Regulatory delivery is one key area of operations and services provided to citizens and businesses by governmental agencies and/or independent regulators. With digital transformation transforming businesses and societies, regulatory delivery needs to evolve as well especially through the adoption of such technologies to continue to ensure that balance required to be maintained between burden reduction and protection of public and consumer interest. Regulatory delivery is generally defined as the means by which policy expertise and practical experience are brought together to ensure that regulation is effectively delivered in ways that reduce burdens on business, save public money and properly protect citizens and communities. The delivery process represents a complete cycle, from rulemaking, licensing, inspection and enforcement and other aspects of actual "delivery" of the regulations.

109. Digitising regulatory delivery involves developing an ecosystem of various technology-based applications and systems applied across various stages of the regulation delivery cycle described earlier in a manner that the delivery of regulations indeed reduces regulatory burden on businesses while properly protecting citizens and communities. This section examines the conditions necessary to digitize regulatory delivery, evaluates potential opportunities and describes some early experiments and pilots being undertaken in this direction. It needs to be acknowledged early in this section that there is very limited research being carried out in this domain and as a result, limited knowledge is available in literature. However, some recent studies by organisations including The World Bank[5], Prism Institute[6] and Deloitte[7] suggest the use of emerging technologies as forming the basis for development of smarter regulations developed using collaborative partnerships with businesses and stakeholders and, delivered using innovative frameworks.

110. This section throws some light on these more recent trends in the use of emerging technologies for regulatory delivery, identifies opportunities for further research and guidance that may be developed by the OECD for regulatory agencies to consider as they modernize their regulatory delivery frameworks. In particular, using the limited evidence available, it examines the early applications of technology across the regulatory life cycle and some emerging conditions and themes that may be considered for further investigation.

5.2. Emerging Technologies and the Regulatory Cycle

111. OECD recognises one of the great benefits of new technologies is for government administrations themselves to use to increase their capacity and regulate effectively (OECD, 2018). AI, the use of algorithms and the growing uptake of open data, as well as social media enable regulators to collect timely information, conduct analysis engage with stakeholders when developing coherent policies. Digital technologies can also replace or complement traditional compliance enforcement methods and support policy

[5] Internet of Things – The New Government to Business Platform
[6] Risk Based Regulatory Delivery – Review and Toolkit of Modern Practices
[7] The Regulator of Tomorrow – Rulemaking and Enforcement in an Era of Exponential Change

evaluation. Let us examine the potential applications of digital technologies across the policy life cycle in this section.

5.2.1. Decoding and Influencing Legislation

112. It is not unusual to find businesses complaining of overlapping, conflicting, redundant and outdated regulations in areas protecting public health, safety and environment. In many regions, these issues get compounded by the existence of multiple levels of jurisdiction spanning multiple sectors. Artificial Intelligence and Machine learning tools can be used to sieve through volumes of such regulations to help understand and dissect such issues and providing information to modernize and reform future regulations. The Canadian government through the Canada School of Public Service (CSPS) has recently embarked on such a project to eventually help identify opportunities for regulatory modernisation.

113. Business, in many instances, also struggle to understand what legal and regulatory requirements they face everywhere they operate. Inevitably, they struggle to ensure compliance, are unable to demonstrate it to management and regulators, resulting in compliance failures, regulatory fines and, increasingly, personal legal sanctions for their management. More often, they result from difficulties in trying to decode complex and confusing legal jargon in many of these regulations. AI tools can analyze unstructured content such as laws and regulations and when combined with machine learning, they can 'read' such documents and perform a range of tasks including: extracting metadata, identifying entities that are referred to, and 'understanding' the intent or purpose of specific parts of the document.

114. E-participation, e-rulemaking, and crowdsourcing legislation are far from being recent concepts. Instead, their effectiveness and growing potential have been discussed in the literature in the past decade (Ranchordas, 2017). The development of crowdsourcing, the "sharing economy," and the different uses of digital platforms as a peer-to-peer process have changed the traditional model based on top-down regulation and expert-driven rules designed to address information asymmetries in the consumer-professional relationship.

115. While the formal participation of stakeholders in the lawmaking process has been formally regulated in many Western countries in the context of public consultations and parliamentary hearings, the active participation of anonymous citizens beyond these instruments remains limited. Examples of how the platform Uber has attempted to mobilize citizens to initiate and sign electronic petitions regarding the deregulation or flexible regulation of this ride-sharing platform is well documented (Ranchordas, 2017).

116. Similarly, the direct participation of citizens in the drafting of legislation involving Brazil's Internet Bill of Rights is also well known (Ranchordas, 2017). This innovative and well-known piece of legislation has not only convinced a number of jurisdictions to rethink their laws on privacy but also narrates the participatory process conducive to the implementation of this statute.

117. Clearly, the potential exists for governments and regulators to use technology for the purposes of effective consultation with citizens and businesses in framing future regulatory policies while at the same time using them for scrutinising and managing existing regulations in trying to achieve results and outcomes such as burden reduction on businesses and better public protection.

5.2.2. Policy Design and Regulatory Alternatives

Digital technologies can allow for the use of a number of regulatory alternatives which were previously technologically infeasible or, at the very least, too costly to implement. For example, automatic detection and payment systems can lower transaction costs of compliance by users for road-charging schemes. These systems have removed the need for less efficient means of addressing local congestion, such as restrictions on vehicle use by license plate numbers. Initiated in Singapore and replicated in a number of cities including Toronto, London and Stockholm, technological systems automatically detect and record the vehicles entering a predefined "congestion zone and charge a variable fee depending on the time of day or level of congestion. Vehicle-owners can also register in a centralised directory and be charged via direct debit automatically. Such systems result in both improved regulation outcomes and lower administrative costs.

118. The ability to move away from prescriptive regulation for more flexible economic instruments has also been made possible through technology. The case of environmental regulation and the move to a tradable permit system in the United States is illustrative. The original Clear Air Act was established on technology-based standards and did not entail the direct monitoring of emissions. The introduction of the Clean Air Act Amendments in the United States required the installation of on-site monitoring equipment relaying information in real-time to the Environmental Protection Agency. The use of digital technologies made it feasible for the regulator to guarantee the "integrity" of the asset to be traded (the permit), thus giving sufficient confidence to allow for the shift from the less economically efficient regulation which had been in case previously (see Ellerman 2013).

119. The use of digital technologies can improve the efficiency and lower the administrative costs associated the implementation of a range of policy measures.

5.2.3. Regulatory Enforcement and Monitoring Outcomes

As described extensively in DSTI/CIIE(2017)20 one of the principle benefits of the application of digital technologies is the increased capacity for government officials to monitor outcomes related to meeting regulatory objectives. The application of digital technologies can help to overcome, or significantly reduce the costs, of monitoring economic, environmental, or social outcomes. For instance, in the area of financial market regulation, big data is playing an increasing role in monitoring financial flows at a level of granularity and periodicity that was previously not possible. This is commonly referred to as RegTech, which is defined as the use of technology, particularly information technology, in the context of regulatory monitoring, reporting, and compliance (Arner, 2017). In the area of competition policy enforcement, the analysis of "big data" has been used to identify possible infractions as a lead for further inspection (see DAF/COMP(2013)27). Observing outcomes is a pervasive problem in environmental and natural resource management. For instance, the GRACE (Gravity Recovery and Climate Experiment) and CHAMP (Challenging Minisatellite Payload) satellite missions have allowed for the mapping of surface and groundwater resources, and their changes over time. (see ENV/EPOC/WPWBE(2016)/REV3). In the area of forest management, the use of satellites and drones has allowed for much improved monitoring of the status of forest resources, and their changes over time. (see Goetz et al.

2014) Digital technologies have also had significant implications for monitoring ambient environmental quality, affordably increasing the periodicity, granularity and accuracy of observations. (see Ziegler et al., 2015).

5.2.4. Transforming Regulatory Delivery – Licensing/Registration through Enforcement

120. Examples of advancements are starting to emerge in the actual delivery and implementation of regulations particularly when the regulations themselves are risk or outcome-based. Reliable and trustworthy risk assessments that support the delivery of regulations are those that have been able to address and reduce sources of uncertainties.

121. UK Food Standards Agency (FSA) is currently evaluating a new digitally-enabled service which it intends to roll out in 2019 that would make it easier for businesses to register and easier for them to access tailored information and guidance that will enable them to be compliant from the start (Food Standards Agency, 2018). To do this FSA is building an online registration service which will give them more information on food businesses at the time they register and will provide real-time access to registration details of all businesses in England, Wales and Northern Ireland. The data collected through this process will in turn feed their risk methodology to help segment markets on a risk and allow them to target their inspection resources accordingly.

122. Use of disruptive technologies for data collection, analysis and decision support is receiving the most attention particularly as they help address the limitations of traditional inspection approaches. A new study (Prism Institute, 2018) documents examples of some regulators who are just beginning to realize the potential benefits for the use of disruptive technologies for data collection such as the use of Internet of Things (IoT) sensors to remotely inspect food establishments (UK). UK's Department for the Environment, Food and Rural Affairs (DEFRA) has developed a blockchain Proof of Concept (PoC) with IBM that helps to monitor compliance through the meat supply chain. Finland is currently testing "Skype" inspections of chemical facilities in remote locations to reduce travel time and improve efficiencies. The Queensland government in partnership with academia and the private sector is working on the development of systems that include location tracking, smart sensors and image recognition of fish species which are designed to replace slow and costly manual logbooks with automated real-time monitoring. Automated technology will save fishers time and money by reducing the burden to record their daily catch and fishing effort in traditional hard copy logbooks. The regulator, Fisheries Queensland, will receive more accurate information in real time rather than waiting for logbooks to be sent in and data entered, giving the community greater confidence in the quality of data.

123. The Prism Institute study also reveals that the most significant use of disruptive technologies has involved the application of a combination of artificial intelligence and machine learning tools for risk assessment of inspection and other sources of compliance data primarily for the purposes of resource allocation, target setting, and inspection prioritisation. Examples of such applications have emerged in the drinking water (UK Drinking Water Inspectorate), technical and electrical safety (Electrical Safety Authority of Ontario, British Columbia Technical Safety), and health care (UK Care Quality Commission).

124. A World Bank report (World Bank, 2017) suggests, the most extensive application of disruptive technologies such as Internet of Things in the public sector domain have been more focused on delivery of services such as in the context of municipal and city applications. The adoption of such technologies for regulatory delivery is still primarily in concept stages.

5.3. Emerging Roles for Regulators

125. As regulators grasp the relevance and applicability of these digital technologies, they are beginning to assume different roles particularly in the context of data ownership/stewardship and as enablers. This is an area of pending research and requires further investigation. However, some early signs suggest three distinct roles emerging for regulators.

1st Party – Data Owners

126. In this role, the regulator develops and maintains technologies for the purposes of data collection, transmission and/or analytics. The costs of implementation and maintenance are completely borne by the regulator. In the observed examples, the regulators tend to take ownership for the use of monitoring and surveillance (e.g., airport security), resource allocation and enforcement (use of AI/ML tools for risk-based inspections and enforcement decisions such as revoking licenses).

127. As an illustrative example, Technical Safety BC in Canada, a safety regulator for technical devices, uses a combination of data generated through inspections and investigation along with permits and declarations and has applied AI/ML to predict the risks associated with regulated technical assets in BC. The machine learning tools scan the information, analyze, predict the chance of finding medium, high or severe hazards and if the percentage is above a threshold, the tool prompts an inspection by a safety officer. The predictions made by the machine learning tools are verified empirically by safety officers. Safety officers are informed daily on inspection priorities but significant changes to resource allocation is done more on annual basis (though that may change in the future). After having piloted it in a sector the model has been scaled across several sectors.

128. While regulators tend to find direct ownership to be the most effective they are fraught with significant risks including the potential for misuse (e.g., ticketing traffic violations), having the need to address privacy issues with stakeholders and the public, high capital and maintenance costs, and creating disincentives for industry and regulated parties fearing censure.

2nd Party – Data Receivers

129. In this role, businesses and regulated parties are influenced and incented to adopt and implement technology and share data with regulators. The regulators periodically receive data elements that provide compliance assurance while the data is owned by the businesses. In addition, regulators may choose to undertake audits to verify and validate the technology systems. This approach is only likely to work if businesses are incented to share data (e.g., reduced physical inspections, positive rating schemes, subsidies etc.). In extreme cases, regulators are considering mandating such applications but the likelihood of success in such cases are not known. The UK FSA has piloted a case study that uses this approach.

130. Recognising that the data in the Food Business Operator system was much better (quality and much more granular) than what UK Food Standards Agency (FSA) possessed, FSA has developed a proof of concept using blockchain which provided the results of the inspection not just to the last farmer but also to all of the other farmers that owned that animal. It uses an ear tag and information from an animal passport to collect the data. Meat Inspectors enter data about conditions into the Food Business Operator (FBO) system. These are batch uploaded to the blockchain by the vet once the data has been approved. The vet, FSA, FBO and farmer can access the data. FSA is starting to develop dashboards for data visualisation and once this is done are hopeful that the industry will adopt this (or a similar equivalent) system or systems.

131. Some of the risks that need to be addressed include:

- Businesses may feel concerned that their competitive advantages may be affected if there is inappropriate sharing of proprietary data. Risks associated with data privacy and costs for implementation though not as significant as in the earlier case, remain an issue. Businesses unable to implement such technologies may feel that they may receive unfair treatment by regulators.

3rd Party – Data Stakeholders

132. In this third-party role, regulators are provided data by regulated parties who may already own and be using the technology for their business applications and are able to share relevant compliance data. Typically, in these instances businesses volunteer and are incented to supply data elements for compliance assurance. Business may supply data and trends in response to single or multiple failures or accidents (e.g., legal or liability scenarios), or choose to participate in aggregated data sharing models (e.g., integrity of systems, traceability of value chains). This is seen to be the most practical and feasible approach with some risks (competition, privacy, costs, fairness, enforcement implications). However, this approach is most likely to succeed in sectors involving large industries with automated applications.

133. Gas Tag, an industry driven initiative, involves RFID Tags attached to the gas meter at every 'Gas Tag Property'. Gas Tag maintains Register of "Authorised" Engineers who are provided with Smart Devices that "tag" to property meters. An App on these devices validates that the engineers are registered, time/date stamps records of work, and geo-tags engineers to prove on-site when work completed. The information is then transferred to a Cloud based database where the data is captured and stored safely and securely. Dashboards allow landlords to monitor their property portfolio in real-time including providing immediate visibility of their overall compliance that they are able to share with regulators.

5.4. Conclusions

134. As policy-makers and regulators embark on regulating better using emerging technologies, some key themes and elements that need to be considered include governance and leadership, collaboration and sandboxes, and building capacity and change management (Prism Institute, 2018). These elements and themes are identified as key for implementation:

Governance and Leadership

135. The most effective institutionalisation of disruptive technology applications for regulatory inspections are possible when they tie directly to key strategic priorities and initiatives of these agencies wherein real problems and challenges exist in monitoring and obtaining compliance assurance. This would therefore require the leadership in the regulatory agencies to become aware and recognize the role of disruptive technologies and, support their implementation. Successful applications of these technologies have always benefited from a top-down recognition.

136. Given the pace of disruption, the wide diversity of stakeholders, the cross-boundary nature of the digital economy, and the scale of new digital services, it is important for regulators to look beyond traditional regulatory models including considering trade-offs between compliance, risk and benefits of such technologies. For example, regulators should be open to the idea of not engaging in physical inspections when not required and using alternative means such as remote inspections of real-time monitoring. Regulators should also consider third-party sources for data collection and should be judicious in the way data is used with the focus being more on managing risks as opposed to achieving 100% compliance. Such strategies and governance frameworks can be achieved by implementing modern regulatory guidance and practices available through the OECD and a number of agencies across OECD countries.

Collaboration and Sandboxes

137. Public-private partnership has emerged as a key characteristic for successful execution of pilots and possible scaled implementation of disruptive technologies and innovations for regulatory delivery. Governments and regulators have typically provided the necessary infrastructure, funding, sandbox environments, and coordination to organize the pilots. In some instances, governments have established "third-party coordinators" to organize pilots. Private sector including the responsible regulated businesses, technology companies, and academic institutions need to participate as "equal" players in the regulatory system. In addition to bearing the costs, private sector is most likely to be able to identify and introduce these innovative solutions as long as they are not seen to be burdensome and impacting their business models, and therefore will need to play a proactive role in the partnership.

138. Regulators play a key role in creating the necessary sandbox environments for testing disruptive technologies. They can help create test beds which provide themselves, industry and other stakeholders with an opportunity to test innovative solutions for monitoring and compliance assurance and also help with answers to a number of fundamental questions to enable them to take the correct policy decisions.

139. These sandboxes can be used for:

- collecting and transmitting data on compliance and risk factors relevant for regulatory oversight and reduce sources of uncertainty in traditional data collection approaches;
- modeling, analysing and predicting compliance performances and behaviors that can be used to support decisions such as allocating inspection resources, targeting inspections and audits, and monitoring the value chains

- responding to known and emerging risks including policy changes, delivery strategies and methods, data governance and ownership, business incentives including market enhancements, and enforcement tools.

Capacity Building and Change Management

140. Implementing disruptive technologies and innovations in regulatory delivery will bring significant changes in the workforce and support structures not only within businesses and the regulated sectors but also in regulatory organisations. A significant challenge to the disruptions would be the presence and adequacy of competent professionals as also the capacity and awareness to understand and embrace change.

141. Regulatory agencies should begin working towards addressing the future of regulatory inspections by scoping out partnerships for working with academic institutions in designing programs and curriculum focused on creating "future" inspectors. Agencies can also consider other models such as establishing a "secondment" program for industry to allow its employees to take on roles as inspectors alongside their inspection team to understand the regulatory delivery environment and share knowledge and expertise.

142. Agencies having an objective of adopting and implementing alternative and innovative regulatory delivery approaches need to consider implementing change management frameworks based on best practices in behavioral economics and other emerging concepts in behavioral sciences. While the frameworks exist, agencies with success have had to design and tailor very specific change management strategies recognising their mandates, the stakeholder needs and expectations, and the maturity of the regulated sector. In addition to proactively engaging internal stakeholders particularly in gaining their trust and confidence while implementing technologies such as AI, agencies find it beneficial to engage stakeholders in the design and development of disruptive solutions. Time and effort are required to gain the acceptance of stakeholders including internal operations teams such as inspections. Agencies will have to use all available communication and capacity building tools to demonstrate the benefits and positive impacts of the technology-based approaches with their inspections to create awareness and build confidence.

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