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Building an Enabling Environment for FinTech

ISSUES PAPER

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Contents

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Summary

This Issues Paper was commissioned as part of the APEC Workshop on "Building and Enabling FinTech Environment" hosted by New Zealand under the ambit of the APEC Economic Committee (EC 02, 2021A) to further support and stimulate discussions on key developments in FinTech. The Workshop was held on 27 and 29 September 2022 and was attended by 128 delegates from 19 economies.

Key findings and takeaways from the Issues Paper and the Workshop are summarised below.

Overview of FinTech and its Relevance in a post-COVID-19 recovery across APEC

FinTech - that is any technologically enabled innovation in the financial service sector that could result in new business models, applications, processes, or products – is rapidly becoming a key element to the maturity and growth of an economy's financial sector, with socioeconomic developments and technological advancements laying the foundation for greater FinTech adoption and innovation.

The COVID-19 pandemic accelerated the adoption of FinTech, most notably in digital payment methods, due to FinTech's ability to provide financial services in a timely and inclusive manner. Many APEC economies saw an uptake in the number of individuals that opened an account and made an online transaction for the first time since the pandemic started.

The post-COVID-19 economic recovery will rest on two key pillars – i) the continued growth of the digital economy, and II) the achievement of the Sustainable Development Goals (SDGs). FinTech is expected to play a major role in the development of both pillars given its essential nature in facilitating digital transactions and its power in driving finance to achieve the SDG targets.

Fintech has a large scope and spectrum of financial tools. For the purposes of this paper and workshop we have focused on two critical applications of FinTech – the role of blockchain in enabling better trade practices and trade finance, and FinTech's role in enabling sustainable finance and the development (or meeting) of environmental, social, governance (ESG) standards.

(i) Opportunities, Limitation, and Emerging Trends in Blockchain

Modern trade value chains are complex, fragmented, and face challenges in accuracy, traceability, and transparency. To this end, applications of blockchain can help address key challenges in modern day trade in three major ways: i) blockchain can facilitate verified, more secured, and cheaper trade transactions; ii) blockchain can modernise and streamline the trade finance process; and iii) blockchain can facilitate faster and cheaper cross-border payments, and enabler smoother and faster due diligence processes.

While there is immense potential for blockchain applications to transform the modern trade value chains, it is important to acknowledge that much of its real-life applications international trade and trade finance are relatively nascent, and the technology is still developing. Implementing blockchain solutions can be a resource intensive undertaking and require economies or organisations to have more than a baseline level of internet connectivity or digital skills. In some instance, the adoption of

blockchain may even prove to have limited additional benefits over an existing solution, particularly if the existing solution functions well.

(ii) ESG Standards and FinTech

Sustainable finance is the practice of integrating ESG criteria in an investment decision and is an increasingly important lever to help drive finance towards achieving international commitments such as the UN SDG and the Paris Agreement targets.

FinTech has the potential to be a critical enabler of sustainable finance in three major ways: (i) Technologies used in FinTech can provider richer, more accurate ESG data for better accounting of SDG-related risks and impact; (ii) Fintech can help reorient capital flows towards more sustainable investments at scale; (iii) the rise of FinTech services like robo-advising/ -investing, marketplace lending, and crowdfunding platforms have made it easier to raise funds for green, socially responsible, or sustainability-themed projects.

The integration of ESG criteria in investment decisions or as part of compliance requirements for companies, has contributed to the varied development of ESG standards and reporting frameworks. To address this fragmented expansion, regulatory authorities and government bodies have taken several innovative approaches that promote more uniform accounting standards on ESG criteria at the domestic, regional, and global level. This includes introducing common reporting standards at a domestic level, implementing a sustainability strategy at a regional level, and establishing base-line standards at a global level.

Policy Recommendations and Next Steps

Innovative product and services that draw on advancements in FinTech as discussed in this report are driving greater adoption and new applications in modern-day trade value chains and sustainable financing. APEC and its member economies could consider the following policy recommendations to help advance the development of emerging technologies for trade and sustainable finance, and to realise the socioeconomic benefits from the FinTech applications discussed above. Specifically:

To advance development of emerging technologies for trade and sustainable finance, APEC and its member economies could consider the following five high-level approaches:

- Develop in-house government expertise on key innovations, in line with domestic capacity-building initiatives on digital upskilling and upgrading of existing technology infrastructures.
- Establish public-private partnership to allow greater collaboration between public and private sector in the development of cutting-edge technologies.
- Provide capital for research and development such as an innovation fund, that is dedicated to helping bring breakthrough technologies to market.
- Evaluate the use of regulatory sandboxes given the nascency of the technology applications discussed in this report.
- Establish innovation centres to foster market growth and serve as a one-stop hub for relevant information on emerging technologies.

To help realise socioeconomic gains from FinTech, APEC and its member economies could consider the following five actionable steps:

- Incorporate applications that facilitate trade and promote a more sustainable economy as part of domestic agendas.
- Establish clear and flexible regulations that boost investor confidence and reduce adoption cost of new technologies and innovation.
- Launch public consultation processes with industry stakeholders to ensure that views and needs of relevant non-state actors are incorporated in the policy development process
- Create an environment that enables and strengthens internationalisation, including supporting the adoption of common standards.
- Create channels for knowledge sharing that help APEC economies identify areas of mutual priorities for collaboration and potential cross-border pilots.

1. Overview of FinTech and its Relevance in a Post-COVID-19 Recovery Across APEC

The purpose of this issues paper is to support and stimulate discussion at the virtual APEC Fintech Workshop hosted by New Zealand on 27 and 29 September 2022. This workshop is a project under the Economic Committee (EC02, 2021A).

The FinTech sector has seen rapid growth and innovation in the past decade. Developments in FinTech have led to the introduction of new products and services, unique business models and entry of non-traditional market players that are profoundly changing the financial sector. FinTech also played a critical role in providing aid and relief during the COVID-19 pandemic given its essential nature in facilitating digital transactions while maintaining social distances and will continue to be a key element in the continued expansion and promotion of the digital economy.

Fintech has a large scope and spectrum of financial tools. For the purposes of this paper and workshop we will focus on two critical applications of FinTech, with Section 2 setting out the role of blockchain in enabling better trade practises, and Section 3 setting out FinTech's role in enabling sustainable finance and the development (or meeting) of environmental, social, governance (ESG) standards.

1.1 Emergence of FinTech

FinTech—that is any technologically enabled innovation in the financial service sector that could result in new business models, applications, processes, or products—is rapidly becoming a key element to the maturity and growth of a financial sector. New digital technologies are enabling the unbundling and decentralisation of financial services from large financial institutions and facilitating the rise of specialised service providers in key segments such as payments, credit and loans, investment and asset management, and insurance. Rather than relying on a single institution to provide one or more of the financial services mentioned, consumers can now choose from a host of providers and assemble options that best suit their financial needs.

Socioeconomic and technological developments such as increased penetration of fast and affordable Internet, widespread use of smartphones, and availability of low-cost computing and data storage abilities are driving FinTech adoption and innovation. The digitalisation of financial services and commerce is creating reams of data about users and transactions which can be mined for insights and used to grow and scale data-driven business models. Increased data and connectivity are alleviating existing pain points in the provision of financial services, such as information asymmetries and transaction costs, and making it more convenient for consumers to access financial services anytime and anywhere. Consequently, consumers are no longer limited by physical location when choosing a financial service provider. These drivers have also facilitated the entry of non-traditional players such as big technology firms or telecoms companies.

At the same time, the increased access to and use of data in developing personalised financial products and services has raised concerns. Policymakers and regulators need to ensure that data rights are protected, and service providers do not infringe consumer privacy through exploitation of consent

mechanisms or through improper collecting and handling of data. To ensure that the responsibilities that apply to service providers regarding the use of data are appropriate, some economies have reassessed their regulatory landscape and introduced new approaches to licensing, data, and competition.[1]

1.2 COVID-19 and the Expansion of FinTech

COVID-19 accelerated the transition to a more digital economy and society. Restrictions on mobility imposed by COVID-19 pushed businesses and governments to shift towards digitalisation, prompting an uptake in cloud technologies and removal of barriers to greater adoption of digital and cloud solutions. It has also been a major catalyst for the adoption of digital financial services and FinTech innovation, most notably in digital payment methods. Prolonged mobility restrictions that curbed most physical exchanges of goods and services, and perceptions that cash-based payments were unsanitary, prompted millions of individuals to change the way they paid for goods and services, leading to an increase in the number of individuals that opened an account and made an online transaction for the first time since the pandemic started.[2] Companies were also forced to change the way that they operated, and those that were able to shift their businesses online saw less disruption than those that remained offline.

COVID-19 also highlighted FinTech's ability to provide financial services in a timely and inclusive manner. Mobile wallets/ e-wallets[3] allowed governments to quickly roll-out financial assistance and provide timely relief to vulnerable parts of the society while social distancing. Economies with established digital identity systems or existing government-to-person (G2P) programs had the advantage of delivering relief faster and more accurately. For example, in Thailand, the government was able to quickly determine the eligibility of a beneficiary and make direct deposits into an account linked to the beneficiary through the existing digital identity program and fast payment system.[4]

FinTech services such as online marketplace lending (MPL)[5] and person-to-person (P2P) crowdfunding platforms also played an important role in mitigating the impacts of the pandemic and to avoid a complete standstill to the financial sector.[6] P2P crowdfunding platforms helped raise funds to buy much needed medical supplies and personal protection equipment on top of those provided by the

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[1] World Bank (2022) FinTech and The Future of Finance Overview Paper, https://documents1.worldbank.org/curated/en/099450005162250110/pdf/P17300600228b70070914b0b5edf26e2f9f.pdf
IMF (2021) Big Tech in Financial Services, https://www.imf.org/en/News/Articles/2021/06/16/sp061721-bigtech-in-financial-services

[2] World Bank (2022) Covid-19 boosted the adoption of digital financial services, https://www.worldbank.org/en/news/feature/2022/07/21/covid-19-boosted-the-adoption-of-digital-financial-services

[3] Mobile wallet/ e-wallet refers to a virtual wallet that allows users to store payment card information on a mobile device. See: https://www.investopedia.com/terms/m/mobile-wallet.asp#:~:text=A%20mobile%20wallet%20is%20a,the%20mobile%20wallet%20service%20provider.

[4] World Bank (2020) Responding to crisis with digital payments for social protection: Short-term measures with long-term benefits, https://blogs.worldbank.org/voices/responding-crisis-digital-payments-social-protection-short-term-measures-long-term-benefits

[5] Marketplace lending (MPL) can be described as online lending intermediated by FinTech platforms that match borrowers and lenders with the use of technology. Initially developed as peer-to-peer lending involving retail investors, the model has evolved into MPL with the wholesale debt funding base now including institutional investors and banks, as well as platforms deploying their own balance sheet. See: https://doi.org/10.1787/ff11697f-en

[6] Presentation by OECD policy analyst, Ms. Iota Nassr at the APEC FinTech Workshop on Building an Enabling Fintech Environment 27-29 September, 2022.

government, and deliver emergency relief to poor and disadvantaged households.[7] MPL platforms equipped with remote onboarding processes and assisted with big data analytics or artificial intelligence to score creditworthiness of a borrower was able to provide businesses and entrepreneurs underserved by banks with timely access to credit that allowed them to maintain their operations. For example, empirical evidence of US market behaviour suggested that FinTech helped expand the overall supply of financial services during the pandemic, instead of merely redistributing it. Quality controls introduced on loans facilitated by MPL platforms helped address some of the concerns around compliance and fraudulent or suspicious transactions. In the US, mandatory loan assessments and guidelines around risk management practices helped improve compliance standards and quality assurance of loans issued out by FinTech companies as part of government-funded support lending schemes.[8]

1.3 FinTech as a Key Element to Post-Covid-19 Economic Recovery and Growth

The post-COVID economic recovery will rest on two key pillars—i) the continued growth of the digital economy, and ii) the achievement of the Sustainable Development Goals (SDGs)[9]. Both are expected to build resilience in socioeconomic systems to external risks such as trade value chain shocks, climate change, and inequality. FinTech is expected to play a major role in the development of both pillars given its essential nature in facilitating digital transactions and its power in driving finance to achieve SDG targets.

Innovations in FinTech will continue to drive and support the boom in e-commerce, a key segment of the digital economy. Globally, the e-commerce market as a share of total retail sales grew from 15% in 2019 to 22% in 2022 and is expected to be worth USD5.4 trillion by 2026.[10] Much of this growth will be driven by improvements in digital payment methods (e.g., QR-code initiated transactions, biometric authentication, etc.) and trade value chain and fulfilment capabilities that will enhance the experience and further drive lasting changes in consumer behaviour. For businesses, FinTech solutions will help identify new revenue streams based on insights gleaned from big data analytics and introduce greater efficiency and cost savings to operations.

The FinTech sector is also poised to empower workers in the gig economy,[11] a growing segment in the digital economy. Gig workers typically have unique financial, tax, and insurance requirements given their relatively unpredictable income patterns, and for these reasons are underserved by banks. By leveraging their technological edge and competitive advantage, FinTech companies can provide innovative solutions to core financial products such as savings account, budget planning tools, and flexible pay-as-

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[7] Jakarta Post (2020) Anti-Covid-19 initiatives helping Indonesia fight the outbreak, https://www.thejakartapost.com/life/2020/03/20/anti-covid-19-initiatives-helping-indonesia-fight-the-outbreak.html

[8] OECD (2022), Marketplace and FinTech lending for SMEs in the COVID-19 Crisis, https://doi.org/10.1787/ff11697f-en; Presentation by OECD economist and policy analyst, Ms. Iota Nassr, at the New Zealand APEC Workshop on Building an Enabling FinTech Environment, 27-29 September 2022.

[9] ADB (2022), Implementing a green recovery in Southeast Asia, https://www.adb.org/publications/implementing-green-recovery-southeast-asia

[10] Morgan Stanley (2022) Global E-commerce growth forecast for 2022, https://www.morganstanley.com/ideas/global-ecommerce-growth-forecast-2022

[11] The gig economy refers to the exchange of labour for money between individuals or companies via digital platforms that actively facilitate matching between providers and customers on a short-term and payment-by-task basis. See: https://www.weforum.org/agenda/2021/05/what-gig-economy-workers/

you-use insurance policies that are better suited to the needs of a gig worker.[12] This supports efforts in achieving goal number eight and ten of the SDGs on decent work and economic growth and reducing inequalities.[13]

FinTech has the ability to mobilise finance to achieve SDG targets. Development in technologies such as blockchain, big data analytics, machine learning, cloud technology, etc. can spur progress in fields such as sustainable financing where a lack of high quality, consistent, granular, and verifiable data has been a challenge to its growth and development. Innovative business models are being developed to fulfil the SDGs and direct investments towards sustainable solutions.

FinTech solutions are also integral to promoting cross-border digital trade and level the playing field on cross-border payments. For instance, blockchain has the potential to facilitate faster, cheaper, and more secured digital transactions for digital trade. Advancement on central bank digital currencies that rely on distributed ledger technology (DLT) could facilitate instant cross-border transactions, thereby making digital trade with multiple economies more secure, convenient, and straightforward. Many of such promising innovations would benefit from policy dialogues and coordination at a cross-border level given the inherently global nature of digital economies, and to prevent a situation where regulatory arbitrage or fragmentation is prevalent.[14]

[12] KPMG (2019) Insuring the Gig Economy, https://home.kpmg/xx/en/home/insights/2019/05/insuring-the-gig-economy.html
Deloitte (2020) Beyond Covid-19: New Opportunities for FinTech Companies, https://www2.deloitte.com/us/en/pages/financial-services/articles/beyond-covid-19-new-opportunities-for-fintech-companies.html
[13] United Nations Department of Economic and Social Affairs. (n/a) Sustainable Development Goals. https://sdgs.un.org/goals
[14] Presentation by OECD policy analyst, Ms. Iota Nassr at the APEC FinTech Workshop on Building an Enabling Fintech Environment 27-29 September, 2022.

2. Opportunities, Limitations, and Emerging Trends of Blockchain in Trade

Blockchain is a form of distributed ledger technology (DLT) with data encrypted and recorded across a network of computers and updated in real-time through predetermined rules. Participants in the network all have access to an identical copy of the data on the network and every change made is recorded and highly visible, thus reinforcing blockchain as a single source of truth shared across all participants.[15] Unlike traditional databases which are administered by a central entity, blockchains rely on a P2P network—such that no single party has control. Blockchain represents a novel governance tool ruled by protocols and codes rather than law and policy, and allows information and value to be secured, verified, and transacted without a central authority or intermediaries. This decentralisation and disintermediation has the potential to fundamentally transform the market and governance structures of a wide range of industries, including international trade.

The potential use cases of blockchain are vast and varied. For the purpose of this workshop, this paper will focus on blockchain in relation to trade and post-COVID-19 economy recovery. Specifically, the following three sub-sections will explore:

- Potential benefits and opportunities blockchain present in international trade and cross border payments;
- Potential limitations and implementation challenges of certain blockchain applications; and
- Overview of the emerging trends and uptake in blockchain in APEC.

2.1 Potential Benefits and Opportunities of Blockchain in Trade

Modern trade value chains are complex and fragmented. Despite efforts to streamline processes and remove non-tariff barriers, modern trade value chains still face challenges in accuracy, traceability, and transparency. Efficiency and intermediary trust remain low at different stages of the value chain with various processes still handled manually and with a multiplicity of paperwork. The time and cost to clear goods for import and export also adds a significant financial burden on trade due to layers of authorisations (licensing, inspections, certification, documentation, and verification, etc.) to ensure that the goods being imported or exported are accurately described, meet all the regulatory requirements stated, and lawfully declared. The COVID-19 pandemic further illustrated the importance of building more transparent and resilient trade value chains. The ability to deliver personal protection equipment (PPE) or vaccines in time, or to track down tainted or counterfeit products, became a matter of utmost

[15] UNCTAD (2020) Trade facilitation in developing countries: Can blockchain prompt a leap forward?
OECD (2022) Global blockchain policy forum, https://www.oecd.org/finance/oecd-blockchain-policy-forum.htm
PWC (2022) Bitcoin, cryptocurrency, blockchain…so what does it all mean? https://www.pwc.com/us/en/industries/financial-services/fintech/bitcoin-blockchain-cryptocurrency.html

importance and demonstrated further the need to address many of the challenges in our current trade value chains.[16]

To this end, applications of blockchain can help address key challenges in modern day trade in three major ways: i) blockchain can facilitate verified, more secured, and cheaper trade transactions; ii) blockchain can modernise and streamline the trade finance process; and iii) blockchain can facilitate faster and cheaper cross-border payments. Each of these applications are discussed in further detail below.

2.1.1 Facilitate verified, more secured, and cost-effective trade transactions.

Blockchain applications can replace traditional verification, transaction processes and data storage and management, therefore reducing the cost of transactions, and speeding up processes. Its functions can reduce fraud, ensure the safety and preservation of stored, verified documents, and automate payment processes. Specifically:

- **Blockchain can lead to more effective anti-fraud efforts.** Adopting blockchain technology to underpin financial processes such as payments, changes of ownership, and related documentation, can improve the efficiency of anti-fraud efforts. The nature of blockchain dictates that data and processes are decentralised, and broadly accessible to those with the necessary permissions. Unlike current labelling systems that can be manipulated, participants in the blockchain check against each other and agree upon the correct information on the ledger. As a result, it is easier to detect fraudulent tampering with processes and documents, since erroneous information will stand out and be disregarded by other participants.[17] Additionally, participants include those involved in the transaction, plus any authority with oversight that has been invited into the system.
- **Blockchain can enhance security and preservation of information.** The decentralised nature of the technology means that once data is sent to a blockchain network, it cannot be deleted or removed from the system. The digitised records of transactions, ownership and other statuses also means that such information is more likely to survive natural disasters or power outages in a single locale. In conventional payment systems, data stored in a single locale may be jeopardised by such events. Blockchain averts this possibility entirely.[18] This improved preservation of data would lead to more secure growth and greater confidence in businesses, organisations, and potentially governments' operations.
- **Smart contracts running on blockchain can speed up and lower the cost of transactions.** Smart contracts are programmes on a blockchain that run when certain conditions are met. They can automate the execution of agreements so all participants can be certain of the outcome, without the involvement of an expensive or time-consuming intermediary. For instance, a decision for

[16] Presentation by Ms. Emmanuelle Ganne, Economic Research and Statistics Division, World Trade Organisation at the APEC Workshop on Building an Enabling FinTech Environment, 27-29 September 2022.
[17] World Bank (2018) Can Blockchain Revolutionize Trade?, https://blogs.worldbank.org/trade/can-blockchain-revolutionize-trade
[18] UNCTAD (2020) Trade Facilitation in Developing Countries: Can Blockchain Prompt a Leap Forward?, https://unctad.org/system/files/official-document/presspb2020d1_en.pdf

someone to make a purchase may be triggered by its price reaching a certain level, and this could be automated on the blockchain. Blockchain also allows for the seamless storage of key documents as part of this automation process. This means that all the documents pertaining to data segregation, data standardisation, data privacy, safeguarding of proprietary (or economy-specific) business rules, and cross-border exchange of ownership of documents and payments can be safely stored. As a result, time and money can be saved.[19] Smart contracts can facilitate transactions and ensure trust, whilst safeguarding sensitive data.

Box 1: Australia-Singapore's Blockchain Trial to Reduce Transaction Costs

In August 2021, Australia Border Force (ABF), Singapore Customs, the Infocomm Media Development Authority of Singapore (IMDA), and several industry participants, concluded a trial to prove that trade documents can be issued and verified digitally across two independent systems, thereby reducing cross-border transaction costs [20].

The trial was initiated as part of the Australia-Singapore Digital Economy Agreement (SADEA) to make cross-border trade simpler between the two economies. The trial successfully tested the interoperability of two digital verification systems—ABF's Intergovernmental Ledger (IGL) and IMDA's TradeTrust reference implementation. A key success of the trial was the acceptance of verifiable digital Certificates of Origins by a regulatory authority. Industry participants for the trial included the Australian Chamber of Commerce and Industry, Australian Industry Group, ANZ Bank, DBS Bank, Standard Chartered, and Rio Tinto.[21]

2.1.2 Modernise and streamline the trade finance process

Traditional trade finance is often associated with high costs and burdensome procedures due to paper-heavy processes and the challenges of coordinating with multiple players involved in the trade transaction. Trading on open account terms using value chain finance tools can also lead to increased risks for exporters. Blockchain has the potential to address current fragmentation and information asymmetries of current trade finance processes by streamlining operations, increasing interoperability between players, and facilitating access to information for all parties involved. Specifically:

- **Blockchain allows parties involved in an accounting process to make the same information visible at the same time.** This interoperability can reduce the huge quantity of paperwork, duplication of entries, and multiple versions of 'truth', that interfere with trade financing. Each participant has end-to-end visibility of any shipment, as well as the quality, status, and movement of products, which can make value chain management and financing, cargo tracking, and customs clearance far easier. It also improves the transparency of inputs, insofar as when all members of the value chain (including suppliers, manufacturers, logistics and stockyard companies, and trade finance banks,

[19] ADB (2020) Blockchain Technology for Paperless Trade Facilitation in Maldives, https://www.adb.org/sites/default/files/publication/663131/blockchain-technology-paperless-trade-facilitation-maldives.pdf
[20] Trade document processing and administration is estimated to add 20% to the physical cost of shipping a single container. See: https://www.customs.gov.sg/news-and-media/media-releases/2021-08-18-Media-Release.pdf
[21] Singapore Customs (2021) Australia and Singapore's blockchain trial shows promising results for reducing transaction costs, https://www.customs.gov.sg/news-and-media/media-releases/2021-08-18-Media-Release.pdf

etc.) are able to input data and view any changes in real time all on the same chain. Access to such information can reduce the need for any intermediaries. For example, banks facilitating trade finance through blockchain do not require a trusted intermediary to assume risk as they have direct access to verified information, thus eliminating the need for correspondent banks.

- **Blockchain can ease cash flow and reduce payment delays.** Blockchain allows for immediate compensation of transactions without the need for complex manual approvals which can reduce payment delays. This in turn can ease cash flow for importers, exporters, and speed up fulfilment commitments in a transaction. For example, contract terms executed via smart contracts can automate the settlement process, removing the need for correspondent banks, thereby reducing the presence of additional transaction fees, and lowering overall costs.

Box 2: Hong Kong, China's Blockchain-Based Trade Finance Platform

In 2018, the Hong Kong Monetary Authority (HKMA) launched eTradeConnect, a blockchain-based trade finance platform fully funded by a consortium of seven major banks in Hong Kong, China. The platform was launched with a view to digitalise paper-based documents and automate the trade financing process to reduce errors and risks of fraud. Specifically, eTradeConnect allows users to reduce the costs and dispense of inefficient paper-based processes, speed up the process of obtaining working capital from banks, and facilitate applications of trade financing to banks for open account trades.

Since it launched, HKMA has signed memorandums of understanding (MoUs) with other economies to connect their respective blockchain-based trade finance platforms. For example, in 2018, an MoU was signed to connect eTradeConnect with we.trade, a European blockchain-based trade finance platforms. In 2019, a similar MoU was signed to link up eTradeConnect with the People's Bank of China (PBOC)'s Trade Finance Platform. Additionally, HJMA is also working with the Monetary Authority of Singapore (MAS) to develop the Global Trade Connectivity Network (GTCN), a DLT-based cross-border trade finance network built on an open architecture such that other economies may easily join.[22]

2.1.3 Facilitate development of faster and cheaper cross-border payments

Cross-border payments have traditionally relied on a mutually trusted central entity (or entities) to facilitate the transfer and settlement of payments. Developments in blockchains, smart contracts, and distributed ledgers could provide alternative channels that bypass the need for a central entity and connect directly between the sending and receiving parties. This development could potentially reduce cross-border transaction costs by one-third,[23] while ensuring transactions are equally if not more secured and processed on a near real-time basis. Cross-border payments made on blockchain/ DLT can

[22] HKMA (n/a) Distributed ledger technology, https://www.hkma.gov.hk/eng/key-functions/international-financial-centre/fintech/research-and-applications/distributed-ledger-technology-dlt/
eTradeConnect, https://www.etradeconnect.net/Portal
[23] IADB (2022) Blockchain and international trade, https://publications.iadb.org/publications/english/document/Integration--Trade-Journal-Volume-24-No.-46-December-2020-Blockchain-an-International-Trade-New-Technologies-for-a-Bigger-and-Better-Latin-American-International-Insertion.pdf

also be more transparent as it shares information with all nodes storing the data in real time, which could improve the efficiency and quality of supervision. At the same time, advanced data partition concepts[24] where only a portion of the data is accessible to all parties could reduce data protection and privacy concerns. [25]

There are three major applications of blockchain that could facilitate greater cross-border payments:

- **Blockchain for the development of Central Bank Digital Currencies (CBDCs):** CBDCs are digital assets that are managed on a digital ledger (which can be a blockchain or otherwise) that acts as a single source of truth. Interest in CBDCs have grown in recent years, with various APEC economies actively exploring its use in retail payments or wholesale payments.[26]
- **Blockchain as a base for payment processing services:** Blockchain based payment processing services for digital payments already exist. Some of these run-on popular cryptocurrencies such as BitCoin and Ethereum, while others address a much larger audience by using the blockchains developed by the latter to transfer payments in conventional currencies. For example, the provider will convert the payer's local currency into a cryptocurrency, then convert the cryptocurrency into the receiver's local currency. This allows the processing provider to bypass existing banking infrastructure with the goal of accelerating payments and reducing cost.[27]
- **Blockchain for Know Your Customer (KYC) [28] utilities:** KYC processes in the context of cross-border payments remain a challenge for financial institutions as information can be stored in various institutions' databases. With blockchain, all background information and identification could be stored on one network for institutions to tap into during the customer due diligence process, thus making KYC faster and more secured against instances of human error or internal fraud. Additionally, the application of digital identities that run on blockchain could further ease the customer due diligence/KYC process.[29]

Box 3: Multi-CBDC Platform for Faster, Cheaper Cross-Border Payments

mBridge, is an ongoing multi-CBDC project undertaken by the BIS Innovation Hub Hong Kong Centre, HKMA, the Bank of Thailand, the Digital Currency Institute of the People's Bank of China, and the

[24] Data partitioning is a technique of distributing data across multiple tables, disks, or sites in order to improve query processing performance or increase database manageability. In this instance, advance concepts of data partitioning can be used to design intrusion detection systems that could be used to protect data privacy on a distributed ledger. See: https://docs.microsoft.com/en-us/azure/architecture/best-practices/data-partitioning; https://www.bis.org/publ/work1015.pdf;

[25] BIS Working Papers (2022) DLT-Based Enhancement of Cross-Border Payment Efficiency-a Legal and Regulatory Perspective, https://www.bis.org/publ/work1015.pdf

[26] Wholesale payments are between financial institutions – for example, payments to settle securities and foreign exchange trades, payments to and from central counterparties, and other interbank funding transactions. Such payments that are typically of a large value that need to be settled on a particular day or time. Given their systemic importance to the financial sector, wholesale payment systems are generally owned and operated by central banks. See: https://www.bis.org/publ/qtrpdf/r_qt2003f.htm

[27] American Express (2017) Blockchain to accelerate payment processing services, https://www.americanexpress.com/us/foreign-exchange/articles/blockchain-to-accelerate-payment-processing-services/#:~:text=Blockchain%20technology%20promises%20to%20facilitate,as%20correspondent%20banks%20and%20clearing

[28] Know Your Client (KYC) are standards used in the investment and financial services industry to verify customers and know their risk and financial profiles.

[29] Deloitte (n/a) Can blockchain turn the tide on financial crime compliance?, https://www2.deloitte.com/mt/en/pages/financial-services/articles/mt-risk-article-can-blockchain-turn-the-tide-on-financial-crime-compliance.html

Central Bank of the United Arab Emirates. The project explores the potential of a multiple CBDC platform that joins up digital currencies in a common interoperable platform with the purpose of improving the various limitation of payment systems today. To date, the common prototype platform for mCBDC settlements has been able to complete international transfers and foreign exchange operations in seconds, as opposed to the several days normally required for such transactions. The cost of such operations was also reduced by up to half. [30]

Going forward, mBridge will continue to explore the limitations of the prototype platform, including issues related to privacy controls, liquidity management, and scalability and performance of DLT in handling large transaction volumes. [31]

2.2 Potential Limitations of Blockchain

While blockchain has the potential to transform various aspects of modern-day trade value chain management, it is important to understand that much of its real-life applications are still relatively young and its technology is still developing. This subsection briefly explores the potential limitations and implementation challenges of certain blockchain applications.

2.2.1 Blockchain can serve as a single point of truth only if the solution is adopted by majority of stakeholders.

Blockchain has the potential to provide better and more accurate solutions in traceability or the origin of a material or asset, which can help organisations better analyse the risk of pre-financing or investing in the asset. However, its ability to serve as a single point of truth can only be realised if a majority of stakeholders involved adopt it as the solution.

For instance, in a scenario where a permissionless blockchain[32] is used to facilitate trade (i.e. where the blockchain is public and the identity of participants are not known) participants along the various stages of the value chain will have to be willing to unveil certain proprietary details (e.g. demand, quantity, client information, etc.). If the majority or participants are unwilling to do so, benefits arising from the use of this blockchain may be limited. Alternatively, if access to the blockchain is restricted and the number of trusted parties is small, then the need to independently validate consensus protocols used in the public domain may be limited. [33]

[30] BIS (2021) Multi-CBDC prototype shows potential for reducing costs and speeding up cross-border payments, https://www.bis.org/press/p210928.htm

[31] ibid

[32] Blockchains are commonly classified as public (no specific entity manages the platform), private (the platform is controlled by a single entity), or managed by a consortium of companies. Blockchains can also be classified as permissioned, whereby restrictions are imposed on who can read or write on the blockchain, or permissionless, whereby the blockchain is open to everyone, resides in the public domain, and trust is established through a consensus verification protocol. See: WTO (2018) Can blockchain revolutionize international trade?, https://www.wto.org/english/res_e/booksp_e/blockchainrev18_e.pdf

[33] IFC (n/a) Blockchain: the potential and pitfalls, https://www.ifc.org/wps/wcm/connect/news_ext_content/ifc_external_corporate_site/news+and+events/news/insights/perspectives-i2c5 Mckinsey (2017) Blockchain technology for supply chains – a must or a maybe? https://www.mckinsey.com/business-functions/operations/our-insights/blockchain-technology-for-supply-chainsa-must-or-a-maybe

The use of different trade platforms based on different blockchain design[34] (i.e. consensus mechanism, smart contracts, authentication/authorisation, etc) may also limit the blockchain-based trade platform from its potential of enhancing cross-border trade. To this end, leveraging existing global standards in terms of data, modals, semantics, and legal and regulatory framework on related areas such as e-signatures and e-documents, could support interoperability between the different platforms and help overcome some of the limitations discussed.

Box 4: Interoperable Digitalisation Frameworks for Blockchain

The World Trade Organisation (WTO) and the International Chamber of Commerce (ICC) has published a Standards Toolkit for cross-border paperless trade to provide an overview of existing digital standards that could help drive adoption, identify potential gaps, and promote interoperability. Among other issues, the toolkit highlights existing digitalisation frameworks that can support the exchange and interoperability of electronic trade documents. This includes the Digital Negotiable Instrument (DNI) Initiative, a technological framework to leverage blockchain/ DLT in a manner that remains predominantly interoperable with existing practices, systems, and channels; the Distributed Ledger Payment Commitment (DLPC), which is a digital asset and global standard for a payment commitment that can be used on any blockchain network and operate across different networks; and TradeTrust, a set of globally accepted standards and framework to support trusted interoperability of electronic trade documents in terms of authenticity, provenance, and legally valid title transfer, among other frameworks. [35]

2.2.2 Blockchain can dispense of intermediaries insofar as the asset involved already exists within the system

While blockchain can eliminate the need for intermediaries, this is only the case once the asset involved exists within a system, with the verification of the asset still having to come from a trusted party. For example, in some cases, the tokenisation of a real-world asset still requires an intermediary to create the link between the token and the real asset.[36] This intermediary would need to verify that the real-world asset exists and is in the condition it is intended as, which would also mean that the intermediary would have to be a trusted party. For cases where the asset exists entirely within the digital realm such as cryptocurrencies, interactions with real-world supply and demand can lead to extreme volatility with no governing or central authority to smooth the effects.

2.2.3 Implementation of blockchain can be resource intensive

The implementation costs of blockchain solutions can be challenging for businesses and even for some developing economies. Even after deciding on what type of blockchain to adopt, the implementation

[34] In theory, there can be many variants of blockchain depending on its access, design, and application of the solution sought.
[35] WTO-ICC (2022) Standards Toolkit for Cross-Border Paperless Trade, https://www.wto.org/english/res_e/booksp_e/standtoolkit22_e.pdf
[36] IFC (n/a) Blockchain: the potential and pitfalls, https://www.ifc.org/wps/wcm/connect/news_ext_content/ifc_external_corporate_site/news+and+events/news/insights/perspectives-i2c5

stage of this decision may prove to be the biggest challenge in uptake, with one survey finding that for firms that do eventually deploy blockchain as part of their operations, they end up throwing out many of the features that make blockchain unique.[37] To date, companies that have incorporated blockchain into their operations tend to be large multinationals, or entities with access to sufficient capital or a mandate to develop such capabilities, such as central banks.

Other requirements for blockchain to operate at a beneficial scale can also require significant resource investment. For example, economies with low digital literacy rates and limited Internet penetration will need to build up those capabilities before it can properly adopt blockchain solutions. Economies will also need to build up their digital talent pool to address current shortages supply, and invest in low cost, renewable energy developments to account for the high energy consumption of DLTs.[38]

Given this, it may be worthwhile for an organisation to conduct a feasibility study prior to embarking on the process of implementing blockchain as a solution to a problem statement. The feasibility study would help identify the use case or develop the rationale for implementing blockchain as the most appropriate tool to address the issue compared to other possible initiatives and help to identify the necessary resources and capabilities required for the process. These feasibility studies or test trials may reveal that the adoption of blockchain provides limited advantage over the existing solution, in which case its implementation may not be the best path froward in addressing the problem statement.

Box 5: Learnings from Project Jasper

The Bank of Canada, in partnership with Payments Canada, R3 and Canadian commercial banks partnered to create Project Jasper, to explore a digital ledger technology (DLT) wholesale payment system. The goal of Project Jasper was to build a proof-of-concept system that leveraged a settlement asset issued and controlled by a central bank.

The Bank of Canada, Bank of England and the Monetary Authority of Singapore partnered to explore alternative models for cross border payments and settlements with a focus on improving speed, cost and transparency for users. This recent collaboration was highlighted as a step forward in international cooperation and an improved understanding of possible benefits.

While Project Jasper has shown success, there have been some key learnings in that the current payment mechanisms are highly efficient, but cost savings could occur with a focus on reducing bank reconciliation efforts. There is also potential for more savings if other applications are added such as trade finance. The real benefit of DLT is in transitioning movement onto a single system where previously multiple systems were required to ensure operability and ease of access to data. The technology of DLT and blockchain is still in its infancy and will likely undergo several transformations before being scaled up and comprehensively integrated.

[37] Economies. (2018) Bitcoin and other cryptocurrencies are useless. https://www.economist.com/leaders/2018/08/30/bitcoin-and-other-cryptocurrencies-are-useless

[38] We note there has been some developments to promote lower-energy consumption, such as Ethereum's Proof-of-Stake system which consumes approximately 99.95% less energy than the standard proof-of-work required by cryptocurrencies. There is also a growing number of carbon negative or sustainable blockchains, with unique proof-of-stake systems that promises to be energy efficient, such as Tezos and Algorand.

2.3 Other Emerging Trends in Blockchain

Research and development (R&D) in blockchain have so far been focused on its use to make transactions faster, cheaper, more transparent and secured; as a tamper-proof, immutable storage mechanism for data. Additional focus has been on its use as a platform to encourage interoperability and communication between various parties that can dispense of certain existing intermediations.

Within the financial sector, a prominent application of blockchain has been the development of cryptocurrencies and other digital assets, such as non-fungible tokens (NFTs), and stablecoins (cryptocurrencies with values pegged to a fiat currency). These applications of blockchain are being closely monitored by governments and monetary authorities around the world. In particular, the fluctuations of cryptocurrency and ensuing economic instability have prompted central banks and regulators to reconsider the role of cryptocurrency in the financial system.[39] Across APEC, economies such as Australia, Japan, Singapore, and the US, have introduced regulations on the use of cryptocurrency and digital assets with the intention of boosting financial stability and consumer protection. For example, Japan passed a bill in June 2022 to regulate stablecoins with the aim of curbing financial system risks arising from stablecoins and to strengthen user protection. There are also an increasing number of economies that have instituted reforms to tax crypto assets and holdings. Canada, for example, treats crypto assets as a financial transaction applicable to capital gains tax, while New Zealand treats crypto assets as a form of property.

Beyond international trade and the financial sector, the unique features of blockchain also make it a valuable application to other aspects of the economy and society, including healthcare and pharmaceuticals, media and entertainment, real estate, automotive, insurance, government and public finance management, oil and gas, manufacturing, travel and transportation, and telecommunications.[40] Nevertheless, the ability to realise the potential of blockchain at a relevant scale may ultimately depend on factors such as access to affordable Internet, sufficient digital capital and talent, use of sustainable or low energy-based blockchains, and the maturity of markets and regulations.

Box 6: Blockchain in Media and Entertainment

The music business still operates primarily on legacy systems and business models when songs were distributed and released in hard-copy format. Digital piracy, fraudulent copies, infringed studio intellectual property and duplication of digital items cost the film and TV industry billions of dollars annually.

Blockchain solutions can help address many of the existing pain points within the media and entertainment industry. For example, blockchain can help decrease IP infringement in media and entertainment due to its time-stamped, immutable ledger nature. Blockchain can help bring disintermediation to the industry, in turn increasing the take home for artists. Blockchain can also

[39] Nasdaq (2022) Cryptocurrency Regulation in 2022: A Year for Change, https://www.nasdaq.com/articles/cryptocurrency-regulation-in-2022%3A-a-year-for-change

[40] IBM (n/a) Blockchain Industries, https://www.ibm.com/blockchain/industries

help empower content creators by streamlining royalty payments and enabling usage-based billing models. A smart contract can be utilised to execute automatic micropayments between the consumer and creator every time a work is used or referenced.[41]

[41] Consensys (n/a) Blockchain in media and entertainment, https://consensys.net/blockchain-use-cases/media-and-entertainment/

3. ESG Standards and FinTech

The first part of this section explores how FinTech can be a critical enabler for sustainable financing with the use of technologies that can enhance the quality and richness of ESG standards, improve investor decision making, and broaden the investor base for sustainable solutions, that will further drive finance towards achieving international commitments such as the SDGs and the Paris Agreement targets.

The second part of this section delves deeper into ESG standards and identifies initiatives that can help encourage its use on a wider scale at a domestic level, as well as initiatives that seek to harmonise ESG standards on a regional and global level.

3.1 FinTech as a critical enabler of Sustainable Finance

Sustainable finance is the practice of integrating ESG criteria in an investment decision on a company or economic activity. Over the past two years, sustainable financing or ESG investing has seen a sharp rise due to the effects of the COVID-19 pandemic and green recovery efforts.[42] Notably, in 2021, global ESG assets under management (AUM) peaked at USD41 trillion, with growth expected to continue and reach USD53 trillion by 2025, accounting for one-third of the projected global AUM.[43]

FinTech can be a critical enabler of sustainable financing in three major ways:

- Technologies used in FinTech can provide richer, more accurate data, and can account for wider scope of indicators and criteria when developing new financial models to assess.
- This richer, and wider pool of data can help reorient and scale capital towards sustainable investments and close the SDG financing gap.
- Fintech services like crowdfunding and P2P platforms have made it easier to raise funds for sustainable solutions and technologies used in FinTech can incentivise more sustainable consumer choices.

Each of these factors are discussed in further detail below.

3.1.1 Better ESG data for better accounting of SDG-related Risks and Impacts

A key challenge to sustainable financing is the lack of high quality, granular, reliable, and investor-relevant data. These data gaps can lead to investor uncertainty and make it difficult for investors to accurately assess the ESG impact of their investments. These data gaps can also mean that companies are not pricing their products and services at points that best reflect their impact on the environment or society.

[42] For many economies, the COVID-19 pandemic offered an opportunity to rethink traditional business practices and financial models that were unsustainable, and to rebuild with sustainability as a key focus.
[43] Bloomberg (2021) ESG assets may hit $53 trillion by 2025, a third of global AUM, https://www.bloomberg.com/professional/blog/esg-assets-may-hit-53-trillion-by-2025-a-third-of-global-aum/

Emerging technologies in FinTech like blockchain, big data analytics, artificial intelligence (AI)/ machine learning (AI/ML), etc. can bridge these information gaps and provide richer, more accurate and trustworthy data. For instance, another application of blockchain as a tamper-proof method to store data is the verification of a material or consumer goods' origin, from source to end-use, and to grant validity on the sources of information stored. Armed with this data, credit rating and auditing agencies can integrate more reliable sustainability metrics into their assessments and develop more accurate reports for investors.

Developments in other technologies used in FinTech, such as big data analytics, that are used in tangent with new technologies such as satellite imagery, drones, IoT, etc. can also assist in tracking company activities beyond those covered in standardised ESG reports. This is done, in particular, by obtaining disaggregated data on the performance of a company's physical assets and their impact on the environment. This robust asset-level data can form the basis of more accurate analysis on an asset's impact to the climate, by factoring in risks associated with climate change such as extreme weather conditions, carbon emissions and deforestation exposure, into calculations and scenarios that can influence financing decisions. For example, the climate fintech company, Carbon Delta,[44] uses satellite imagery to develop three-dimensional understanding of activities happening at facilities. This asset-level data forms the basis of their Climate Value-at-Risk model which identifies how much a company's value is potentially affected by climate change, enabling investors to get up-to-date alerts about the climate risk profile of a company.[45]

The availability of cheaper, more accurate big data and the ability to analyse them can also be used to build new financial models that consider the impact of climate change. For example, companies like Four Twenty Seven[46] are developing comprehensive technology platforms that provide quantitative and forward-looking climate risk assessments for an area's exposure to six different climate change hazards: floods and extreme rainfall, heat stress, hurricanes and typhoons, sea level rise, water stress, and wildfires. These platforms estimate hazard risk on a gross basis, before considering mitigants such as insurance, and measures taken by government authorities to reduce or address potential risks or pool diversification.[47]

These solutions not only help to reorient capital towards sustainable solutions, but also encourages the mainstreaming of sustainability into risk management. They allow investors to better adapt and diversify their portfolios in anticipation of the impact of climate change and transition towards more sustainable solutions.

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[44] Carbon Delta was acquired in 2019 by MSCI, an American financial company. https://ir.msci.com/news-releases/news-release-details/msci-strengthen-climate-risk-capability-acquisition-carbon-delta

[45] BNP Paribas (2019) FinTech and the ESG Data Challenge, https://securities.cib.bnpparibas/app/uploads/sites/3/2019/11/art-fintechs-esg-2019-09-09.pdf
Accounting for Sustainability (2019) Carbon Delta AG: Modelling the impact of climate change on the financial risks of investments, https://www.accountingforsustainability.org/en/knowledge-hub/case-studies/carbon-delta-climate-change-financial-risk-modelling.html

[46] LinkedIn (n/a) Four Twenty Seven, https://www.linkedin.com/company/four-twenty-seven-llc

[47] Moody's Investors Service (2021) Moody's Investors Service adds Four Twenty Seven climate score data to RMBS presale reports, https://www.moodys.com/research/Moodys-Investors-Service-adds-Four-Twenty-Seven-climate-score-data--PBS_1280638

3.1.2 Scale capital in sustainable solutions and investments

FinTech can help reorient capital flows towards more sustainable investments at scale. Innovative FinTech solutions that transmit material and robust ESG data can facilitate the creation of cheaper more trustworthy sustainable investment instruments such as carbon credits, green and social impact bonds, blended finance initiatives[48] etc., which in turn can lead to further investor interests and trust. For example, the use of smart contracts enabled by blockchain can help track the completion of tasks in green bond projects and allow for the timely distribution of payments without complex manual approval processes. The digitalisation of the process improves traceability of project outcomes, lowers issuance costs, eases cash flow for project developers, and improves the overall credibility of the green bond.

Developments in blockchain technology can also lend to the creation of standardised smart contracts that would make sustainable financing instruments more uniform and allow them to be traded at scale. This can promote liquidity on carbon exchanges and generate trade volumes that are robust enough to produce reliable daily price signals. On the payments side, development of stablecoins or CBDCs could be used as an appropriate form to further optimise operational efficiency on carbon exchanges.[49]

There is also the possibility of using decentralised autonomous organisations (DAOs)[50] to decentralise the verification of environmental data. For example, the company dClimate is helping to quantify and verify carbon data through a decentralised climate information ecosystem that enables independent climate data producers to publish climate data, events and forecasts, via a DAO network. dClimate's ecosystem encourages external data providers to upload information, where it is then scored for reliability, to help consumers find verifiable data. A key goal for dClimate's data has been for parametric insurance, which are insurance policies that allow environmental data, such as floods or droughts, to automatically trigger insurance pay-outs without lengthy and complicated process of manually submitting a claim.[51]

3.1.3 Incentivise sustainable retail investments and consumer choices

The rise of FinTech services like robo-advising, MPL and crowdfunding platforms have made it easier to raise funds for green, socially responsible, or sustainability-themed projects. Advancements in technologies like AI/ML, big data analytics, and cloud computing allow companies to develop

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[48] Blended finance refers to the strategic use of development finance to mobilise additional finance towards sustainable solutions. The instrument allows governments and development finance donors to transition from being a direct financier of a solution to a mobiliser of future funding, by taking on the initial risk and demonstrating project viability that attract further investments. See: https://www.oecd.org/development/financing-sustainable-development/blended-finance-principles/#:~:text=Blended%20finance%20is%20the%20strategic,providing%20financial%20returns%20to%20investors.

[49] Hong Kong Monetary Authority (2022) Carbon Market Opportunities for Hong Kong, https://www.hkma.gov.hk/media/eng/doc/key-information/press-release/2022/20220330e3a1.pdf
McKinsey (2021) A blueprint for scaling voluntary carbon markets to meet the climate challenge, https://www.mckinsey.com/business-functions/sustainability/our-insights/a-blueprint-for-scaling-voluntary-carbon-markets-to-meet-the-climate-challenge

[50] DAO refers to an entity structure in which token holders participate in the management and decision making of an entity. Thus, power is distributed across token holders who collectively cast votes. All votes and activities through the DAO are then posted on a blockchain, making all actions of users publicly viewable. The promise of DAO investments is the democratisation of the decision making process to make investments more inclusive.

[51] Ledger Insights (2022) Mark Cuban-backed blockchain DAO partners with Namibia for sustainability initiative. https://www.ledgerinsights.com/mark-cuban-backed-blockchain-startup-namibia-for-sustainability-dclimate-green-hydrogen/

increasingly personalised investment solutions. This combined with the rise of a new socially- or environmentally- engaged investor class has encouraged the growth of socially responsible/ESG-focused investment portfolios or crowdfunding platforms. For example, WealthFront is a US-based robo-advisor that recently launched a socially responsible portfolio designed around projects that focused on sustainability, diversity, and social equity. CoPower is a sustainable investment crowdfunding platform based in Canada that allows users to invest directly in energy efficiency and renewable energy projects. Crowde, a P2P lending company based in Indonesia has designed a platform that connects farmers with retail investors to help the former obtain capital for farming operations and give the latter alternative investment options. [52]

Some organisations are also beginning to explore the potential of using smart contract based DAOs to raise capital and make investment decisions on behalf of a community, with the aim of truly decentralising the investment and decision-making process on how raised funds are used. For example, organisations like the Big Green DAO, a food and nutrition focused non-profit, is decentralising how donations are spent.[53] A DAO-based crowdsourcing platforms for green or sustainable investment opportunities could address issues of traditional crowdsourcing systems that are centralised, and vulnerable to data loss or false reporting on green or sustainable assets.[54]

Additionally, technologies in FinTech can improve consumers' ability to track the environmental or social impact of their purchases and incentivise more sustainable consumption decisions. Big data analytics, and Application Programming Interfaces (APIs) can be used to translate financial transaction data into individual carbon footprints, making it possible to highlight the environmental and social impact of a purchase in real-time. Customer-facing apps that leverage blockchain solutions to track the value chain provenance of food, clothing, and other consumer goods can also empower individuals and companies to make more sustainable sourcing decisions. To this end, FinTech companies or start-ups may be best positioned to help mainstream the use of ESG data through reporting innovation given their ability to move quickly and innovate faster than most traditional players. For instance, a FinTech company could offer as part of its services to help companies with the financial disclosure, the ability to also incorporate non-financial information such as ESG data, within the report. The company could further offer services that would help its client measure, monitor, and set their own emissions, and even measure the latter's return-on-investment (ROI) on projects and initiatives taken to reduce their impact.

Box 7: Mainstreaming Sustainability with Blockchain

EverLedger is a United Kingdom based company that used a variety of technologies, including blockchain and Internet-of-Things (IoT)[55] to offer consumers, businesses, and governments, value

[52] Wealthfront (n/a) socially responsible investing, https://www.wealthfront.com/socially-responsible-investing
Copower, https://copower.me/
Crowde, Platform P2P Lending untuk Permodolan Petani, https://crowde.co/
[53] Pymnts (2022) From movies to fast food, DAOS are bringing decentralisation to investing, https://www.pymnts.com/blockchain/2022/from-movies-to-fast-food-daos-are-bringing-decentralisation-to-investing/
[54] MedForest (2022) From patient investments to DAO crowdsourcing for afforestation, reforestation, and plantations. https://medforest.net/2022/03/20/from-patient-investments-to-dao-crowdsourcing-for-afforestation-reforestation-and-plantation/
[55] Internet-of-Things describes a network of physical objects or "things" that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. IoT can apply to a range of things, from

chain transparency, object traceability, trustworthiness of claims, and relevant digital identities. The company's digital transparency solutions can be applied in various industries, including art, diamonds and gemstones, critical mineral, fashion, and luxury goods, among others.

In 2021, the company was awarded an AUD 3 million (USD 2.08 million) project from the Australian government to create a digital certification for critical minerals throughout the value chain, from extraction to processing to export to global markets. The pilot project aims to help companies in the sector adhere to compliance regulations and increase the demand for Australian minerals in global markets, while also simplifying the process and lowering costs. [56]

3.2 Establishing ESG Standards

Over the past decade, there has been significant movement in the creation and usage of ESG standards and reporting frameworks. This has primarily been driven by investor interest as well as increasing compliance requirements from regulators on companies, in particular large, publicly listed entities.

Box 8: ESG Standards

ESG standards refer to a set of criteria that can be used to measure a company's environmental and social impact, and internal governance behaviour. ESG standards can be useful tools to help organisations measure, understand, and communicate their exposure to ESG risks and opportunities, promote transparency with stakeholders, and enable better informed strategy and decision making.

Commonly used global standards include those set by the Global Reporting Initiative (GRI), the Sustainability Accounting Standards Board (SASB), the Financial Stability Board's Task Force on Climate-Related Financial Disclosures (TCFD), the ISO/TC 322 on sustainable finance,[57] while platforms for disclosure of sustainability targets such as the Science-Based Targets network (SBTn) have also become popular reference points for investors, businesses, and governments.

However, the expansion of ESG standards and reporting frameworks have been fragmented, with a lack of harmonisation that increases the cost of compliance for businesses and reduces comparability between companies for investors. For instance, it is estimated that there are over 600 ESG reporting provisions globally.[58] This is a result of the complexity of measuring ESG impacts through a single methodology. The lack of harmonised standards (a regulatory barrier) creates further gaps in sustainable investing despite the presence of capital and can lead to lags in sustainability reporting

ordinary household objects to sophisticated industrial and manufacturing tools. See: https://www.oracle.com/sg/internet-of-things/what-is-iot/

[56] Everledger, https://everledger.io/

[57] Global Reporting Initiative, https://www.globalreporting.org/
SASB.org, https://www.sasb.org/
FSB-TCDF.org, https://www.fsb-tcfd.org/
ISO/TC 322 Sustaianble Finance. https://www.iso.org/committee/7203746.html
Science-Based Targets Network, https://sciencebasedtargetsnetwork.org/

[58] EY (2021) The Future of Sustainability Reporting Standards, https://assets.ey.com/content/dam/ey-sites/ey-com/en_gl/topics/sustainability/ey-the-future-of-sustainability-reporting-standards-june-2021.pdf

uptake. For instance, there are large variations across APEC economies in terms of company disclosure rates across environmental and social practices, ranging from 31 percent disclosure in Japan to just three percent in Indonesia.[59] Alignment of domestic regulation with international frameworks such as the TCFD will be important to ensure that the scope, governance, and assessment of climate disclosures are in line with international best practices and standards.

The following sub-sections explore initiatives that have been undertaken by regulatory authorities and government bodies to address some of the issues above at the domestic and regional level. It also provides a brief overview of the International Sustainability Standards Board (ISSB) that was formed in November 2021 at the COP26 summit[60] and responsible for developing a global baseline for high-quality sustainability reporting.

3.2.1 Common reporting standards at a domestic level

Mandatory climate-related disclosures for certain companies and sectors are becoming popular tools in some economies to facilitate more efficient allocation of capital in SDG goals and meet net zero targets under the Paris Agreement. For example, in October 2021, New Zealand passed a law that made climate-related disclosures mandatory for publicly listed companies above a certain size, insurers, banks, non-bank deposit takers, and investment managers.[61] In doing so, the government of New Zealand ensured that climate-related information reported by the aforementioned organisations followed standards issued by the External Reporting Board that were based on the TCFD framework recommendations. The new disclosure regime will be implemented in phases with the financial regulator, the Financial Markets Authority, responsible for independent monitoring, reporting, and enforcing the regime.[62] Refer to Box 9 for further details.

Box 9: New Zealand's Mandatory Climate-Related Disclosure

The External Reporting Board (XRB) develops and issues reporting standards on accounting, audit and assurance, and climate, for entities across the private, public, and not-for profit sectors. In October 2021, the Financial Sector (Climate-related Disclosures and Other Matters) Amendment Act was passed. As a result, the XRB now has a mandate to issue climate standards as part of a climate-related disclosures framework, and non-binding guidance on non-financial reporting.

The purpose of the Aotearoa New Zealand Climate Standards is to provide a consistent framework for entities to consider the climate-related risks and climate-related opportunities that climate change presents for their activities over the short, medium and long term. The regime covers large, listed entities and debt issuers with a market capitalisation of NZ$60m or greater and large financial organisations (including banks issuers and investment scheme managers) with total assets worth

[59] The Conference Board (2019) Sustainability Reporting Across Asia: Trends and Challenges, https://conference-board.org/blog/sustainability/Asia-Sustainability-Reporting-Trends
[60] COP26 refers to the 2021 United Nations Climate Change Conference which was held at the SEC centre in Glasgow, Scotland.
[61] Reuters (2021) New Zealand passes climate change disclosure laws for financial firms in world first, https://www.reuters.com/business/sustainable-business/new-zealand-passes-climate-change-disclosure-laws-financial-firms-world-first-2021-10-21/
[62] MBIE (n/a) Mandatory climate-related disclosures, https://www.mbie.govt.nz/business-and-employment/business/regulating-entities/mandatory-climate-related-disclosures/

NZ$1b or more. The aim is to support the allocation of capital towards activities that are consistent with a transition to a low-emissions, climate-resilient future. The three standards comprising Aotearoa New Zealand Climate Standards have been written in a principles-based manner, focusing more on high-level areas for disclosure, rather than being overly prescriptive. This is intended to allow sufficient flexibility for reporting entities to provide information that is of most use for their investors' decision making. For example, the standards allow for flexibility in the metrics used, providing they meet the principles and general requirements for disclosure. This framework is set to be in place by January 2023.

Another example of a domestic initiative to standardise ESG data is the development of a common ESG disclosure portal by MAS in Singapore. The ESG disclosure portal will provide a common platform to ease sustainability reporting and enhance access to ESG data for companies and investors. Reporting companies can upload corporate-level sustainability data onto the portal based on a list of 27 core ESG metrics that are mapped against relevant disclosure frameworks, including TCFD recommendations. With a structured set of ESG data, companies will be able to generate their sustainability report and streamline the current practice of responding to multiple questionnaires and ESG data intermediaries. Smaller companies that make disclosures on the portal may also enhance their visibility to investors and improve access to capital. Widespread use of the portal will promote data consistency and clarity in disclosures and enable comparability of ESG data.[63] The portal is one of four digital platforms under Project Greenprint, which is detailed further in Box 8.

Box 10: Project Greenprint[64]

Project Greenprint is a collection of initiatives that aims to harness technology and data to enable a more transparent, trusted, and efficient ESG ecosystem to enable green and sustainable finance. The project is spearheaded by MAS and currently consists of four digital platforms, all at varying stages of development. The four digital platforms are:

- **ESG Disclosure Portal:** the portal aims to provide a common platform that will ease sustainability reporting and enhance access to ESG data for companies. Reporting companies can upload corporate-level sustainability data onto the portal based on a list of 27 core ESG metrics and mapped against relevant disclosure frameworks, including TCFD recommendations. With a structured set of ESG data, issuers will be able to generate their sustainability report and streamline the current practice of responding to multiple questionnaires and ESG data intermediaries. Widespread use of the portal will promote data consistency and clarity in disclosures, thereby enabling comparability of data.[65] The portal is currently opened to companies listed on the Singapore Exchange (SGX) with plans to extend the platform to non-SGX listed companies in the longer term.

[63] MAS (n/a) Green FinTech, https://www.mas.gov.sg/development/fintech/Green-FinTech
[64] MAS (n/a) Green FinTech, https://www.mas.gov.sg/development/fintech/Green-FinTech
[65] SGX (2021) Starting with a common set of core ESG metrics, https://api2.sgx.com/sites/default/files/2021-12/Response%20Paper%20on%20Starting%20with%20a%20Common%20Set%20of%20Core%20ESG%20Metrics.pdf

- **ESG Registry**: the registry aims to support sustainable finance by improving data quality and serving as a single source of ESG verified data and certifications. The blockchain-powered data platform will aggregate, record, and maintain tamper-proof ESG certifications and verified data for various sectors, providing financial institutions, companies, and regulatory authorities a single access point to the data. Use of the registry will enable better tracking and analysis of a company's sustainability commitments, alleviate greenwashing risks, and improve management of ESG financial products.[66]
- **Data Orchestrato**r: an aggregator platform that amass sustainability data from multiple data sources, including the ESG Disclosure Portal, utilities provider, major ESG data providers, and other open, ground-up data sources. The platform will enable new data insights to be generated through analytics to better support sustainable investment and financing decisions.
- **Greenprint Marketplace:** an open marketplace that will provide a curated list of solution providers, seekers, and investors to facilitate discovery, acceleration of partnerships, and channelling of investments towards green and sustainable solutions.

3.2.2 Sustainability strategy at a regional level

Sustainable development strategies at a regional level, whether through a multilateral organisation or through a political or economic unions are rare. Nevertheless, regional-level sustainability strategies can be useful tools to provide a concrete and actionable framework that will have members implement and develop solutions towards achieving the SDGs or Paris Agreement Targets. For example, the European Union (EU) Action Plan on Sustainable Finance (the "Action Plan") is a regional level sustainability strategy that essentially sets out a comprehensive and implementable plan to further connect finance with sustainability within the capital market union.

The Action Plan was adopted in March 2018 and includes ten key actions. Notably, a key action of the strategy is the establishment of a clear and detailed EU taxonomy that would serve as a classification system for sustainable activities. The taxonomy regulation was published in 2020 and sets out overarching conditions that an economic activity must meet to qualify as environmentally sustainable. The taxonomy establishes six environmental objectives: i) climate change mitigation, ii) climate change adaptation, iii) sustainable use and protection of water and marine resource, iv) transition to a circular economy, (v) pollution prevention and control, and vi) the protection and restoration of biodiversity and ecosystems. A platform on sustainable finance that draws inputs from experts was established to further develop and improve the taxonomy.[67]

Another initiative under the Action Plan is the creation of an EU green bond standard to encourage market participants to issue and investment in EU green bonds and improve the effective, transparency, comparability, and credibility of the market. The current proposed framework for this includes

[66] STACS (2022) ESGpedia official launches, aggregating verified ESG data and certifications across various sectors to enable more effective green finance, https://stacs.io/esgpedia-officially-launches-aggregating-verified-esg-data-and-certifications-across-various-sectors-to-enable-more-effective-green-finance/

[67] Europa (n/a) EU Taxonomy for sustainable activities, https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-taxonomy-sustainable-activities_en

alignment with the EU taxonomy, insofar as funds raised by a bond should be allocated fully to projects that are aligned with the EU taxonomy; full transparency on how bonds proceeds are allocated through detailed reporting requirements; compliance checks by an external reviewer; and the supervision of external reviewers by the European Securities Market Authorities.[68]

Other initiatives under the action plan are similarly focused on reorienting capital flows towards a more sustainable economy, mainstreaming sustainability into risk management, and fostering transparency and long-termism in capital markets.[69]

3.2.3 Base-line standards at a global level

Competing ESG standards have meant that there are no uniform accounting standards to measure a company's progress on sustainability, leading to calls for a global ESG reporting standard. To this end, the ISSB, an international standards board established in 2021 at COP26 is a promising new initiative to develop baseline ESG standards at a global level.

The ISSB promises to do what the International Accounting Standards Board has done for financial reporting – develop internationally-accepted standards for companies to report their performance to investors. If successful, the ISSB will have to develop a comprehensive global baseline of sustainability disclosures designed to the meet the information needs of investors to assess enterprise value.

Development of the ISSB standards is to support further global convergence on sustainability-related disclosure, create a common reporting baseline, and help mainstream sustainability related issues into regular business strategy and management. As a corollary of enabling broad understanding of enterprise value and creating a global baseline, the ISSB standards will aim to provide clear guidance on what constitutes appropriate sustainability analysis and management, encourage entities to set sustainability targets, require geographically contextualised disclosures, and adopt an explicit long-term time horizon.[70]

To date, ISSB has published two proposed standards—one that sets out general sustainability related disclosure requirements, and the other on specific climate-related disclosure requirements. Both proposals build on the work of the Climate Disclosure Standards Board, the International Accounting Standards Board, the Value Reporting Foundation (which houses the Integrated Reporting and SASB standards), the TCFD recommendations, and the World Economic Forum. Additionally, initial proposals for an IFRS Sustainability Disclosure Taxonomy that will enable structured electronic tagging of a company's sustainability disclosure is currently under development.

[68] Europa (n/a) European green bond standard https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/european-green-bond-standard_en

[69] Europa (n/a) Renewed sustainable finance strategy and implementation of the action plan on financing sustainable growth, https://ec.europa.eu/info/publications/sustainable-finance-renewed-strategy_en#action-plan

[70] UNEPFI (2022) Joint statement on the standards to be developed by the International Sustainability Standard Board, https://www.unepfi.org/wordpress/wp-content/uploads/2022/06/UN-Joint-Statement-ISSB-Consultation.pdf

4. Policy Recommendations and Next Steps

Innovative product and services that draw on advancements in FinTech are driving greater adoption and new applications in modern-day trade value chains and sustainable finance. Blockchain-based solutions such as smart contracts, authenticity tracking, and digital identities are enabling cheaper, more secured digital transactions that are improving processes in cross-border trade and trade finance. The use of blockchain, big data analytics, AI/ML, and other emerging technologies are also helping to bridge the data gap in ESG standards and drive more capital and investment towards sustainable financing.

In light of this, APEC and its member economies could consider taking the following long-term policy recommendations to help promote development of emerging technologies in trade and sustainable finance, and to realise the socioeconomic benefits from the FinTech applications discussed above. Specifically:

4.1 Five high-level approaches to promote development of emerging technologies

To advance development of emerging technologies for trade and sustainable finance, APEC and its member economies could consider the following five high-level approaches:

- **Develop in-house government expertise on key innovations, in line with domestic capacity-building initiatives on digital upskilling and upgrading of existing technology infrastructures.** As newer technological applications in trade and sustainable finance are introduced, policymakers and regulators, particularly those responsible for promoting and overseeing its development, will need to keep pace and be familiar with the technologies powering the innovation (e.g. blockchain). This will allow governments to better understand a technology's impact and draft regulations that are digital-first, interoperable, and inclusive. Initiatives to develop this in-house expertise can be aligned with domestic capacity building initiatives such as efforts that raise the population's digital and financial literacy skills, digital upskilling programs for the workforce, and planned upgrades to existing information technology and connectivity infrastructures by the government.

- **Establish public-private partnerships (PPPs) to allow greater collaboration between public and private sector in the development of cutting-edge technologies.** For instance, PPPs in blockchain can allow for greater collaboration between the public and private sector to explore the use and implications of blockchain in trade. The incorporation of ESG standards in PPPs can help unlock more capital investments in sustainable solutions that will assist economies achieve SDG targets. PPPs provide an important opportunity for governments to leverage the technological expertise of the private sectors in developing solutions to fundamental challenges—such as standardisation and digital identities—and give these solutions the regulatory clarity and critical mass needed to succeed when backed at a governmental level.

- **Provide capital for R&D such as an innovation fund, that is dedicated to helping bring breakthrough technologies to market.** Implementing blockchain solutions at scale can be resource intensive and cost prohibitive for solution providers. Governments could address this challenge by establishing an innovation fund that would help bring breakthrough technologies to the market. An

innovation fund would also help direct R&D efforts to address issues in priority areas identified by the government, such as initiatives to mainstream sustainable finance using technologies powered by blockchain, big data analytics, AI/ML, etc. It could also help identify promising solutions that are not yet sufficiently mature but would benefit from further project development assistance under a separate channel, such as a regulatory sandbox.

- **Evaluate the use of regulatory sandboxes given the nascency of the technology applications discussed in this report.** The creation of a regulatory sandbox to pilot test the use of these technologies may help policymakers and regulators better understand how to apply global best practices to their markets and encourage local innovation. For example, trialling the use of blockchain in a limited manner in a few key sectors and for specific commodities with relatively digitalised value chains could help identify potential challenges and the role of policies in addressing these. Similarly, trialling the use of mandatory ESG reporting for a subset of publicly listed companies for 1-2 years could help identify the standards that work for specific economies. APEC could also introduce a coordination mechanism to monitor the progress of sandboxes across member economies to understand best practices and harmonise new regulations, and for solutions arising from the sandboxes to be applicable in other APEC economies.

- **Establish innovation centres to foster market growth and serve as a one-stop hub for relevant information on emerging technologies**. To encourage innovative use cases for these technology applications in individual member economies, economies could establish innovation centres or model factories with public funding for local start-ups. This could be particularly useful for blockchain applications to gather relevant information at all levels of the commodity production value chain leading up to trade, which can differ significantly by economy, for instance in the production and certification of agri-food commodities. Innovation centres could also be helpful for ESG standards—less so from the perspective of developing new or tweaking existing ESG standards, but more in terms of developing novel digital methodologies to track and report company data that align to different ESG standards. For instance, there are promising advancements in online products and dashboards for companies to monitor their ESG performance indicators with pre-loaded methodologies to ascertain emissions levels and the use of AI to generate reports that align with standards such as GRI and SASB. Similar products could be developed for local markets through innovation centres. Success stories and solutions could be showcased at an APEC level through workshops, webinars, or published on a web portal maintained by APEC.

4.2 Five actionable steps to realise socioeconomic gains from FinTech

To help realise socioeconomic gains from FinTech, APEC and its member economies could consider the following five actionable steps:

- **Incorporate applications that facilitate trade and promote a more sustainable economy as part of domestic agendas.** Given the significant role that blockchain applications could play in trade facilitation and development of the digital economy, and the importance of using clearly defined and outcome oriented ESG standards, it is imperative that these be included under relevant domestic and APEC policy agendas. This could be achieved through a variety of domestic strategies

for APEC member economies, including digital transformation plans, economic development plans, net zero, and emissions reductions strategies, measures to improve trade facilitation, and efforts to harmonise regulations across member economies on monitoring and reporting standards. Relevant ministries to elevate this to the domestic agenda include those overseeing trade, ICT, and finance. Development of these domestic strategies, should where available and possible, align with international best practices and standards. For instance, alignment with international frameworks on ESG standards would encourage greater comparability of information for investors, better regulatory oversight of companies or projects that span multiple jurisdictions and reduce the compliance cost for companies when adopting the new standards.

- **Establish clear and flexible regulations that boost investor confidence and reduce adoption cost of new technologies and innovation.** Development of new technologies can often raise concerns around consumer protection, market stability, and even questions around the legality of its application. Establishing clear and flexible regulations, based on strong foundational frameworks (e.g. data protection law, cybersecurity frameworks, etc.), can help provide a sense of regulatory clarity that can boost R&D efforts and help bring breakthrough innovations to market. It can give consumers a better understanding of how a new technology, product or service, is being viewed by regulators, encourage widespread market adoption, and even deter arbitrary decisions from being enforced. Clear and enabling regulations also provide a level of regulatory certainty and trust that can help advance policy dialogues for cross-border cooperation, boost investor confidence, and reduce complexity and compliance cost for businesses that seek to adopt the new technology or innovation. To this end, the use of a regulatory sandbox can help explore many of these issues within a controlled space to provide regulators with useful information to establish clear and flexible regulations.

- **Launch public consultation processes with industry stakeholders to ensure that views and needs of relevant non-state actors are incorporated in the policy development process.** APEC member economies could launch public consultation processes with industry stakeholders to ensure that the views and needs of relevant non-state actors are incorporated in the policy development process. For instance, for blockchain applications in trade, the views of trade associations, chambers of commerce, logistics and transportation sector participants, relevant commodity and product certifying bodies, worker unions, consumers, and indigenous sectors, and the tech sector could be sought to understand the maturity of current applications and how to support further innovation, requirements for trade clearance (including as part of the development of single windows), and the readiness of the value chain of key commodities and products to adopt relevant blockchain applications. Similarly, it will be crucial to seek the views of chambers of commerce and various industry and consumer associations to understand the readiness of companies to meet the reporting requirements across various ESG standards and the suitability of standards for different sectors, as well as understanding the needs of public, private, and institutional investors in using existing or developing new ESG standards.

- **Create an environment that enables and strengthens internationalisation, including supporting the adoption of common standards.** While blockchain for trade and ESG standards have the potential to be ‘globally born’ rather than ‘evolved to internationalise’, understanding local trade

and market regulations is often the main barrier reported by internationalising businesses. Government-to-government cooperation to enable these connections could be not only of a significant support to emerging technologies, but also make codes and protocols more reliable for businesses looking to expand overseas. Policy and regulatory initiatives could support adoption of common global standards that would help ensure new products and services developed are interoperable and accepted across jurisdictions. While certain adjustments can be made to accommodate local contexts, establishing a domestic standard that is aligned with global standards can help economies realise several benefits, including greater comparability of data by domestic and international investors, greater regulatory oversight of companies or projects that span multiple jurisdictions, and reduced compliance costs for companies when producing standardised climate-related disclosures.

- **Create channels for knowledge sharing that can help APEC economies identify areas of mutual priorities for collaboration and potential cross-border pilots.** Many promising FinTech innovation such as blockchain for trade, or harmonised ESG standards for sustainable finance, would benefit from policy dialogues and coordination a cross-border level given the global nature of their applications and impact. At the same time, several APEC economies are at the forefront of some of the key topics discussed in this paper (e.g., application of blockchain in the trade value chain, sustainable investing, and ESG standards), both in terms of research and development, and policy initiatives and regulatory frameworks. As a coordination mechanism, APEC could establish platforms that would allow APEC economies to share learnings, success stories, and emerging practices. These platforms would help different economies identify mutual priorities for greater collaboration and opportunities for cross-border pilot trials. It could help facilitate efforts to harmonise standards and prevent a situation where growth and trade is inhibited due to regulatory fragmentation.