World Trade Organization

Trading with intelligence

How AI shapes and is shaped by international trade

Disclaimer

Table of contents

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Abbreviations

AfCFTA	African Continental Free Trade Area
AI	artificial intelligence
CPU	central processing unit
DSU	Dispute Settlement Understanding
ECJ	European Court of Justice
EU AIA	EU Artificial Intelligence Act
GATS	General Agreement on Trade in Services
GATT	General Agreement on Tariffs and Trade
GenAI	generative artificial intelligence
GPA	Government Procurement Agreement
GPU	graphics processing unit
ICT	information and communications technology
IEC	International Electrotechnical Commission
IMF	International Monetary Fund
IoT	Internet of Things
IP	intellectual property
ISO	International Organization for Standardization
ISO/IEC JTC 1/SG 4	ISO/IEC Joint Technical Committee and subcommittee
IT	information technology
ITA	Information Technology Agreement
ITU	International Telecommunication Union
LDC	least-developed country
LLM	large language model
MFN	most-favoured nation
MSME	micro, small and medium-sized enterprise
NTM	non-tariff measure
OECD	Organisation for Economic Co-operation and Development
R&D	research and development
RTA	regional trade agreement
S&DT	special and differential treatment
SDG	United Nations Sustainable Development Goal
SCM	subsidies and countervailing measures
SPS	sanitary and phytosanitary measures
STC	specific trade concern
TBT	technical barriers to trade
TPR	trade policy review
TPRM	Trade Policy Review Mechanism
TRIMS	trade-related investment measures
TRIPS	trade-related aspects of intellectual property rights
UNCTAD	UN Trade and Development
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization
WCO	World Customs Organization
WTO	World Trade Organization

Foreword

I am delighted to present the World Trade Organization Secretariat's first comprehensive report on artificial intelligence (AI) and international trade. This report marks a milestone in our efforts to understand the impacts AI is having, and will continue to have, on global trade. As AI continues to evolve and transform the ways we work, live and do business, the global trade community must recognize these impacts and respond to maximize the gains for people, businesses and economies, and minimize potential risks.

Declaring AI to be "the new electricity" has already become a cliché, but it may still be an understatement. AI is a general-purpose technology that has entered the public consciousness with remarkable speed and intensity. Its current and potential applications affect virtually all domains, from life-saving medical discoveries to smart agriculture. AI is challenging the ways we think about the world, and international trade is no exception, as AI promises to transform trade logistics and supply chain management and give rise to new forms of services.

As this report shows, AI has the potential to reduce trade costs, enhance productivity across sectors, and reshape traditional trade patterns. I often say, the future of trade is services; digital; and green; and that it must be inclusive. AI can accelerate trade's journey into this future.

The digital transformation driven by AI is poised not only to boost services trade; it may also create whole new categories of tradable AI-powered goods, from autonomous vehicles to robotics and beyond. If we successfully harness its potential, AI can also support greener trade by optimizing resource use and reducing the carbon footprint of supply chains.

But the inverse is also true. AI raises significant challenges, from the growing risk of an "AI divide" to questions around data governance and privacy, how to regulate AI-enabled

products and associated ethical and societal risks, as well as how to protect intellectual property in an AI-driven age. While we still need to find good answers to many of these questions, it is already clear that making the most of AI-related opportunities will require their benefits to be widely shared across different economies.

WTO economists simulated various AI uptake scenarios for this report, and the differences were substantial. Under an optimistic scenario they dub "global synergy", in which AI is adopted evenly across regions and contributes to strong productivity gains, cumulative real growth in global goods and services trade would increase by almost 14 percentage points through 2040, with global trade in digitally delivered services nearly 18 percentage points higher than the baseline projection. Conversely, under a cautious "tech divergence" scenario – characterized by divergences across regions in terms of productivity increases and AI adoption – the impacts of AI on trade growth would be halved, with a cumulative boost of only 7 percentage points by 2040. In other words, failing to diffuse AI technology across different economies would mean foregoing many of the potential gains.

This report aims to stimulate a discussion on how the WTO can promote the development and deployment of AI and help mitigate its associated risks and looming concerns about regulatory fragmentation. In this respect, two guiding questions the report tries to address are: how can the WTO help ensure that the benefits of AI are broadly shared? How can the challenges that AI presents be addressed in a globally coordinated manner?

The WTO matters here not just because of its rules and adjudication functions, but also its role as a global forum for discussion, coordination and cooperation. As the report notes, this latter role is particularly relevant and suitable for AI: a complex and fast-evolving technology that is inherently global in nature.

Of course, AI-related global governance cannot be reduced to trade issues. But trade rules and policy have important roles to play. The WTO, with its 166 members of all sizes and income levels, is well placed to participate in ongoing AI global governance debates. As the report notes, WTO members themselves are slowly bringing AI into the agenda of various of our deliberative bodies.

Because of the remarkable pace at which AI is evolving, we need to look beyond today and anticipate what lies on the horizon. This is why the report contains views from scholars working at the intersection of AI, trade and the multilateral trading system. I want to emphasize that these views and lines of inquiry do not reflect official positions or carry the endorsement of WTO members or the Secretariat. They are in the report because they put before us some complex issues and difficult questions that we cannot afford to sidestep, and that should be read as an invitation for reflection and further research that will help us better understand the fast-changing technological landscape in which the multilateral trading system operates. They may also serve as an inspiration for discussion on the role of the WTO in supporting international AI governance efforts.

By working together to leverage AI responsibly, we can drive sustainable economic growth, foster innovation, and ensure that the benefits of this technology are shared by all.

I invite all WTO members, stakeholders, and the broader international community to engage with the findings of this report and to contribute to the ongoing discussions on AI governance, including through the lens of trade policy. Together, we can shape a future where trade and technology work hand-in-hand to create a more prosperous, sustainable and equitable world.

Dr Ngozi Okonjo-Iweala
Director-General

Executive summary

The widespread and transformative impact that artificial intelligence (AI) is currently having on society is being felt in all areas, from work, production and trade to health, arts and leisure activities. New applications of AI are expected to create unprecedented new economic and societal opportunities and benefits. However, significant ethical and societal risks are also associated with the development and application of AI. These risks have implications for all these areas too, including trade. AI is a global issue, and as governments increasingly move to regulate AI, global cooperation is more important than ever.

Against this backdrop, the present report examines the intersection of AI and international trade. It begins with a discussion of why AI is a trade issue, before delving into the ways in which AI may shape the future of international trade. It discusses key trade-related policy considerations raised by this technology and provides an overview of government initiatives taken both to promote and to regulate AI. The report also highlights the looming risk of regulatory fragmentation and its impact, in particular on trade opportunities for micro, small and medium-sized businesses. Finally, the report discusses the critical role of the WTO in facilitating AI-related trade, ensuring trustworthy AI and addressing emerging trade tensions.

Why is AI a trade issue?

AI is distinct from other digital technologies in several key ways, and it has the potential to affect international trade significantly. It is a general-purpose technology, capable of adapting to a wide range of domains and tasks with unprecedented flexibility and efficiency. It relies on large datasets to learn and improve its performance and accuracy. AI's functions and efficiency can evolve rapidly, leading to dynamic shifts in its capabilities and autonomy. Finally, its inherent complexity and opacity, as well as its potential failures and biases, raise significant concerns related to matters such as how to understand the reasons for and basis of AI decisions and recommendations, or regarding ethics and broader societal implications.

AI can be leveraged to overcome trade costs associated with trade logistics, supply chain management and regulatory compliance. By enhancing trade logistics, overcoming language barriers, and minimizing search and match costs, AI can make trade more efficient. It can help to automate and streamline customs clearance processes and border controls, navigate complex trade regulations and compliance requirements, and predict risks. AI-based tools can be used in trade finance, and can significantly enhance supply chain visibility by providing real-time data analytics, predictive insights and automated decision-making processes. All of this could lower trade costs and, as a result, level the playing field for developing economies and small businesses, helping them to overcome trade barriers, enter global markets and participate in international trade.

AI can transform patterns of trade in services, particularly digitally delivered services. It can enhance productivity, especially in services sectors that rely on manual processes, by enabling low-skilled workers to leverage best practices of more high-skilled workers more effectively. For example, generative AI can amplify the performance of business consultants by up to 40 per cent compared to those not using it. Greater productivity gain is also observed for lower-skilled workers (Dell'Acqua et al., 2023). Research also shows that access to generative AI increases the productivity of call centre workers by an average of 14 per cent, and by 34 per cent specifically for novice and low-skilled workers (Brynjolfsson et al., 2023). AI can also foster the development of innovative services and increase demand for them. However, while AI can enhance trade in digitally delivered services significantly, it has contributed to reducing the demand for certain traditional services. AI-enabled automation can also reduce the necessity to outsource certain services.

AI can increase demand and trade in technology-related products. Because AI systems often rely on real-time data streams and seamless connectivity, the adoption of AI is spurring demand for complementary goods related to information and communications technology (ICT) infrastructure and information technology (IT) equipment. These include computer and telecommunications services, specialized development tools and software libraries. For example, the global market for AI chips was valued at US$ 61.5 billion in 2023 and it has been projected that it could reach US$ 621 billion by 2032 (S&S Insider, 2024). As many of these goods and services are often supplied by a small number of economies, international trade serves as a major channel to foster AI development worldwide. Further upstream in the value chain, trade in the extraction and processing of critical metals and minerals, as well as trade in energy, are also likely to gain in importance. In addition, AI has substantially heightened the demand for data, fundamentally reshaping the landscape of data usage and trade.

By affecting productivity, and through shifts in production dynamics, AI may reshape economies' comparative advantages. AI is expected to enhance productivity across all economic sectors in both developed and developing economies, and to change the composition of inputs required for production, placing greater emphasis on capital investment, rather than on labour inputs. This shift in production dynamics could reshape trade patterns. Conversely, new sources of comparative advantage may emerge from factors like educated labour, digital connectivity and favourable regulations. Because AI is energy-intensive, economies with abundant renewable energy may also gain comparative advantages. However, although AI can potentially benefit all economies, the development and control of AI technology are likely to remain concentrated in large economies and companies with advanced AI capabilities, resulting in industrial concentration.

The adoption of AI can drive productivity increases across various sectors and reduce trade costs, leading to global gains in trade and GDP. Simulations using the WTO global trade model show that, under an optimistic scenario of universal AI adoption and high productivity growth up until 2040, global real trade growth could increase by almost 14 percentage points. In contrast, a cautious scenario, with uneven AI adoption and low productivity growth, projects trade growth of just under 7 percentage points. The simulation further shows that, while high-income economies are expected to see the largest productivity gains, lower-income economies have better potential to reduce trade costs.

The global trade and GDP impact of AI varies significantly across economies and sectors, depending on choices made concerning innovation and policies. While trade growth in high-income economies remains relatively stable across projected scenarios, low-income economies could experience much higher trade growth under the scenarios of universal AI adoption and high productivity growth (18.1 percentage points) compared to those of uneven AI adoption and low productivity growth (6.5 percentage points). The simulation results suggest that if developing economies improve their AI readiness by strengthening digital infrastructure, enhancing skills and boosting innovation and regulatory capacity, they will be in a better position to adopt AI effectively.

These simulations show that digitally delivered services[1] are expected to experience the highest trade growth. In an optimistic scenario of universal AI adoption, digitally delivered services are projected to see cumulative growth of nearly 18 percentage points relative to the baseline scenario, the largest increase across all sectors. The expected impact of AI on real trade growth also differs within sectors. Potentially digitally delivered services such as education, human healthcare, and recreational and financial services, as well as manufacturing sectors such as processed food, are projected to experience significant trade growth, largely driven by trade cost reductions. Meanwhile, sectors related to natural resource extraction and manufacturing sectors such as textiles are expected to see limited growth.

The policies of AI and trade

The discussion on how AI might reshape international trade raises important policy questions. The risk of a growing divide resulting from applications of AI is significant, as are data governance challenges and the need to ensure that AI is trustworthy and to clarify how it relates to intellectual property (IP) rights. The implementation of AI at the domestic, regional and international levels entails both benefits and risks, and a lack of coordination could cause increasing regulatory fragmentation with regard to AI.

Addressing the risk of a growing AI divide is essential to leverage the opportunities offered by this technology. Currently, the capacity to develop AI technology is concentrated in a few large economies, and this is creating a significant divide between economies that are leading research and development (R&D) in AI – in particular China and the United States – and the rest of the world. This imbalance could be further exacerbated by the use of government subsidies to develop AI. The risk of industry concentration within a few large firms could also intensify the divide between firms. These features, combined with the opacity of AI algorithms and the possibility of tacit collusion among competitor firms to maintain higher prices, present challenges for competition authorities.

The rise of AI is raising important data governance issues that will need to be addressed to prevent further digital trade barriers. Cross-border data flows are essential to AI, as vast amounts of data are needed to train AI models, as well as minimize possible biases. Thus, restrictions on data flows can slow AI innovation and development, increase costs for firms, and negatively impact trade in AI-enabled products. A recent study (OECD and WTO, 2024) found that if all economies fully restricted their data flows, this could result in a 5 per cent reduction in global GDP and a 10 per cent decrease in exports. However, the large datasets required by AI models raise significant privacy concerns. Therefore, a reasonable trade-off between accessing large amounts of data to train AI models and protecting individual privacy must be found.

Ensuring that AI is trustworthy without hindering trade can be challenging. "AI trustworthiness" means that it meets expectations in terms of reliability, security, privacy, safety, accountability and quality in a verifiable way. However, given the behaviour and opaque nature of AI systems, as well as the potential dual-use of some AI products (i.e., for both civilian and military applications), striking a balance between ensuring that AI is trustworthy and enabling trade to flow as smoothly as possible may prove especially challenging. The evolutionary nature of AI makes regulation a perennial moving target. "Traditional" regulations and standards for goods, which normally focus on tangible, visible and static product requirements, may not be fully capable of addressing all of the different types of potential risks, including the ethical and societal questions that may result from the integration of AI into goods and services. Regulating to address questions of public morals, human dignity and other fundamental rights, such as discrimination or fairness, is not only challenging, but is also prone to causing regulatory fragmentation because the meaning and relative importance of such values may vary across societies.

AI also poses new conceptual challenges for the traditional, "human-centric" approach to IP rights. Issues that deserve particular attention include the protection of AI algorithms and of copyrighted material for training AI, and the protection and ownership of AI generated outputs. These questions may call for a re-evaluation of existing IP legal frameworks.

The immense potential of AI has prompted governments around the globe to take action to promote its development and use while mitigating its potential risks. At the domestic level, more and more jurisdictions are putting in place AI strategies and policies to enhance their AI capabilities. The number of economies having implemented AI strategies increased from three in 2017 to 75 in 2023. According to Stanford University's 2024 "AI Index", 25 AI-related regulatory measures were adopted in the United States in 2023, compared to just one in 2016, while the European Union has passed almost 130 AI-related regulatory measures since 2017. However, most domestic AI policy initiatives are being implemented by developed economies, which could further deepen the existing AI divide between developed and developing economies: while around 30 per cent of developing economies have put AI policy measures in place, only one least-developed country (LDC) – Uganda – has done so according to data from the Organisation for Economic Co-operation and Development (OECD) AI Policy Observatory. Also high on governments' policy agendas are domestic initiatives to promote access to data through open data and data-sharing initiatives, with a view to fostering domestic innovation and competition, protecting privacy and controlling the flow of data across borders.

What is emerging is a landscape of fragmented measures and heterogeneous domestic initiatives, which may lead to regulatory fragmentation. This fragmentation extends beyond AI-specific regulations to include sector-specific legislation, such as IP and data regulations, which also impact AI. In addition, the design of some border measures imposed on the hardware components and raw materials crucial to AI systems can affect competitors in other economies, leading to trade-distorting effects and further exacerbating fragmentation. The economic costs of regulatory fragmentation, in particular for small businesses, highlight the importance of mitigating regulatory heterogeneity; according to OECD and WTO (2024), the economic costs of the fragmentation of data flow regimes along geo-economic blocks amount to a loss of more than 1 per cent of real GDP.

The increasing number of bilateral and regional cooperation initiatives on AI governance, many focusing on different priorities, add to the risk of creating a multitude of fragmented approaches. For example, while some bilateral cooperation initiatives focus primarily on aligning AI-related terminology and taxonomy, and on monitoring and measuring AI risks, others prioritize collaboration to promote alignment in general terms or focus primarily on AI safety and governance. Likewise, some regional initiatives prioritize human rights and ethics, while others focus on economic development and growth.

Regional trade agreements (RTAs) and digital economy agreements are important vehicles to promote and regulate AI. AI-specific provisions have started to be incorporated into such agreements, but they mainly take the form of "soft" – i.e., non-binding – provisions focusing on the importance of collaboration to promote trusted, safe and responsible use of AI. Several AI-specific provisions explicitly refer to trade. Digital trade provisions included in RTAs, such as provisions on data flows, data localization, protection of personal information, access to government data, source code,[2] competition in digital markets, and customs duties on electronic transmissions, are also important for AI development and use. The number of RTAs with digital trade provisions has been growing steadily since the early 2000s, and by the end of 2022, 116 RTAs – representing 33 per cent of all existing RTAs – had incorporated provisions related to digital trade (López-González et al., 2023). However, the depth of digital trade provisions included in RTAs varies significantly, reflecting diverging approaches. Few developing economies and LDCs have negotiated digital trade provisions. Disciplines on trade in services in RTAs are also an important channel through which governments' trade policies and trade obligations can affect the policy environment for AI, but the level of commitments undertaken differs significantly across economies.

The last few years have witnessed a wave of international initiatives related to AI. While there are elements of complementarity among such initiatives and alignment on core principles, different initiatives prioritize different aspects of AI governance. A number of initiatives also contain various common elements that have important trade and WTO angles, such as the recognition of the role of regulations and standards, the need to avoid regulatory fragmentation, the importance of IP rights, the importance of privacy, personal data protection and data governance, and the importance of international cooperation, coordination and dialogue. Several of these initiatives also address the environmental impacts of AI.

However, there is still no global alignment on AI terminology. Differing priorities, the overlap between initiatives, and lack of global agreement on key terminology could pose challenges at the implementation stage, limiting efforts to prevent fragmentation and to put in place a coherent global AI governance framework. Nevertheless, beyond initiatives to govern AI, an increasing number of international organizations, such as the International Telecommunication Union (ITU), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Industrial Development

Organization (UNIDO) and the World Bank, are developing courses on AI and integrating AI in their technical assistance activities, some of which have a trade component.

The WTO, as the only rules-based global body dealing with trade policy, can contribute to promoting the benefits of AI and limiting its potential risks. It can play an important role in limiting regulatory fragmentation, promoting the development of trustworthy AI and access to it, and facilitating trade in AI-related goods and services, thereby enabling the growth of AI and promoting innovation through IP.

What role for the WTO?

WTO rules and processes promote global convergence. The WTO is a forum that promotes transparency, non-discrimination, discussion, the exchange of good practices, regulatory harmonization, non-mandatory policy guidance, and global alignment through the negotiation of new binding trade rules on trade. Transparency provisions included in WTO agreements allow WTO members, as well as economic operators and consumers, to be kept abreast of latest regulatory developments. One example is the enhanced transparency provisions in the Technical Barriers to Trade (TBT) Agreement. By requiring early notification of regulatory measures and allowing opportunities to provide comments on these measures at a draft stage, the TBT Agreement can help to prevent obstacles to trade, as well as promote and accelerate global convergence. WTO members are increasingly notifying a wide range of regulations on digital technologies to the TBT Committee. For instance, more than 160 notifications have been made on regulations addressing cybersecurity and the Internet of Things (IoT)/robotics, both of which are relevant for AI. More recently, the TBT Committee has started receiving notifications of AI-specific regulations. Another example is the WTO Trade Policy Review Mechanism, which contributes to transparency in members' trade policies. Finally, in terms of possible new substantive rules, various issues negotiated under the Joint Statement Initiative on E-commerce, which currently brings together 91 WTO members, may matter for AI.

The WTO also provides a global forum for constructive dialogue, the exchange of good practices, and cooperation. This enables discussion among members of how best to design nuanced, flexible and adaptable regulatory solutions to address the goods, services and IP-related aspects of AI in a coordinated manner. In some areas, the WTO also promotes regulatory harmonization and coherence by encouraging the use of international standards, mutual recognition and equivalence, and through various "soft law" instruments, such as voluntary committee guidelines.[3]

The WTO is the cornerstone of global efforts to facilitate trade in services and goods that enable or are enabled by AI. Various aspects of the WTO rulebook can contribute to promoting the development of and access to AI. For example, the General Agreement on Trade in Services (GATS) plays an important role in shaping a policy environment that facilitates the development and uptake of AI. A majority of WTO members (out of 141 schedules of commitments, 84, or 60 per cent, contain commitments on computer services) have made specific commitments on market access and national treatment related to ICT services, which play a fundamental role in enabling and promoting AI. However, commitments in other sectors remain limited, and barriers to services trade remain high in overall terms. When it comes to goods, the Information Technology Agreement (ITA) aims to increase worldwide access to high-technology goods essential to AI by eliminating tariffs on the ICT products it covers. Meanwhile, the TBT Agreement can help to ensure that, when governments adopt AI standards and regulations, these are, to the extent possible, not trade-restrictive, and are optimal for attaining policy objectives. The Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement aims to foster a balanced IP system that incentivizes innovation through the enforcement and protection of IP rights, while promoting dissemination of and access to technology, to the mutual benefit of both producers and users of technological knowledge. Various WTO agreements also include provisions to promote the transfer of technology, and this can play an important role in the development of AI. Finally, the WTO Agreement on Government Procurement (GPA) 2012 promotes access to internationally available new AI technologies.

Various principles, provisions and guidelines in the WTO rulebook can support trade in AI systems and AI-enabled products by minimizing international negative spillovers. Examples include the non-discrimination principle and the Agreement on Trade-Related Investment Measures (TRIMS), which recognizes that certain investment measures can restrict and distort trade and states that members may not apply investment measures that discriminate against foreign products or lead to quantitative restrictions. When it comes to technical regulations, standards and certification procedures, the TBT Agreement provides that regulatory intervention shall not be discriminatory nor any more trade-restrictive than necessary to achieve the intended policy objectives, and that it should, when justified, be subject to periodic reviews. And the Agreement on Subsidies and Countervailing Measures (SCM) can play a crucial role in navigating the dual aspects of AI development, by promoting technological innovation while preventing negative spillovers in international trade from government financial support.

The WTO can help to prevent and settle trade tensions and frictions. The practice of raising "specific trade concerns" (STCs) allows WTO committees to serve as a venue for defusing potential trade tensions with regulatory measures in a cooperative, pragmatic and non-litigious way. In the TBT Committee, for instance, members have already been using this practice to discuss and address concerns with regulations involving a wide range of digital technologies and issues, including IoT, autonomous vehicles, 5G in robotics, industrial automation, cybersecurity, and more recently AI. The WTO also serves as a global forum to settle trade-related disputes. While there has been no dispute on AI so far, the WTO Dispute Settlement System has dealt with resolving disputes related to various aspects of the digital economy.

The WTO promotes inclusiveness through special and differential treatment and technical assistance for developing economies. WTO agreements recognize the constraints faced by developing economies and, for this reason, include various special and differential (S&D) treatment provisions to help them to implement WTO rules and participate more effectively in international trade. Technical assistance and capacity-building are key pillars of the WTO's work and play a fundamental role in furthering understanding of the WTO rules and agreements, as well as of other topics relevant to trade. Multi-stakeholder programmes, such as Aid for Trade and the Enhanced Integrated Framework, could, however, be leveraged further to help developing economies seize the benefits of AI for trade.

As a forum for negotiation, discussion and rule-making, the WTO provides a multilateral framework that can help address the trade-related aspects of AI governance. Nevertheless, AI may have implications for international trade rules. Although it is a new technology, AI is developing rapidly, and is certainly already advanced enough to be a subject of discussions at the WTO. Its cross-cutting nature requires a cross-cutting policymaking approach to promote policy coherence.

While AI governance extends beyond trade, trade remains a crucial element within AI governance. The WTO can contribute significantly to developing a robust AI governance framework. This report is a first attempt to explore some key implications of AI for trade and trade rules. As AI continues to evolve, governments should continue to discuss the intersection of AI and trade and its possible implications for the WTO rulebook.

Endnotes

1 Simulations in this report define digitally delivered services as services that can be delivered remotely over computer networks, are measured instead (WTO et al., 2023).

2 See Annex 1 for further explanation of key concepts in AI.

3 Such "soft law" instruments also include the set of Principles for the Development of International Standards, Guides and Recommendations agreed by the TBT Committee in 2020 (the "Six Principles") and the TBT 2024 Conformity Assessment Procedures (CAP) Guidelines

1 Introduction

Introduction

With the launch of ChatGPT in November 2022, artificial intelligence (AI), and in particular generative AI – capable of generating high-quality text, images and other content based on the data on which it is trained – entered into public consciousness and has been experiencing rapid adoption.

AI is a general-purpose technology that is already having, and will continue to have, a pervasive impact on our societies. It encompasses a broad spectrum of technologies with numerous applications that have the potential to transform deeply the way we work, produce and trade.

Rapid advances in AI are expected to reduce trade costs, boost productivity and innovation, and reshape economies' comparative advantages, creating unprecedented new economic and societal opportunities and benefits. An international trade environment prepared to facilitate these changes is key to further developing AI and to reaping its related benefits and opportunities.

Through the rules and commitments contained in its agreements, the WTO can play an important role in this context, by ensuring that goods using or supporting AI can flow without encountering trade obstacles, and by providing a conducive climate for trade and investment in AI-related services.

However, AI is also giving rise to significant risks and challenges. The fact that it can already be used and applied globally means that any action taken to develop, apply and control it must also take place at a global level.

As the broader regulatory and policy landscape surrounding AI is taking shape, it is critical to establish a better understanding of the intersection between AI and trade in order to ensure that AI's benefits for trade and economic growth are harnessed, and that related risks are mitigated.

This report discusses how AI impacts trade and how trade and trade policies impact AI. It explores how AI may shape the future of international trade and examines some of the key trade-related policy considerations that this technology raises.

It discusses how governments are responding to the new opportunities and challenges raised by AI, and the consequent potential risk of policy fragmentation, and it explores the role that the WTO can play in facilitating trade in goods and services related to AI, promoting trustworthy AI and addressing trade tensions. Finally, it discusses possible implications of AI for international trade rules.

> “Rapid advances in AI are expected to reduce trade costs, boost productivity and innovation, and reshape economies' comparative advantages.”

2

Why is AI a trade issue?

(a) What is artificial intelligence (AI) and what makes it unique?

AI encompasses a broad spectrum of technologies with numerous applications. There are several definitions of AI systems by international bodies. The Organisation for Economic Co-operation and Development (OECD), for example, defines an "AI system" as "a machine based system that, for explicit or implicit objectives, infers, from the input it receives, how to generate outputs such as predictions, content, recommendations, or decisions that can influence physical or virtual environments. Different AI systems vary in their levels of autonomy and adaptiveness after deployment" (OECD, 2024a). As for the International Organization for Standardization (ISO), it defines an AI system as an "engineered system that generates outputs such as content, forecasts, recommendations or decisions for a given set of human-defined objectives".[1]

While the history of AI as a research field began in the 1950s, recent decades have seen unparalleled growth in AI applications. As illustrated in Figure 2.1, the field was initially met with enthusiasm, leading to the creation of programmes that could play chess and solve algebraic problems. However, progress slowed during an "AI winter"

Figure 2.1: A brief history of AI

1950:
Visionary computer scientist Alan Turing suggests a language-based test to evaluate whether a machine has the ability to exhibit intelligent behaviour equivalent to, or indistinguishable from, that of a human being: the Turing Test is invented.

1956:
The term "artificial intelligence" is coined during a seminal workshop at Dartmouth College, United States.

1950s-60s:
Work focuses on the use of logic by symbolic AI – which processes symbols or concepts, rather than numerical data – to imitate human intelligence.

1970s-80s:
Expert systems, which emulate the decision-making abilities of human experts, have a period of popularity, followed by the "AI Winter", resulting from limitations in computing power and problem complexity.

1997:
IBM's "Deep Blue", a chess-playing computer system, defeats chess champion Garry Kasparov, showcasing AI's potential for complex decision-making.

2012:
Breakthroughs in deep learning advance computer vision, natural language processing and speech recognition.

2017:
Google's AlphaGo defeats Ke Jie, the world champion of the board game Go, demonstrating the potential of deep learning.

2010s-present:
AI becomes broadly available through open-source tools and cloud computing.

2022:
The public launch of Chat GPT3 brings generative AI to the attention of the general public.

2024:
Development of AI ethics and regulatory frameworks to ensure its responsible application and use.

period of reduced funding and interest. Renewed advancements in the 1980s, followed by breakthroughs in machine learning (i.e., the ability of machines to learn without explicit programming) and neural networks (i.e., a type of machine learning by which a computer learns to perform a task by analysing examples) in the 2000s, have since driven AI to its current prominence and its increasing application in various industries and in many people's daily lives (see Annex 1 for further explanation of key concepts in AI).

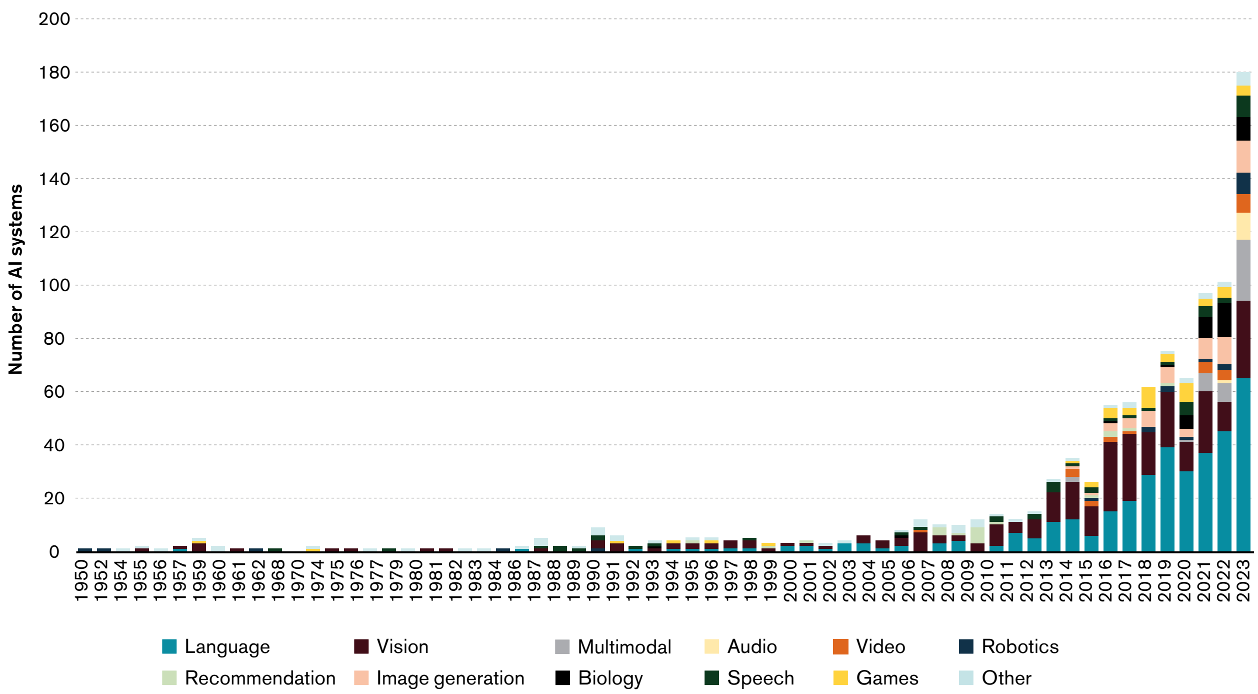
Contemporary advances in generative AI render AI distinct from other technologies in several key ways. First, AI serves as a general-purpose technology, capable of adapting to various domains and tasks with unprecedented flexibility and efficiency. Second, it feeds on large datasets to improve its performance and accuracy. Third, its functions and efficiency can evolve rapidly, leading to dynamic shifts in its capabilities and applications. Finally, AI's inherent complexity and opacity raise significant concerns regarding ethics and broader societal implications.

(i) AI is a general-purpose technology with wide current and potential applications

AI exhibits versatility in its capabilities, as it can be applied to a wide range of tasks and domains. It is increasingly playing a role in every sector of the economy and in every aspect of our daily lives. From driving our cars to controlling our critical infrastructure, diagnosing our illnesses and recommending content for our entertainment, AI is ubiquitous (Shadbolt, 2022), leading some to term AI an "omni-use" technology (Suleyman and Bhaskar, 2023). AI technologies are prevalent across various domains, such as language processing, vision (e.g., image recognition), and multimodal systems that integrate and interpret more than one type of data input. The number of AI systems applied in these domains has grown substantially in recent decades (see Figure 2.2). As detailed in Box 2.1, AI can contribute to addressing environmental challenges and promoting sustainability.

The fact that AI can be applied broadly means that it can potentially be implemented both for beneficial and for harmful purposes. As a general-purpose technology, AI is particularly prone to misuses and dual uses (i.e., for both civilian and military applications). For example, AI algorithms initially designed to enhance productivity and optimize resource allocation can also be repurposed for malicious ends, such as illicit surveillance or misinformation campaigns. AI systems or models initially intended for civil use can be repurposed for military uses, such as the development of autonomous weapons systems.[2] To many, this underscores the critical importance of responsible innovation, ethical AI governance and the establishment of robust regulatory frameworks, to ensure that AI technologies are developed and deployed in ways that prioritize the common good.

Figure 2.2: Domains of notable AI systems



Source: Our World in Data based on Epoch (2024), last updated October 2024

Box 2.1:
The environmental impacts of AI

As a general-purpose technology, AI has the potential to help achieve a wide range of global sustainability goals. But AI also raises concerns regarding its potential adverse effects on the environment.

The potential environmental benefits of AI are manifold. For instance, it can reduce the energy carbon footprint by improving the efficiency of smart electricity grids, complex supply chains and transport operations. In particular when coupled with other emerging technologies, such as synthetic biology (i.e., the design, engineering and modification of biological systems), and advanced materials, such as those used in nanotechnology,[3] AI can foster a whole new wave of revolutionary innovations (Stanford University, 2023).[4]

AI could also improve greenhouse gas absorption and carbon storage by monitoring and predicting emissions from ecosystems (OECD, 2022). It can facilitate sustainable trade and protect biodiversity by means of tools such as image-based detection of illegal wildlife trade, high-risk animal tracking, food value chain optimization and source monitoring and tracking (World Economic Forum, 2018).

Moreover, it can help to measure, simulate and reduce the environmental footprint of supply chains (see Box 2.4 and Barteková and Börkey (2022)).

Certain AI models can play an important role in addressing climate adaptation and resilience. They are increasingly capable of weather forecasting and enhancing severe event prediction, including tracking tropical cyclones, atmospheric rivers (i.e., moisture-carrying sections of the Earth's atmosphere) and extreme temperatures (Lam et al., 2023; Stanford University, 2023). In addition, AI can enhance the efficiency and reliability of renewable energy systems by better understanding the supply and demand dynamics, maximizing the financial value of renewable energy and allowing it to be integrated more easily into the grid (IEA, 2023).

However, AI can also result in both direct and indirect negative impacts on the environment. Direct impacts stem from the use of resources throughout the AI system's lifecycle. Particularly impactful is the consumption of resources such as water, energy and other raw materials, and the associated greenhouse gas emissions (OECD, 2022).

For instance, the training of a ChatGPT2, an earlier version of OpenAI's language model released in February 2019, was estimated to produce 300 metric tons of CO_2 emissions, the equivalent of 125 round trip flights between New York and Beijing (Strubell et al., 2019). The computational and environmental costs of training can grow in proportion to the size of the model (European Commission et al., 2021). Furthermore, during their operational cycle, AI systems can consume significant volumes of water, either directly, for cooling towers, or indirectly, through water use for electricity generation. Some predict that by 2027, the total water consumption of all AI systems may exceed 0.38–0.60 billion cubic metres, roughly 200,000 Olympic-sized swimming pools (Ren, 2023). A study indicates that data centres, cryptocurrencies and AI consumed almost 2 per cent of total global electricity demand in 2022 and these figures could double by 2026 (IEA, 2024).

The environmental impacts of AI are being addressed in several government and intergovernmental initiatives.

(ii) AI feeds on large datasetsand data regulations play a pivotal role in this

AI algorithms require vast amounts of data to learn patterns, make predictions and perform tasks accurately. The quality and quantity of data directly impact the performance and reliability of AI systems: high-quality, diverse datasets enable AI models to generalize and adapt to new scenarios, supporting continuous iteration and improvement. Access to up-to-date, representative datasets is therefore crucial to keep AI systems relevant and effective over time.

In sum, data provide the raw material and fuel enabling AI systems to train, learn and improve.

The data utilized in AI applications can vary widely in terms of its sourcing and accessibility. Some datasets are open-source and may be contributed by organizations, researchers or individuals with the intention of fostering innovation and collaboration within the AI community. On the other hand, proprietary data is owned and controlled by specific entities, and access to these data may be restricted and require agreements or licences for use. Proprietary data sources can include internal company data, research datasets or commercially acquired data. With the exponential growth in the volume and variety of data available to AI systems, privacy and intellectual property (IP) concerns loom larger than ever (see Chapter 3(a)).

Data regulations play a pivotal role in determining the use of data and shaping the process of AI use and innovation. Many regulations establish guidelines for obtaining consent, providing transparency and safeguarding sensitive information (See Chapter 3(b)). Data regulations take into consideration the balance between AI innovation and deployment on the one hand, and the need for privacy protection, ethical considerations, IP rights and data security on the other hand. In an increasingly interconnected world, data regulations also govern the cross-border transfer and sharing of data between jurisdictions.

(iii) AI's functions can evolve rapidly, leading to dynamic shifts in its capabilities and autonomy

A key element of AI systems is their ability to make significant, continual improvements to their performance. This is attributable to, and dependent on, three primary factors: algorithmic innovation, data availability and computational resources. Algorithmic advancements have paved the way for more sophisticated and effective AI models. The abundance of high-quality data is providing AI systems with rich and diverse information to learn from, while the exponential growth in computational power is empowering researchers and practitioners to train larger and more complex models at scale.

As AI models become more sophisticated and datasets grow larger, the quantity of computing resources used in AI training increases exponentially. It is estimated that the computational resources needed to train AI have doubled every 3.4 months since 2012 (Amodei and Hernandez, 2024). This progress is driven by the willingness of industries to use more data centre capacity for large-scale general-purpose AI training. This can be compared to the processing power of computer chips which, since the 1960s, has tended to double approximately every 18 to 24 months, a phenomenon famously known as "Moore's Law" after Gordon Moore, one of the cofounders of Intel Corporation.[5]

AI can exhibit varying levels of autonomy, depending on its design and purpose. AI systems can range from supervised systems that require human oversight to fully autonomous systems capable of independent decision-making. Some AI systems learn from data and adjust their behaviour based on experience, while others operate independently in real time without human intervention, particularly in domains like autonomous vehicles and robotic automation. As AI systems' autonomous capabilities evolve and increase, concerns with the need to ensure human agency and oversight grow.

The need to keep pace with the swift evolution of AI is creating challenges for regulators. AI's potential for rapid capability increases suggests that its capabilities may grow exponentially in the future. While past trends offer valuable insights, they are often insufficient to predict the duration or trajectory of future advancements. Therefore, policymakers aiming to stay abreast of advancements in AI technologies cannot solely rely on past developments; they must adapt to and anticipate changes as they arise.

(iv) AI's inherent complexity and opacity and its potential failures and biases create challenges for regulators

AI models often exhibit a significant degree of opacity in their decision-making processes. Deep learning models (see Annex 1 for explanation of key concepts in AI), in particular, operate through layers of algorithms and vast datasets, resulting in a "black box" phenomenon where the rationale behind specific outputs remains unclear to users and even to the designers of the deep learning models (Castelvecchi, 2016). Recent advancements in AI tools have empowered machines to tackle tasks that go beyond explicit, fully specified sets of rules and procedures, further exacerbating concerns about their lack of transparency.

The opacity of AI models can lead to challenges in understanding how they arrive at their decisions or predictions. While researchers and practitioners are actively exploring various techniques to shed light on the decision-making processes of AI systems, through initiatives such as "Explainable Artificial Intelligence (XAI)",[6] this lack of transparency raises ethical and accountability concerns. There is a lack of standardization in how AI models are developed, documented and evaluated. This variability across models and applications further complicates efforts to make AI systems transparent and understandable (Ananny and Crawford, 2018).

Risks of malfunction, misinformation and bias in AI could have significant ethical and societal impacts. AI algorithms used in decision making processes can perpetuate biases present in historical data, leading to unfair outcomes and reinforcing systemic inequalities. In trade, biased AI systems can unfairly disadvantage certain groups or economies; for example, misclassifying businesses from specific regions as high-risk can limit market access for these businesses. In addition, while AI can optimize global supply chains, it may prioritize cost savings over ethical practices, leading to reputational risks and potential sanctions.

Addressing these challenges requires concerted efforts. It involves developing robust mechanisms for detecting and countering the spread of false information, ensuring transparency and accountability in AI algorithms, and promoting diversity and inclusivity in dataset collection and model development. In addition, it is crucial to carry out continual evaluations of the quality of training data for AI systems, including the adequacy of the data collection and selection processes, proper data security and protection measures, and feedback mechanisms to learn from mistakes and share best practices among all AI actors (UNESCO, 2021). Fostering digital literacy and critical thinking skills among users can help to mitigate the impact of misinformation and bias in AI-driven technologies.

(b) How will AI affect international trade?

This section discusses how AI may reshape the future of trade. It addresses questions as to how AI may be used to overcome trade costs, how it can alter the pattern of trade in services, how it can affect trade in certain goods, and how it may affect economies' comparative advantages.

(i) AI holds the potential to significantly reduce trade costs

AI can reduce trade costs by enhancing trade logistics, overcoming language barriers and minimizing search costs.

AI technologies are revolutionizing supply chain management by optimizing inventory management, demand forecasting and logistics. As illustrated in Figure 2.3, by collecting and analysing data from various sources, including Internet of Things (IoT) devices, AI systems can generate insights into historical data, market trends and external factors in order to predict demand, optimize inventory levels and improve order fulfilment. By using AI to facilitate real-time tracking and monitoring of shipments, it is possible to provide better visibility, resulting in a reduction in delays and an increase in efficiency. For example, AI enables commercial shipping companies to predict ship arrivals five days in the future with high accuracy, thus enabling real-time allocations of personnel and schedule adjustments.[7]

AI systems can eliminate language barriers by providing real-time translations. Various AI-driven language translation systems, powered by deep learning techniques, can provide real-time translation services, facilitating seamless communication between speakers of different languages regardless of their native tongue. Having this level of connectivity facilitates smoother negotiations and collaborations and the sharing of vital information, fostering stronger global ties. A study shows that the introduction of a new machine translation system in a digital platform has resulted in a remarkable 10.9 per cent increase in international trade between pairs of economies where people used this new system (Brynjolfsson et al., 2019).

AI systems have the capacity to enhance international communication. Through AI-driven virtual collaboration tools, including advanced video conferencing with features like noise cancellation and automatic transcription and translation, as well as virtual and augmented reality, seamless communication and collaboration among global teams and partners are facilitated. AI can significantly enhance the functionalities of information and communications technology (ICT) services, which can enable businesses to overcome geographical barriers and engage in real-time interactions, negotiations and decision-making processes, facilitating international trade and reducing the need for physical travel.

AI can significantly reduce search and match costs in trade by streamlining the process of identifying potential trading partners. AI-powered search algorithms can efficiently sift through vast amounts of data from various sources to identify potential trading partners, suppliers, buyers and distribution channels. AI-driven recommendation systems can analyse historical transaction data, user preferences and market trends to provide personalized recommendations for potential trade opportunities. AI-powered marketplace platforms can facilitate matchmaking, automate contract negotiations and optimize pricing strategies based on supply and demand dynamics.

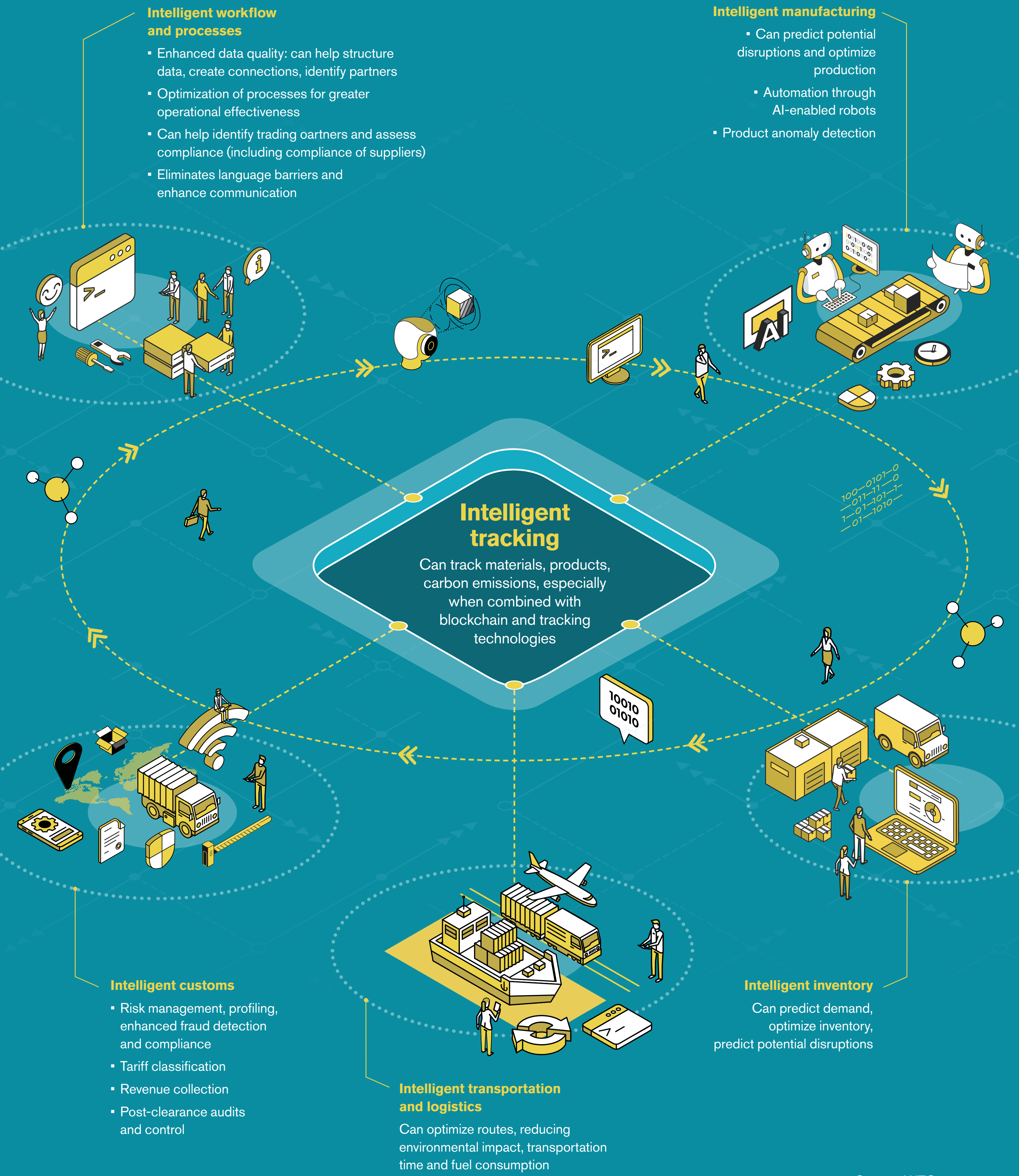
AI serves a multitude of purposes in customs and border controls

As huge volumes of data are generated by people and goods moving across borders, AI can be used for a range of purposes in customs and border controls. This includes optimizing revenue collection models to ensure accurate tax and duty collection, simplifying product classification under the Harmonized System (HS)[8] for enhanced compliance, facilitating faster anomaly identification during customs audits and enabling risk-based targeting of commercial shipments, for example using augmented/mixed-reality glasses for contraband detection (WCO-WTO, 2022).

Many customs administrations are using or plan to use AI. According to a survey by the World Customs Organization (WCO) and the WTO, 25 per cent of respondents currently utilize AI and machine learning in customs administration, with an additional 25 per cent intending to implement them. The primary reported benefits include improved risk management and profiling, enhanced fraud detection and compliance, and more effective customs audits for identifying anomalies (WCO-WTO, 2022). As discussed in detail in Box 2.2, AI can serve multiple functions in streamlining and improving the accuracy of customs processes.

AI-powered automated detection tools can greatly facilitate the work of customs officials. The application of AI to customs risk assessment enhances the security and efficiency of border crossings, allowing for the identification of potential risks and anomalies in shipments, and

Figure 2.3: How AI can enhance supply chain management



Source: WTO

Box 2.2: Case study: Harnessing AI for enhanced trade facilitation and border control at Dubai Customs

Dubai Customs has launched several projects leveraging AI to enhance trade facilitation and border control. For example, iDeclare allows travellers to submit their customs declarations electronically and securely. Passengers wishing to pre-declare goods can upload a photograph of the items to the application. The app then selects the appropriate HS code and determines whether and which customs duties are due. Complementing iDeclare is the AI Munasiq app, a tool that assists users in identifying the correct HS codes for their items. Once the user enters the item's description or photo, the app provides a ranked list of possible HS codes along with relevant information, such as the description of the item, applicable customs duty rate and any related prohibitions and restrictions.

Dubai Customs also launched the Robotic Process Automation Smart Refund System to automate the claim and refund processes. The system uses AI to perform repetitive office tasks, such as extracting data, filling in forms and moving files, and to match and validate transaction details with minimal human intervention, thereby improving transparency and reducing costs.

Post-clearance audits is another area where Dubai Customs is leveraging AI to enhance customs processes by automating the audit procedures for high-value import declarations. Several "bots" have been trained to automate repetitive processes, such as data matching, and to interpret data and identify patterns, leading to significant cost savings.

Last but not least, Dubai Customs has launched a remote inspection initiative that allows companies with the status of authorized economic operator – a status granted by customs authorities to companies meeting security and compliance standards, allowing them to benefit from expedited customs processes – to ask Dubai Customs to conduct inspections of their premises using AI-powered robots equipped with thermal and infrared cameras.

Looking ahead, Dubai Customs is exploring a wide range of additional AI applications, including automated threat detection algorithms, predictive analytics, AI-enabled drones for surveillance and machine vision systems for inspecting containers.

Source: Musabih (2023).

enhancing security and efficiency at borders. In Brazil, for example, an AI system known as SISAM ("Sistema de Seleção Aduaneira por Aprendizado de Máquina", or "Customs Selection System through Machine Learning") has been leveraging the vast customs database to analyse each newly registered import declaration in the country. This system aids customs officers in identifying potentially fraudulent customs declarations, thereby mitigating the risk of errors and enhancing compliance (WCO-WTO 2022).

AI also offers opportunities to streamline en route processes for customs clearance. For seaborne containers, automatic detection transforms customs inspection into a streamlined process, significantly increasing inspection rates without disrupting travel or trade. The Port of Qingdao in China, for example, has installed a modular high-energy inspection system that scans every container along the sky rail route that transports containers. This not only results in significant time savings and comprehensive security vetting, but also reduces the cost of container dispatching (Chen, 2022).

AI can assist in navigating trade regulations and enhancing supply chain visibility

AI can assist in navigating complex trade regulations and compliance requirements, improving the efficiency and effectiveness of government procedures. By facilitating information-gathering on regulation changes and automating compliance procedures, AI technology can help customs officials to stay abreast of evolving regulatory landscapes with greater ease and efficiency. It can augment currently deployed digital solutions and allow for deeper automation, leading to improved efficiency and effectiveness of government control measures. For legislators, AI has the potential to simplify public commenting processing on regulations and to improve the quality and richness of these comments.[9]

Regulatory agencies have increasingly been using AI to predict risks and improve import screening. For instance, the US Food and Drug Administration (FDA) employs the Predictive Risk-based Evaluation for Dynamic Import Compliance Targeting (PREDICT) system to enhance import screening and targeting. This system aims to prevent the entry of adulterated, misbranded or otherwise violative goods into the United States, while expediting the entry of compliant products. Similarly, in the European Union, AI developments are crucial for tracing illegal activities within the agri-food chain, particularly through the application of natural language processing. By leveraging AI to extract text from unstructured databases and documents, these technologies can effectively convert vast amounts of disparate data into structured, actionable intelligence.[10]

Box 2.3: Case study: Benefits and challenges to the use of AI for express delivery carriers

Express delivery carriers have been experimenting with AI to improve compliance, with two main objectives. The first objective is to better detect and challenge the undervaluation (with the aim of paying fewer or no duties or taxes) of declared goods, the misdeclaration of shippers or receivers, who wish thereby to bypass screening by the authorities, and incomplete or inaccurate goods descriptions, as well as shipments of counterfeit or pirated goods. The second objective is to validate client applications to open an account and to ensure that these clients represent a trustworthy individual or company.

Express delivery carriers are also using AI to improve processes. For example, by combining enhanced tracking information with external data about where a parcel is travelling, such as data about weather conditions, they can better predict shipment delivery or provide better real-time intelligence for merchants about fulfilment or returns.

Another application is testing AI-powered robots that have the ability to see, touch, analyse and move quickly to load trucks and trailers with stable, dense walls of randomized boxes.

The main benefits derived from the use of AI in these contexts include better compliance levels, which help to reduce time at borders and to build trust with customs and other authorities, as well as better data-driven insights across the company, which help to build more resilient, faster, and more precise and reliable supply chains.

Conversely, the main challenges that express delivery carriers are facing in deploying AI include the need to balance the most viable technologies with minimal infrastructure changes to ensure that solutions are customized for their business model. For instance, robotic solutions for warehouses with uniform boxes do not work in an express environment where there are variations in the size, weight, shape and packaging materials of boxes. Building the right ecosystem requires quality infrastructure, talent and regulatory environments.

Source: Based on information provided by the Global Express Association.

AI can also greatly reduce the cost of business in complying with trade regulations. Through advanced algorithms and machine learning capabilities, AI systems can sift through vast volumes of regulatory documents, interpret intricate legal language, provide translation services and highlight pertinent updates or amendments relevant to trade activities. As illustrated in Box 2.3, express delivery carriers have been using AI to improve regulatory compliance. By leveraging AI technologies, these carriers can more efficiently manage and adapt to changing conditions and the dynamic regulatory environment.

AI-based tools can also be used in trade finance, and they are particularly useful for credit assessment, risk evaluation and fraud detection. A multitude of data sources are analysed in AI models to identify the creditworthiness of a business and provide a more accurate risk profile by analysing financial records, market information and trade history. AI algorithms can also identify abnormalities and patterns that indicate fraudulent activities, thus assisting financial institutions in effectively mitigating the risks associated with those activities.

AI can significantly enhance supply chain visibility by providing real-time data analytics, predictive insights and automated decision-making processes. Through advanced algorithms and machine learning, AI can identify patterns and anomalies using vast amounts of data from various points along the supply chain. This enables companies to monitor inventory levels, track shipments and foresee potential disruptions with greater accuracy and speed. Moreover, as AI-powered tools can integrate data from disparate sources, they can offer a unified view of the supply chain, which can help to optimize logistics, reduce costs and improve overall efficiency. As illustrated in Box 2.4, enhanced visibility through AI not only facilitates better strategic planning but also supports more responsive and agile supply chain management. This could facilitate the compliance capabilities of micro, small and medium-sized enterprises (MSME) to meet international trade regulations.

Developing economies and small businesses benefit more from AI-enabled trade cost reductions

Lower trade costs enable developing economies to access global markets and participate in international trade. Historically, high trade costs, including tariffs, transportation expenses and administrative burdens, have created significant barriers for developing economies seeking to export goods and services. However, AI and other digital technologies can help to streamline trade processes and diminish these barriers.

Box 2.4: Case study: Using AI to improve supply chain visibility and traceability

Multinational companies often struggle with significant blind spots in their product value chains, as they may be unable to see beyond their direct suppliers. This lack of visibility can jeopardize the delivery and reliability of their highest revenue-earning products.

An AI-enabled value chain management system can address this issue by providing comprehensive insights into all production steps, from raw material extraction to final goods distribution. AI connects and learns from billions of data points, offering detailed insights into facility geolocations, vendor profiles, corporate ownership networks, product transformations and third-party risk analytics, including shipment dates, quantities, geolocations and values.

Interactive maps constructed by AI reflect the complexity of global supply chains, enabling proactive and reactive risk management. For example, in vaccine manufacture, AI is used to provide real-time identification of supply chain risks, such as exposure to current events and bottlenecks that could introduce vulnerabilities in the future. This capability allows for quick human coordination and effective utilization of system outputs.

In one instance, a pharmaceutical company used the AI-enabled value chain management system to identify the fact that a supplier who provides basic components to suppliers higher up the supply chain had filed for insolvency and ceased production after unsuccessfully restructuring its business. The company was able to mitigate the risk quickly by alerting upstream suppliers and sourcing replacement materials, thereby preventing a product shortage. In another case, a company faced a supply shortfall of a key plastic input for vaccine tubing. The AI-enabled value chain management system found that the company's direct supplier was a distributor, not a manufacturer, and that the disruption stemmed from an industry-wide plastic shortage. This insight helped the company address the root cause and seek alternative solutions.

AI can also enhance a company's ability to gain insights into its carbon footprint, promoting compliance with environmental, social and governance (ESG) requirements and sustainable transformation. According to a study by Boston Consulting Group (BCG), applying AI to corporate sustainability could generate up to US$ 2.6 trillion in value through additional revenues and cost savings by 2030.

Companies can use AI-powered data engineering to automatically track emissions throughout their carbon footprint and collect data from operations, from activities such as corporate travel and information technology (IT) equipment, as well as from every part of the value chain, including materials and components suppliers, transporters, and even downstream users of their products. AI can exploit data from new sources such as satellites, can generate approximations of missing data and can estimate the level of certainty of the results. Predictive AI can forecast future emissions across a company's carbon footprint. AI and optimization can improve efficiency in production and transportation, as well as in other areas, thereby reducing carbon emissions and cutting costs.

In summary, AI-driven systems can transform supply chain visibility and traceability, enabling companies to mitigate risks, respond proactively to disruptions and achieve sustainability goals, demonstrating the profound impact of AI on value chain management and driving both economic and environmental benefits.

Sources: Altana (2021) and Degot et al. (2021).

The reduction in trade costs levels the playing field for small businesses, helping them to overcome trade barriers and enter international markets. Small businesses often face challenges like limited market information, high transaction costs and complex trade regulations. AI-powered online marketplaces, digital marketing strategies and e-payment systems enable small businesses to establish a global presence, form partnerships with overseas suppliers and distributors, and expand their customer base. AI applications can automatically analyse, process and verify data and provide integrated services for SMEs, including automated processing with classification algorithms, error and fraud detection through anomaly detection, and capacity planning using regression and forecasting (UNECE, 2021).

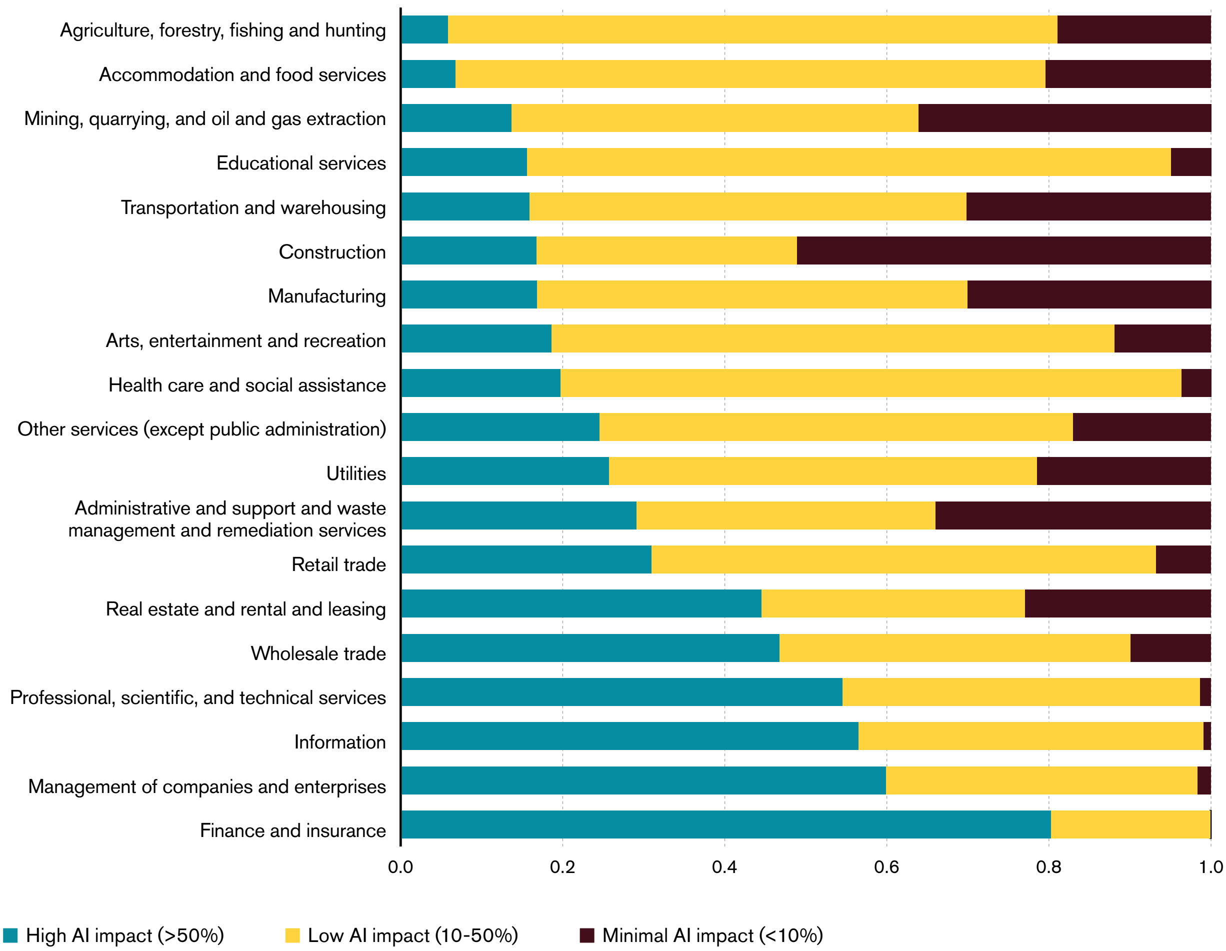
(ii) The most significant trade impact of AI will be on trade in services

AI can boost productivity in certain services sectors

AI can enhance productivity, particularly in services sectors that rely on manual processes. In these sectors, AI can significantly complement humans in improving efficiency, accuracy and the level of personalization (i.e., the ability to tailor products, services, or experiences to meet individual preferences). Initial analysis suggests that significant productivity gains are evident in sectors related to finance and insurance, management, information, and professional services (Figure 2.4).

Recent research indicates that AI can substantially enhance productivity, particularly for low-skilled workers, by leveraging best practices from other workers. With access to a large language model (LLM), it is estimated that about 15 per cent of all worker tasks in the United States could be completed significantly faster at the same level of quality. When incorporating software and tooling built on top of LLMs, this share increases to between 47 per cent and 56 per cent of all tasks (Eloundou et al., 2023). Within its operational scope, generative AI can amplify the performance business consultants by up to 40 per cent compared to those not utilizing it (Dell'Acqua et al., 2023). A study of 5,000 workers responsible for complex customer assistance at a call centre found that, among workers who were given the support of an AI assistant, the least skilled or newest workers showed the greatest productivity gain (Brynjolfsson et al., 2023), while university-educated professionals utilizing ChatGPT were more productive, efficient and satisfied with their tasks. Notably, individuals with weaker skills derived the greatest benefits from using ChatGPT (Noy and Zhang, 2023).

Figure 2.4: AI can complement and enhance productivity in some occupations



Source: Author's elaboration based on an automation index developed by Eloundou et al. (2023).

Note: The figure shows the share of employment exposed to AI. High AI impact refers to sectors where the sector-level automation index is 50 per cent or higher, low AI impact ranges between 10 per cent and 50 per cent, and minimal impact is less than 10 per cent.

AI can also foster the development of innovative services, and boost demand for them

AI's capacity to derive valuable insights from extensive datasets is instrumental in fostering the development of innovative services. In healthcare, for example, AI applications can significantly advance drug discovery and treatment methodologies, and may ultimately facilitate the development of personalized healthcare solutions tailored to individual patients. Similarly, AI-driven smart energy management systems can integrate real-time sensor data, weather forecasts, energy demand projections and equipment degradation profiles to provide dynamic simulations, enabling energy companies to make informed, proactive decisions. These systems optimize energy use, reduce consumption and cut carbon emissions, resulting in cost savings and improved sustainability.

In addition to fostering new discoveries, AI can also enable customization of services to suit specific preferences and use cases. By analysing vast amounts of data to identify patterns and preferences, AI can allow for tailored solutions and adapt its outputs to meet the unique preferences of users. Examples include personalized e-commerce recommendations, customized healthcare treatments or individualized media content recommendations. This customization not only enhances user satisfaction, but also enables the delivery of more targeted and effective products and services across various industries.

As AI becomes more integrated into daily life, services that leverage AI capabilities to enhance convenience, efficiency and personalization are rising in demand. For instance, advancements in autonomous vehicles have paved the way for transportation services such as ride-hailing platforms – matching passengers with drivers for hire via online platforms – and delivery platforms, which rely heavily on AI algorithms to optimize routes, manage fleets and ensure safety. The rise of AI-powered virtual assistants, smart home devices and personalized recommendation systems has fuelled demand for subscription-based streaming services. AI-powered recommendation systems in e-commerce platforms suggest products based on users' past purchases and browsing history, driving increased sales and customer engagement.

By bolstering productivity and increasing demand, AI can boost services trade

Increased productivity allows for greater output using existing resources, thereby lowering production costs. This phenomenon can spur heightened levels of trade across diverse services sectors. Enhanced productivity and innovation capacity can translate into increased trade in certain services, leading to expanded trade volumes and enhanced economic interconnectedness on an international scale. As Richard Baldwin argues in his opinion piece, AI could boost services trade in the future.

Moreover, AI is shown to significantly enhance trade in digitally delivered services. By enabling the development of more diverse mobile phone applications, AI has been shown to increase the number of foreign users of AI-driven mobile applications by an average of tenfold (Sun and Trefler, 2023). Similarly, the projections using the WTO Global Trade Model indicate that services in sectors such as education, human health, recreation and finance could potentially undergo significant trade growth (see Section 2(b)(v)).

AI can automate and reduce the demand for trade in certain services

AI may contribute to reducing the demand for certain traditional services, as AI-driven automation can lead to increased efficiency and productivity. For instance, AI-powered legal research tools and contract review systems can automate some tasks traditionally performed by legal professionals, potentially reducing the demand for certain legal services, especially in routine tasks like document analysis and discovery (OECD, 2024b). AI chatbots and virtual agents have diminished the need for large customer service teams (see Box 2.5 on AI and jobs).

AI-enabled automation can reduce the necessity to outsource certain services. According to recent surveys, companies have been using AI to streamline manual or repetitive tasks and automate customer service interactions (IBM, 2024). As a result, AI could reduce the need for large call centres and business process outsourcing, services that many companies in developed economies often source overseas (Parkin and Kay, 2024). This could significantly impact developing economies, many of which specialize in these types of services.

(iii) The emergence of AI will increase demand and trade in AI-related products

The adoption of AI technology is spurring demand for complementary goods related to ICT infrastructure and IT equipment. As illustrated in Figure 2.5, the AI value chain involves a range of products and services, and the rise of AI is likely to increase international trade in goods and services related to that value chain.

AI applications, especially those involving deep learning and neural networks, often require high-performance computing systems to train complex models and perform intensive computations. Demand is rising sharply for hardware components of AI, such as high-performance CPUs (central processing units) and GPUs (graphics processing units) and specialized AI chips, as well as switches and routers, which ensure fast data transfers between systems. The global market for AI chips

Opinion piece

AI means that services will be the future of trade

Richard Baldwin

Professor of international economics at the IMD Business School

Global trade has long been dominated by manufactured goods, but, as Bob Dylan sang back in 1964, "The Times They Are a-Changin'."

World exports of goods and services enjoyed boomtime growth in the 1990s and early 2000s. Since 2008, trade in goods – specifically manufactured goods – have plateaued; services exports have not. Services trade continues to ride the go-go growth path it has been on since the 1990s.

Digital technologies in general, and AI in particular, are why the times are a-changing, in my view. There are many reasons why manufactured trade slowed a decade and a half ago. This short essay skips over those reasons and jumps straight to how AI has spurred – and will continue to spur – services trade.

Digital technology, including communications, video conferencing and AI-driven machine translation, have rapidly lowered barriers to trade in services. The changes that came with telework during the COVID-19 pandemic accelerated this trend by five to ten years.

The main expansion has come in "intermediate services", which are the services sold by one business to another rather than to consumers. The ability to coordinate work teams across different locations seamlessly has made it feasible for companies in high income economies to source services from emerging markets. For example, a US accountant might hire a bookkeeper in India to manage day-to-day accounting tasks. This arrangement is facilitated by digital tools that make remote collaboration easy, cost-efficient and secure.

Looking ahead, I see services trade growing faster than goods trade for the foreseeable future. I base this conjecture on four facts.

First, barriers to intermediate services trade are technological, since there is almost no regulation of trade in back-office services. Second, digital technology is lowering these barriers at an exponential pace. Third, AI such as machine translation, and soon simultaneous speech translation, are rapidly making domestic and foreign workers better substitutes than they were in the past. Generative AI (GenAI), I believe, will accelerate this, since it levels up skills. GenAI distils the experience of a rich-nation services worker into an app and then gives the app to emerging economy services workers. The output of these low-wage workers will look a whole lot more like that of G7 services workers when both G7 and emerging economy workers are using the same GenAI apps.

Finally, the demand for intermediate services is huge in rich nations and the supply of appropriate workers is huge in emerging economies, since they are already providing these services in their local economies.

What does all this mean? It is essential to recognize that services – not goods – will be at the forefront of global trade in coming years. The WTO Secretariat needs to get ready since, "The Times They Are a-Changin'".

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was valued at US$ 61.5 billion in 2023 and it has been projected that it could reach US$ 621 billion by 2032 (S&S Insider, 2024).

As AI systems often rely on real-time data streams and seamless connectivity, the demand for ICT and network equipment will increase. Equipment such as routers and switches is necessary to ensure high-speed internet connectivity and support AI-driven applications and services. Hardware components like storage servers are crucial to manage efficiently and access the vast amounts of data required by AI systems. Fibre optic cables are essential for high-speed data transmissions over long distances. Sensors and actuators used in robotics and IoT applications are also in high demand.

AI will also boost demand for computer and telecommunications services, including software- and data-related services, as well as cross-border trade and investment in these sectors. Services to

Box 2.5: How will AI impact jobs?

Unlike previous waves of technological transformation, AI is poised to impact white-collar jobs more significantly than blue-collar ones. Historically, automation primarily affected manual labour and manufacturing jobs. However, AI's capabilities extend into areas traditionally occupied by white-collar workers, such as finance, legal services, and administrative roles (Autor, 2022).

This shift means that roles involving cognitive work, which were once considered more secure from automation, are increasingly vulnerable to AI technologies that can perform these tasks faster and with greater accuracy. Some economists argue that AI advances are unlikely to increase inequality as much as previous automation technologies because their impact is more equally distributed across demographic groups, but there is also no evidence that AI will reduce labour income inequality (Acemoglu, 2024).

Advanced economies, particularly those with high levels of automation and technology adoption, are more likely to experience significant impacts from AI. In economies with developed financial, legal and technological sectors, the integration of AI into these industries could lead to substantial changes in job dynamics. IMF research suggests that AI could endanger 33 per cent of jobs in advanced economies, 24 per cent in emerging economies, and 18 per cent in low-income economies (Cazzaniga et al., 2024). A study by the International Labour Organization (ILO) predicts that the overwhelming effect of the technology will be to augment occupations, rather than to automate them, and the greatest impact is likely to be in high and upper middle-income economies, due to a higher share of employment in clerical occupations (Gmyrek et al., 2023).

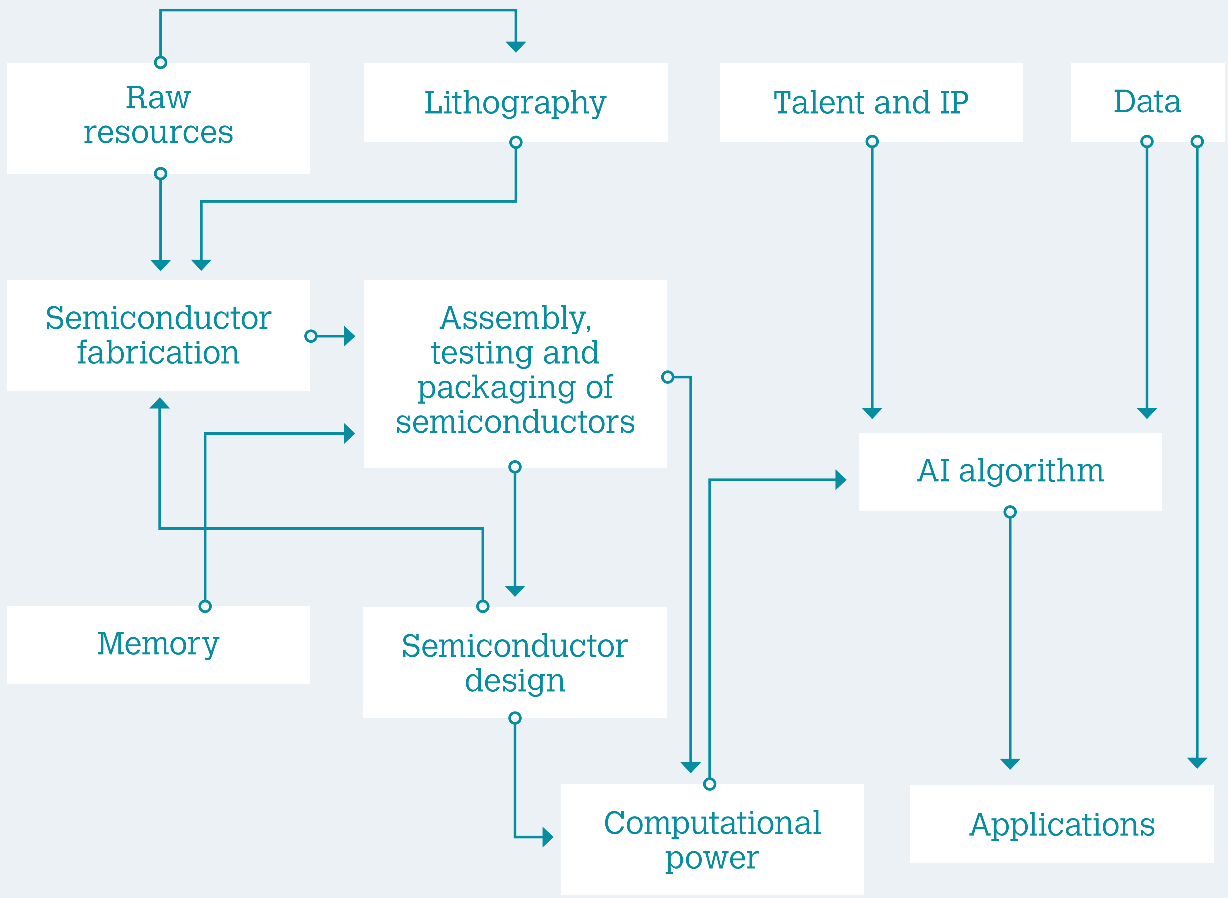
The impact of AI on jobs in advanced economies could exacerbate existing inequalities and make it necessary to develop substantial adaptation strategies. AI has the potential to reshape income distribution by decreasing the labour share and increasing the returns on capital. As AI and automation become more integrated, the value created by human labour may be diminished compared to that generated by capital investments. This shift would benefit those who own capital and intellectual property (IP), or who have invested in AI-driven enterprises, and thus it would further enrich already wealthy segments of society. The concentration of wealth and power in the hands of a few could undermine democratic principles and deepen existing power imbalances within society.

In response to these challenges, policymakers must proactively address the potential consequences of AI on income inequality. This may involve implementing measures such as retraining programmes to equip displaced workers with skills relevant to the evolving job market, fostering inclusive economic growth through investments in education and infrastructure, and reevaluating taxation policies to ensure a fair distribution of the gains generated by AI. In addition, promoting innovation and entrepreneurship among marginalized communities could help to mitigate the adverse effects of AI-induced income inequality while fostering a more equitable society.

access, transmit, store and process data and to perform intensive computations are essential to AI development and deployment. These services include cloud computing, which provides the necessary online infrastructure and platforms for developing and running AI applications; AI model development services, which offer tools and platforms for creating, training and deploying AI systems; data services to gather, clean and label data needed to train AI models; and security services to protect AI systems and data from cyber threats.

AI can increase the demand for specialized development tools and software libraries. As the demand for AI models has experienced a notable surge in recent years, the frameworks designed to streamline the development, testing and deployment of AI models and applications are also increasing. These include integrated development environments (IDEs), machine learning libraries and AI platforms that simplify the implementation of AI algorithms and workflows. Software for designing specialized AI semiconductors is also in high demand.

Figure 2.5: The AI value chain



Source: World Economic Forum (2024b).

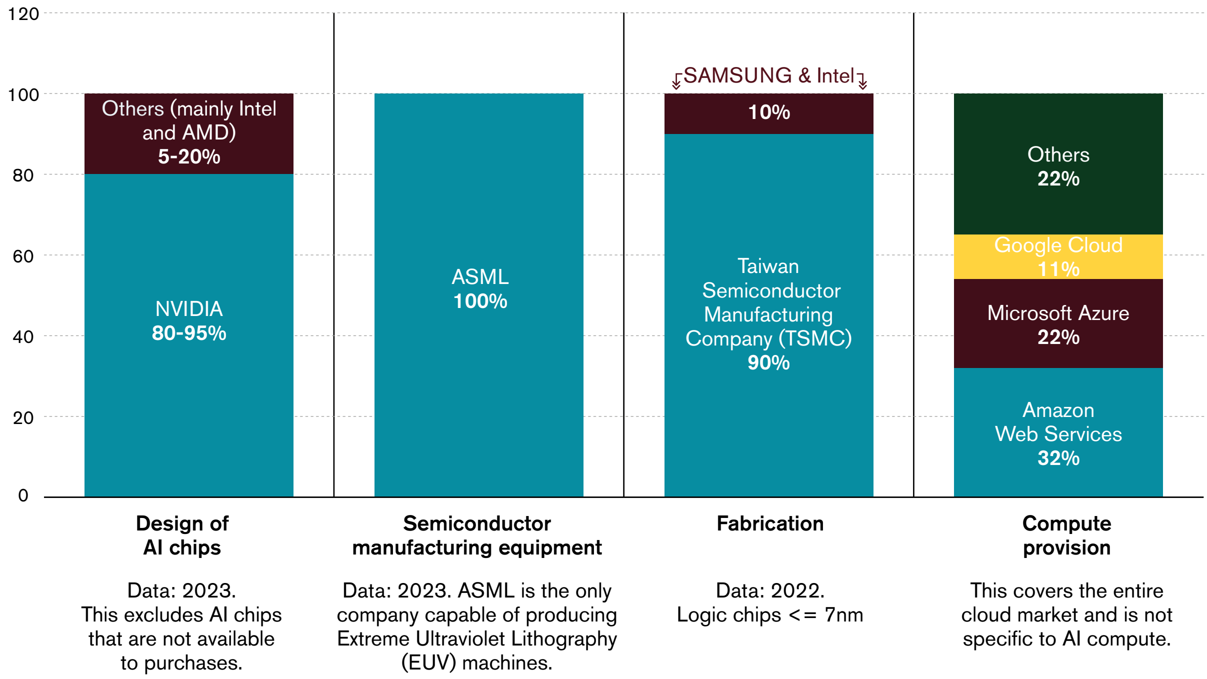
Many of these goods and services are often supplied by a small number of economies. International trade therefore serves as an important channel to foster AI development worldwide. The production of AI technologies is heavily concentrated within a globally integrated supply chain. As indicated in Figure 2.6, alongside the concentration of AI models, various stages of AI production, including AI chip design and manufacturing, are dominated by a small number of suppliers, with some critical steps having fewer than three suppliers (Sastry et al., 2024). This concentration augments risks to the supply chain, including vulnerabilities stemming from export controls and potential cyber threats (Miller, 2022; World Economic Forum, 2023).

Upstream of the value chain, trade in the extraction and processing of critical metals and minerals, as well as in energy, is also likely to rise. Advanced AI chips require elements like neodymium, cerium and praseodymium. The growth of the AI chip industry is inseparably linked to the production and supply of rare earth metals. As this industry evolves, understanding the dynamics of rare earth production becomes ever more critical. These metals and minerals are geographically concentrated, with China (35.7 per cent), Brazil (17 per cent) and Russia (15.7 per cent) hosting the largest reserves yet discovered of rare earths (BP, 2022). As these resources are essential for the production of various technologies, the demand for trade in these products is expected to continue to rise. Furthermore, as AI is increasingly integrated into various sectors, the demand for energy to power these systems is projected to escalate further.

AI has substantially heightened the demand for data, fundamentally reshaping the landscape of data usage and trade. Data assumes a dual role in the production of AI technology, serving both as an input and an output. Given that AI systems rely heavily on data, the demand for high-quality, diverse datasets has surged and will continue to surge. International flows of data are crucial for accurate, complete and representative datasets to feed into AI systems (Aaronson, 2023).

Figure 2.6: Concentration of the AI chip supply chain

(percentage)



Source: Sastry et al. (2024).

(iv) AI can reshape economies' comparative advantages

AI can reshape comparative advantages by affecting productivity

AI is expected to enhance productivity across all sectors in the global economy. Although the productivity impact of AI is more pronounced in the services sector, other economic sectors can also expect productivity growth. In agriculture, AI applications can be employed to forecast weather patterns and optimize resource management. In manufacturing, AI advancements can significantly improve efficiency by automating and optimizing routine processes and tasks, optimizing material and energy usage, and enhancing the accuracy of predictions and forecasting (World Economic Forum, 2022).

The impact of generative AI on productivity could be significant. McKinsey (2023) estimates that generative AI could add the equivalent of between US$ 2.6 trillion and US$ 4.4 trillion annually. Goldman Sachs (2023) estimates that widespread adoption of generative AI could raise overall labour productivity growth by around 1.5 per cent per year over a decade, a similar boost to what occurred with previous transformative technologies such as the electric motor and personal computer. However, a more recent study by Acemoglu (2024) predicts a somewhat more moderate increase in total factor productivity, ranging between 0.55 per cent and 0.71 per cent over a 10-year period.

The widespread use of AI has the potential to boost productivity significantly in both developed and developing economies. Although the development of AI is likely to remain concentrated in a few large economies, the cost of AI use and application in specific domains is relatively low. This will allow developing economies to leverage AI to improve productivity, enhance efficiency, access better public services and reduce costs. Examples include AI-driven learning systems that enable individualized learning at relatively low cost (Muralidharan et al., 2019), the use of LLMs and speech recognition software to assist illiterate farmers in applying for government loans (Yee, 2023), and the implementation of AI to improve healthcare delivery and diagnosis in Africa (Owoyemi et al., 2020).

AI can redefine the comparative advantage of economies through shifts in production dynamics

AI may not only enhances productivity, but also reshape the composition of inputs required for production, leading to a greater emphasis on capital investment relative to labour inputs. As AI technologies become more advanced and widespread, businesses are likely to invest heavily in AI driven automation and intelligent systems that can enhance productivity, efficiency and decision-making processes. This shift may lead to a reduced reliance on human labour, particularly for routine and repetitive tasks, thereby increasing the capital intensity of production.

This shift in production dynamics has the potential to reshape trade patterns. The wide adoption of AI could devalue the comparative advantage of economies abundant in unskilled labour, which may lack the capability to utilize AI effectively. In contrast, advanced economies benefiting from higher AI intensity, driven by higher wages and capital, may experience greater gains. Internationally mobile capital may be drawn towards advanced economies, leading to transitional GDP declines in developing economies (Alonso et al., 2022).

Conversely, new sources of comparative advantage may emerge from educated labour, digital connectivity and regulation. The ability to leverage AI for development critically depends on economies' readiness to use the technology, which includes factors such as digital infrastructure, human capital, innovation and regulation (Cazzaniga et al., 2024). Digital infrastructure and human capital can be considered foundational elements of AI preparedness, because they are prerequisites for its adoption. Innovation and regulation can be considered additional elements likely to influence the ability to develop AI and maximize its economic impact.

As AI is energy-intensive, and many firms are seeking to decarbonize, economies with abundant renewable energy may also have a comparative advantage. As noted in Box 2.1, the International Energy Agency (IEA) estimates that electricity consumption associated with data centres, cryptocurrencies and AI represented almost 2 per cent of global energy demand in 2022, and that energy demand for these uses could double by 2026 (IEA, 2024). To move towards net zero greenhouse gas emissions, companies are developing strategies to rely on renewable energy for AI. Therefore, economies capable of generating renewable energy may have a comparative advantage for hosting data centres and AI infrastructure.

The development and control of AI technology are likely to remain concentrated in large economies and companies

The substantial upfront investment in AI often results in increasing returns to scale. AI development fundamentally depends on ICT infrastructure performance, specialized hardware and extensive data storage systems, all of which require substantial upfront investment. As AI models advance, and their development costs escalate, the up-front costs of developing AI models increase. For instance, training ChatGPT-3 reportedly required over US$ 4 million, while GPT-4's development reportedly surpassed US$ 100 million, and the operation of ChatGPT alone has been estimated to incur US$ 700,000 per day in computer costs. The exorbitant costs associated with AI development can act as barriers, hindering smaller entrants from penetrating the market, and resulting in market concentration.

Large corporations often have extensive numbers of users and consequently vast pools of data with which to train AI algorithms. As more users interact with AI systems, they generate more data, and this in turn improves the performance and effectiveness of the AI algorithms. This positive feedback loop enhances the value of the AI system for existing users, while also attracting new users, who then contribute to the growing pool of data, setting off a feedback loop wherein dominant players attract more users, generate more data and further refine their AI systems, solidifying their market dominance. This dynamic represents a significant hurdle for newcomers and smaller enterprises, which typically lack the resources to gather, manage and safeguard such extensive data. Consequently, smaller competitors face increasing difficulties in developing AI capabilities of comparable scale and sophistication (OECD, 2021; West, 2023). This may lead to a market landscape dominated by a select few major players (Lee, 2024).

Several studies also demonstrate that big data and AI have resulted in industrial concentration. For instance, Begenau, Farboodi and Veldkamp (2018) suggest that access to big data in finance has reduced the cost of capital for large firms relative to smaller ones, leading to increased firm-size inequality. Firooz et al. (2022) provide evidence that the development of automation technology has contributed to the dominance of superstar firms over the past two decades. These findings highlight the influence of big data and AI on market dynamics and how they may consolidate power among dominant players in various industries.

(v) Projection of the impact of AI on trade

The WTO Global Trade Model was employed to project the potential impact of AI on international trade patterns. This is a recursive dynamic computable general equilibrium (CGE) model which enables long-term projections until 2040. Based on insights from the literature and from WTO empirical work, two sets of shocks relative to a baseline without AI were introduced, i.e., increases in labour productivity and reductions in trade costs. It is anticipated that AI will impact trade costs through three main channels: improved logistics, diminished compliance costs and reduced language barriers. Four scenarios that differ along two dimensions were considered: the size of the productivity impact of AI (optimistic or cautious) and the scope for convergence between economies and between workers with different skills (synergy or divergence). When combined, this leads to the four scenarios outlined in Table 2.1. Technical details on the construction of the scenarios are presented in Annex 2:

- Optimistic global synergy: High productivity growth with universal AI adoption
- Optimistic tech divergence: High productivity growth with uneven AI adoption

Table 2.1: Summary of scenarios

	Global synergy	Tech divergence
Optimistic scenario	High average global productivity increase, based on Goldman Sachs (2023) estimate;	High average global productivity increase, based on Goldman Sachs (2023) estimate;
	Uniform productivity increase across economies;	Productivity increase differs by region according to AI preparedness;
	Middle-skilled workers raise productivity more than high-skilled workers;	High-skilled workers raise productivity more than middle-skilled workers;
	All regions implement trade cost reductions through AI equally.	Trade cost reductions account for regional differences in AI preparedness.
Cautious scenario	Low average global productivity increase, based on Acemoglu (2024);	Low average global productivity increase, based on Acemoglu (2024);
	Uniform productivity increase across economies;	Productivity increase differs by region according to AI preparedness;
	Middle-skilled workers raise productivity more than high-skilled workers;	High-skilled workers raise productivity more than middle-skilled workers;
	All regions implement trade cost reductions through AI equally.	Trade cost reductions account for regional differences in AI preparedness.

Source: WTO.

- Cautious global synergy: Low productivity growth with universal AI adoption
- Cautious tech divergence: Low productivity growth with uneven AI adoption

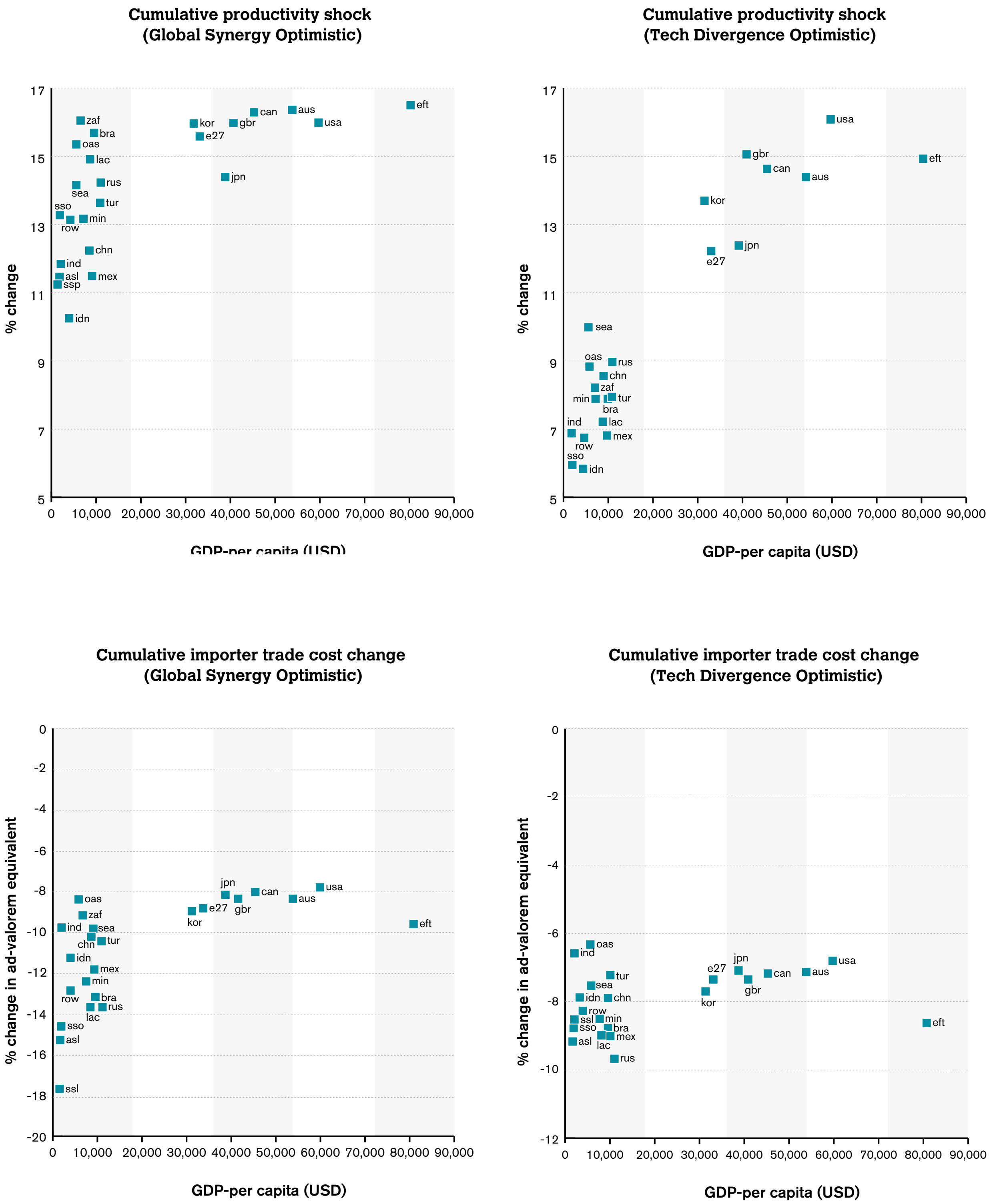
While high-income economies are expected to see the largest productivity gains, trade cost reductions can favour low-income economies. As shown in the upper panel of Figure 2.7, productivity increases are particularly significant in higher-income economies, due to their greater AI preparedness and specialization in AI-intensive sectors. The bottom panel highlights that trade cost reductions can be negatively correlated with current income level. This is particularly pronounced in the global synergy scenario, showing that lower-income economies have more potential to reduce trade costs.

Trade growth is projected to be highest in the optimistic global synergy scenario, with real trade growth increasing by nearly 14 percentage points by 2040. Figure 2.8 illustrates the impact of AI on global trade, comparing cumulative trade growth rates with and without AI over this period. The highest global trade growth is projected for the optimistic global synergy scenario. Furthermore, productivity growth and trade cost reductions contribute equally to trade growth in the optimistic scenarios, whereas projected productivity increases are smaller in the cautious scenarios, and trade cost reductions play a larger role in driving trade growth. AI is also expected to boost real global GDP by 11 per cent until 2040 (see Annex 2 for further details).

The global trade impact of AI varies significantly across economies and sectors. Figure 2.9 illustrates the projected trade changes due to AI across four income groups: low-income, lower middle-income, upper middle-income and high-income economies. The results show that, under the global synergy scenario, low-income economies experience much higher trade growth compared to the tech divergence scenario, while trade growth in high-income economies remains relatively stable across scenarios.

Digitally delivered services are expected to experience the highest trade growth, while other sectors will also benefit. Figure 2.10 compares the projected trade growth across four aggregate sectors: primary (agriculture and mining), secondary (manufacturing), tertiary digital (digitally delivered services) and tertiary other (other services). AI is projected to benefit the digitally delivered services the most, while agricultural goods are expected to see the smallest increase in exports. Digitally delivered services are projected to see the largest increases, with a cumulative growth of nearly 18 percentage points in the optimistic global synergy scenario.

Figure 2.7: Cumulative trade cost reductions (by importer) and productivity improvements (%) in global synergy and tech divergence scenarios



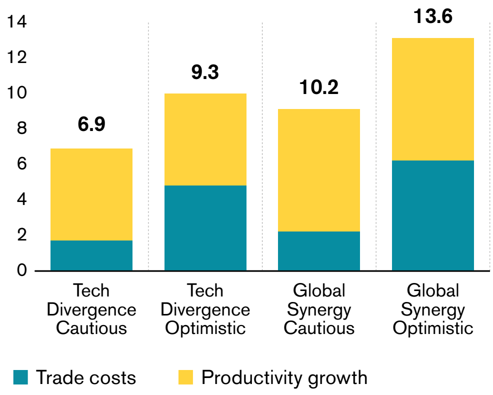
Source: Simulation results based on the WTO Global Trade Model.

Note: The figure represents the relationship between GDP per capita in 2017 and projected cumulative trade cost reduction as ad valorem equivalents over 2018-40 and productivity increases over 2027-40 according to the optimistic global synergy and tech divergence scenarios. Each marker represents a region.

The expected impact of AI on real trade growth differs within sectors. As shown in Figure 2.11, in the optimistic global synergy scenario, digitally delivered services such as education, health, recreational and financial services, as well as manufacturing sectors, such as processed food, are projected to experience significant trade growth, largely driven by trade cost reductions. Conversely, sectors related to natural resource extraction (e.g., petroleum and oil) and manufacturing sectors, such as textiles and computer, electronic and optical products, are expected to see limited growth due to AI.

Figure 2.8: Cumulative global real trade growth rate (2023-40)

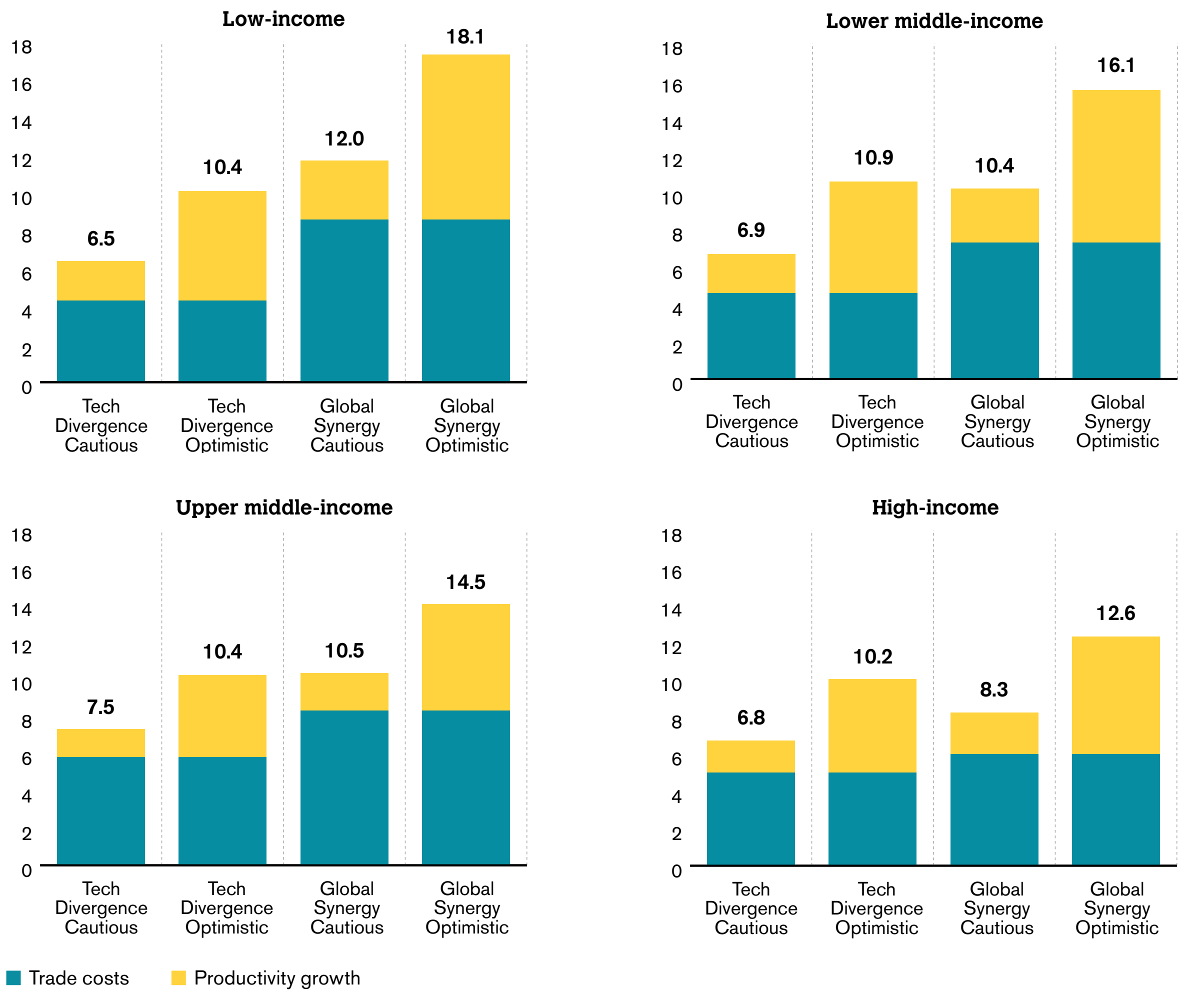
(Difference to baseline, percentage points)



Source: Simulation results based on the WTO Global Trade Model.

Note: This figure demonstrates the impact of policy shocks on projected cumulative global real trade growth (in percentage points) over the period 2023-40 across four policy scenarios. The values represent deviations from the baseline scenario. The yellow and blue bars represent the effects of trade cost reduction and productivity growth respectively, and the values above the bars indicate the total effect.

Figure 2.9: Cumulative regional real export growth rate (2023-40) (Difference to baseline, percentage points)

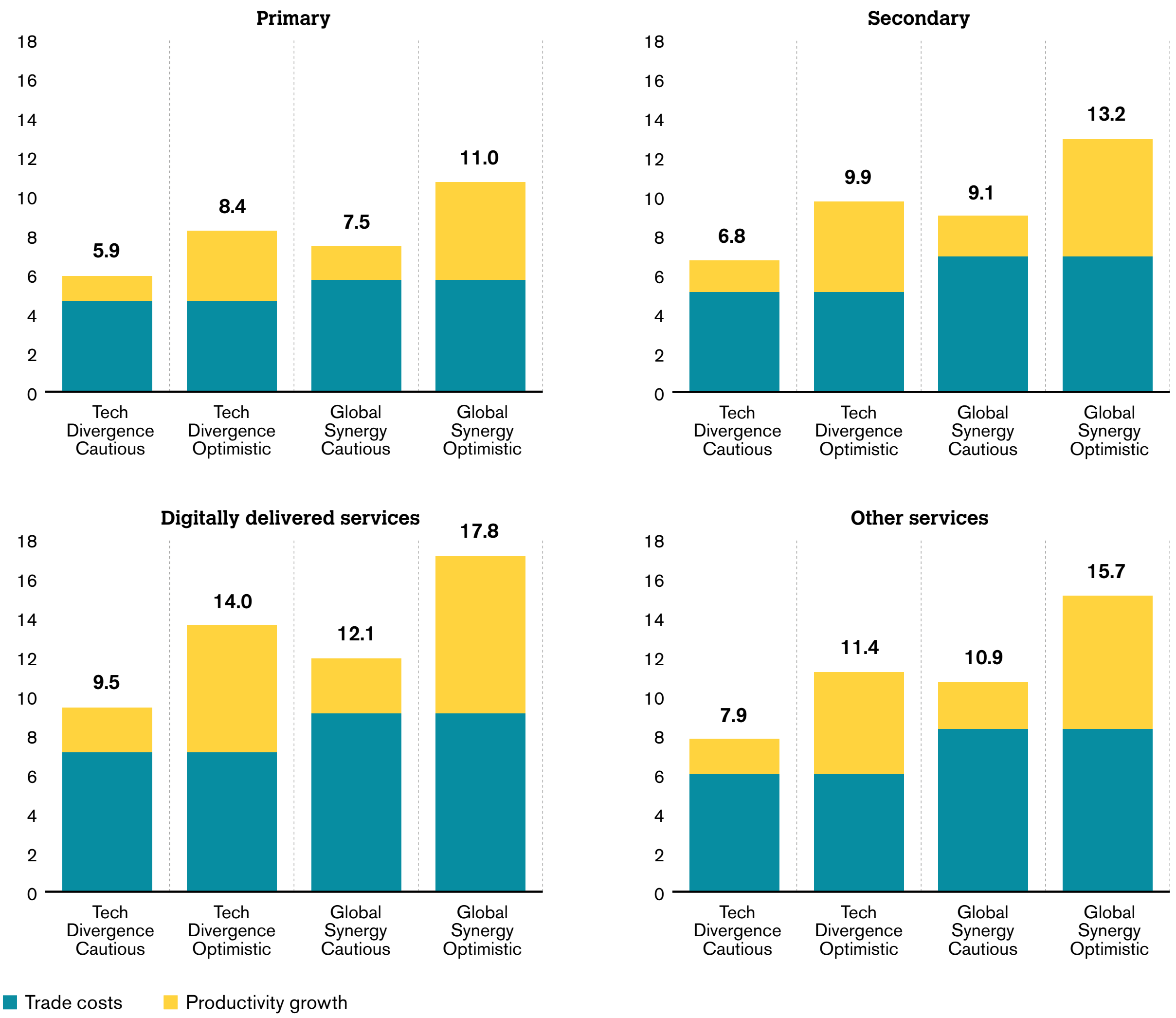


Source: Simulation results based on the WTO Global Trade Model.

Note: This figure demonstrates the impact of AI on projected cumulative regional real exports growth (in percentage points) over 2023-40 in four policy scenarios. The yellow and blue bars represent the effects of trade cost reduction and productivity growth respectively, and the values above the bars indicate the total effect, compared with the baseline scenario.

Figure 2.10: Cumulative sectoral real exports growth rate (2023-40)

(Difference to baseline, in percentage points)



Source: Simulation results based on the WTO Global Trade Model.

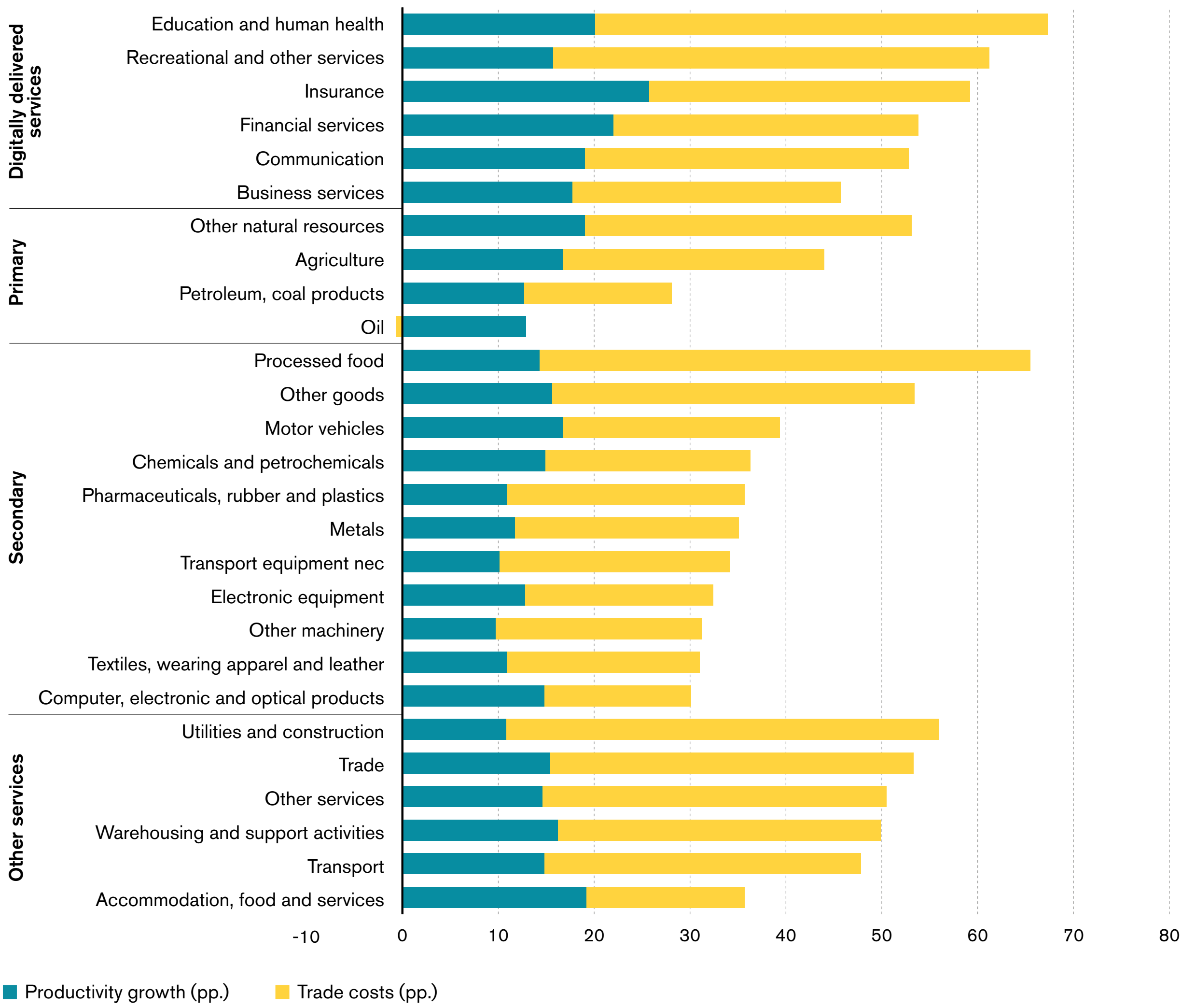
Note: This figure demonstrates the impact of AI on projected cumulative sectoral real exports growth (in percentage points) over 2023-40 in four policy scenarios. The yellow and blue bars represent the effects of trade cost reduction and productivity growth respectively, and the values above the bars indicate the total effect, compared with the baseline scenario.

The varying trade projections across scenarios underscore the critical role of policy in leveraging AI for trade. A key difference between the global synergy and tech divergence scenarios is the ability of developing economies to adopt AI. Developing economies that improve their AI preparedness, by enhancing digital infrastructure, upgrading skills, and boosting innovation and regulatory capacities, can significantly enhance their ability to leverage AI effectively. In addition, directing AI innovation toward benefiting the productivity of middleskilled workers could further help lower-income economies to close the trade and income gap.

While the projections are informative, several caveats must be noted. First, the adoption of AI necessitates investments in digital infrastructure, which could affect trade patterns through the export of intermediate goods and services like semiconductors and telecommunications. However, this impact is not captured in the projections. Second, the scenario in which productivity increases more for middle-skilled workers than for high-skilled workers is inspired by arguments from scholars such as David Autor and Richard Baldwin, who suggest that AI could help rebuild the middle class. (Autor, 2024; Baldwin, 2024). This should ideally be grounded in quantitative analysis. Third, AI may lead to the substitution of labour with capital and intangible assets. Although this effect is not considered in the model, it is expected to primarily impact wages rather than trade projections. Finally, the model assumes no emergence or disappearance of products or tasks due to AI. However, AI could lead to structural changes in the economy, creating new goods and services or rendering some obsolete.

Figure 2.11: Cumulative real trade growth (2023-40) in the optimistic global synergy scenario

(Compared to baseline, percentage points)



Source: Simulation results based on the WTO Global Trade Model.

Note: This figure demonstrates the impact of AI on projected cumulative sectoral real exports growth (in percentage points) over 2023-40 in the optimistic global synergy scenario, compared with the baseline scenario. The yellow and blue bars represent the effects of trade cost reduction and productivity growth respectively; "nec" is "not elsewhere classified". "pp" is "percentage points".

Endnotes

1 See https://www.iso.org/standard/74296.html, Section 3.1.4. Definitions used in this report are without prejudice to the views of WTO members.

2 The issue of the military use of AI is beyond the scope of this report. However, recently, there have been various international and domestic debates, initiatives and proposals on this matter. See for instance the Proposal for a UN General Assembly Resolution on "Lethal Autonomous Weapons Systems (LAWS)" (A/C.1/78/L.56, 12 October 2023) and the United States' "Political Declaration on Responsible Military Use of Artificial Intelligence and Autonomy" (9 November 2023). On Lethal Autonomous Weapon Systems (LAWS), see more broadly https://disarmament.unoda.org/the-convention-on-certain-conventional-weapons/background-on-laws-in-the-ccw/.

3 However, as nanomaterials can also pose health and environmental challenges (e.g., concerning the end of life of products containing them), the special role of regulations and policies to ensure that such risks are addressed must be stressed.

4 Examples include decarbonizing carbon-intensive sectors, such as agriculture, by optimizing production methods that reduce the emission of methane and nitrogen oxides, as well as enabling the production of new kinds of sustainable materials and products, such as algae-based advanced biofuels, synthetic fabrics such as "micro-silk", and bio-based durable packaging materials (Webb and Hessel, 2022).

5 See https://www.intel.com/content/www/us/en/homepage.html.

6 See https://www.ibm.com/topics/explainable-ai.

7 See https://gatehousemaritime.com/solutions/software-solutions/real-time-vessel-tracking/.

8 See https://www.wcoomd.org/en/topics/nomenclature/overview/what-is-the-harmonized-system.aspx.

9 See the Moderator's Report from the November 2023 Thematic Session on the "Use of Digital Technologies and Tools in Good Regulatory Practices" at the WTO Committee on Technical Barriers to Trade (https://www.wto.org/english/tratop_e/tbt_e/tbt_0711202310_e/tbt_0711202310_e.htm).

10 Information summarized from presentations at the WTO Committee on Sanitary and Phytosanitary (SPS) Measures thematic session on digital tools on 25 June 2024 (https://www.wto.org/english/tratop_e/sps_e/sps_2506202410_e/sps_2506202410_e.htm).

3 The policies of AI and trade

(a) AI and trade: key policy considerations

The discussion of how AI might reshape international trade raises important policy questions. The future of AI and international trade hinges on the policy choices of governments and on the strategies and priorities of industries and businesses.

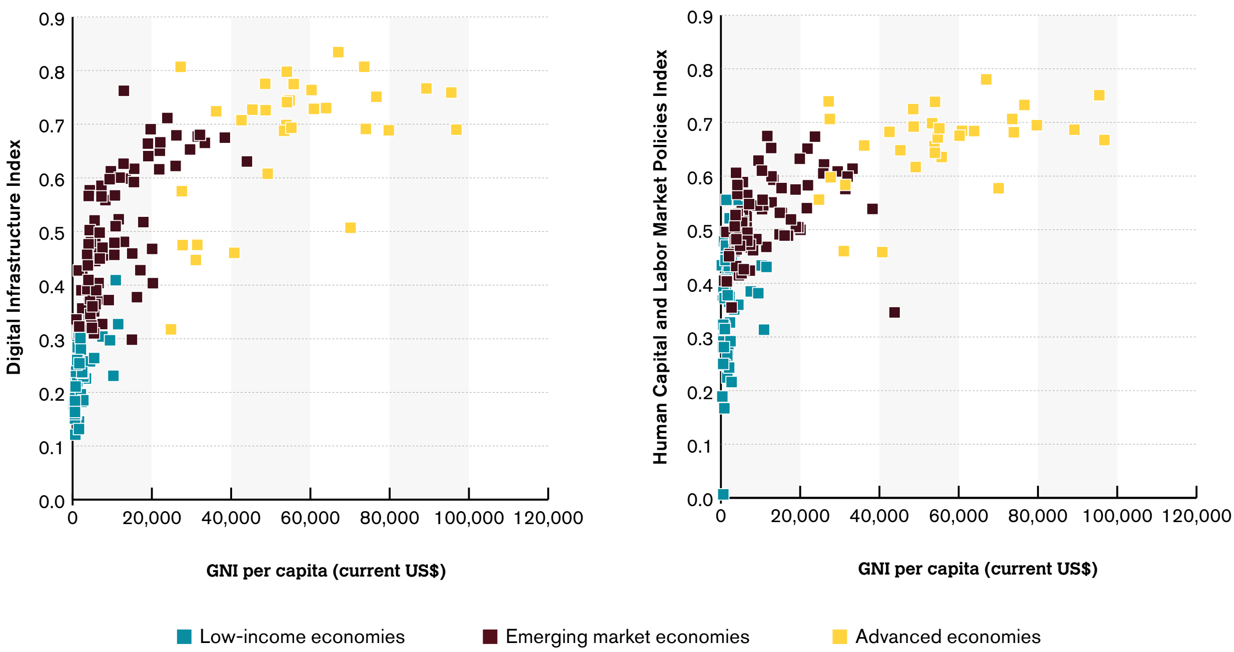
(i) Addressing the growing AI divide

To leverage the opportunities of AI, the digital divide between economies, in terms of both digital infrastructure and skills, must be addressed. As discussed in Chapter 2, ensuring that workers and firms are prepared to adopt AI involves robust digital infrastructure and trained human capital. Digital infrastructure is a crucial determinant of information and communications technology (ICT) adoption, and can lay the foundation for the diffusion and localized application of AI technology (Nicoletti et al., 2020). Nonetheless, such infrastructure is of limited use without a skilled workforce capable of leveraging digital platforms for innovative workplace applications.

Wealthier economies, including advanced and some emerging market economies, are generally better prepared than low-income economies to adopt AI. As illustrated in Figure 3.1, both the Digital Infrastructure Index and the Human Capital and Labor Market Policies Index — components of the IMF's AI Preparedness Index — are positively correlated with income levels. Higher-income economies tend to have stronger digital infrastructure and more trained human capital, making them more equipped to adopt AI technologies.

To address the AI divide, it is crucial to invest in digital infrastructure to ensure that low-income economies have the necessary technological foundation to support AI adoption. Governments and the private sector could collaborate to expand high-speed internet access, improve electricity infrastructure, particularly through renewable energy generation, enhance data storage capabilities, and develop robust cybersecurity measures. Public policies need to incentivize infrastructure development in underserved areas, and international cooperation should focus on providing technical and financial assistance to developing economies. In addition to infrastructure, bridging the AI divide requires a substantial investment in human capital to equip individuals with the skills they need to utilize AI technologies effectively. Education and training programmes should include AI literacy, coding, data analysis and other relevant skills. Public-private partnerships can play a key role in these efforts, as companies can offer practical training and resources, while governments can provide the necessary regulatory support, access to affordable devices and connectivity, and funding (see the opinion piece by James Manyika).

Figure 3.1: AI preparedness is higher in advanced economies



Source: International Monetary Fund (IMF) AI Preparedness Index (Cazzaniga et al., 2024a). The indices are rescaled to range between 0 and 1.

Opinion piece

Harnessing technology to advance shared prosperity

James Manyika

Senior Vice President of Research, Technology and Society at Google; Co-Chair of the United Nations Secretary-General's High-Level Advisory Body on Artificial Intelligence

Artificial intelligence is the most important technology of the present era, offering the potential to make people's everyday lives easier, power economic growth, help middle-class and lower-income workers, drive scientific and health advances, and address longstanding development challenges. In a world that is on track to meet only 15 per cent of the UN's Sustainable Development Goals (SDGs), AI provides an opportunity to reverse that trendline and contribute to progress on 79 per cent of our shared global goals (Hoyer Gosselink et al., 2024).

However, while the economic and societal opportunity offered by AI is immense, we must always remember that the benefits of new technologies are not automatic. At this moment of excitement, it is important to take a step back and consider the history of trade and technology – and make a concerted effort to build an inclusive trading system around AI that avoids the creation of an "AI divide."

The combined forces of technology and trade helped lift over a billion people out of extreme poverty – an achievement unparalleled in human history.[1] This dramatically changed global development, speeding up the flow of data and enabling smaller companies and economies to participate in trade. By 2016, digital flows – often a key aspect of other global flows such as manufacturing, services and financial flows and other intangibles – had begun to exert a larger impact on GDP growth than the centuries-old trade in goods (Manyika et al., 2016), with a surprising share of the benefits from digital trade going to the services, manufacturing and retail sectors (The White House, 2024). These trends on digital and digitally enabled global flows have only accelerated since 2016, with some estimating that up to 40 per cent of GDP now depends on global flows (Seong et al., 2022).

Now with AI, economies stand on the verge of an even more profound economic and scientific transformation that may fundamentally shift and reshape trading patterns. But it is critical to avoid creating an "AI divide." (Ossa, 2023). As of 2023, 93 per cent of people in high-income economies use the internet, compared with only 27 per cent of people in low-income economies (ITU, 2023). The UN's AI Advisory Body has rightly concluded that these divides cannot persist into the AI era (United Nations, 2024a).

We must work together across companies, governments and civil society to harness AI to advance a vision of shared prosperity. At a national level, this means providing access to AI-capable cloud infrastructure, computing capacity, developer tools and datasets relevant to AI development, while equipping workers and students with foundational AI skills that provide pathways to the modern workforce. Most crucially, we must place small businesses and traditional industries like manufacturing and agriculture at the forefront of AI leadership.

At the international level, driving a vision of shared prosperity will require expanding what we think of as "trade" – not just removing barriers to cross-border goods and services, but advancing a global strategy to drive alignment on AI governance and security, support trusted data flows, enable economic integration, and build solutions to cross-border challenges. An inclusive AI strategy must also drive investment in the subsea and terrestrial cables that enable participation in the modern economy (Quigley, 2024).

At its heart, this is a modern form of capacity building, with governments, industry and civil society working together to invest in AI infrastructure, build a global resource for AI research and develop training programmes that promote AI diffusion across sectors and geographies.

In contrast, if economies cannot align trade with the mission of shared prosperity, there is a risk that AI will only be adopted by wealthier economies, and by the wealthiest industries within those economies. This would be harmful not just from an equity perspective but also from an economic perspective – the trillions in potential economic benefits from AI are conditional on broad-based adoption of these technologies, not usage by the privileged few.

The choice is ours. Together, let's build a trade agenda that harnesses the transformative power of AI for all people, regardless of geographical location or economic status.

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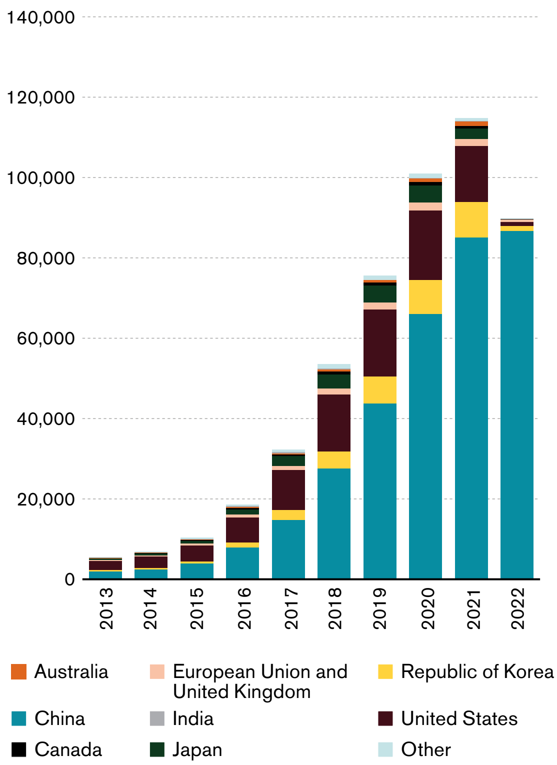
Figure 3.2: Number of AI patent filings by geographic regions, 2013-22



Source: Centre for Security and Emerging Technology (2024).

In addition to differences in the ability to adopt AI technologies, the AI divide across economies, reflected in AI research and development (R&D), investment and expertise, highlights the need to address gaps in AI capabilities. There is a significant divide between economies leading in AI R&D and the rest, especially developing economies and least-developed countries (LDCs). As illustrated in Figure 3.2, China is by far the leading economy in terms of the number of patents registered, with 86,663 AI patent applications and 15,869 patents granted in 2022, followed by the Republic of Korea and the United States.[2] This disparity reflects the underlying technological differences between economies and underscores the importance of facilitating technology dissemination and technical assistance to bridge the gap globally. There is a marked division between where the research, patents and investments in AI are located and where they are lacking, and there is a growing risk of further exacerbating this division, which exists both between and within economies and between urban and rural, less digitally connected areas.

The number of published articles on AI has increased steadily, with industry taking the lead. The number of published articles on AI has increased steadily, except in the United States which saw a drop in 2022. Although China is leading in terms of the volume of published scholarly articles, it is worth noting that the United States ranks first in terms of the number of citations, an indicator of the literature's influence.[3] As illustrated in Figure 3.3, the affiliation of teams researching and publishing on AI systems that "demonstrate the ability to learn, show tangible experimental results, and contribute advancements that push the boundaries of existing AI technology" showed an important switch in the second part of the 2010s: whereas most of the research was led by academia prior to 2016, industry took the lead in the number of publications afterwards.

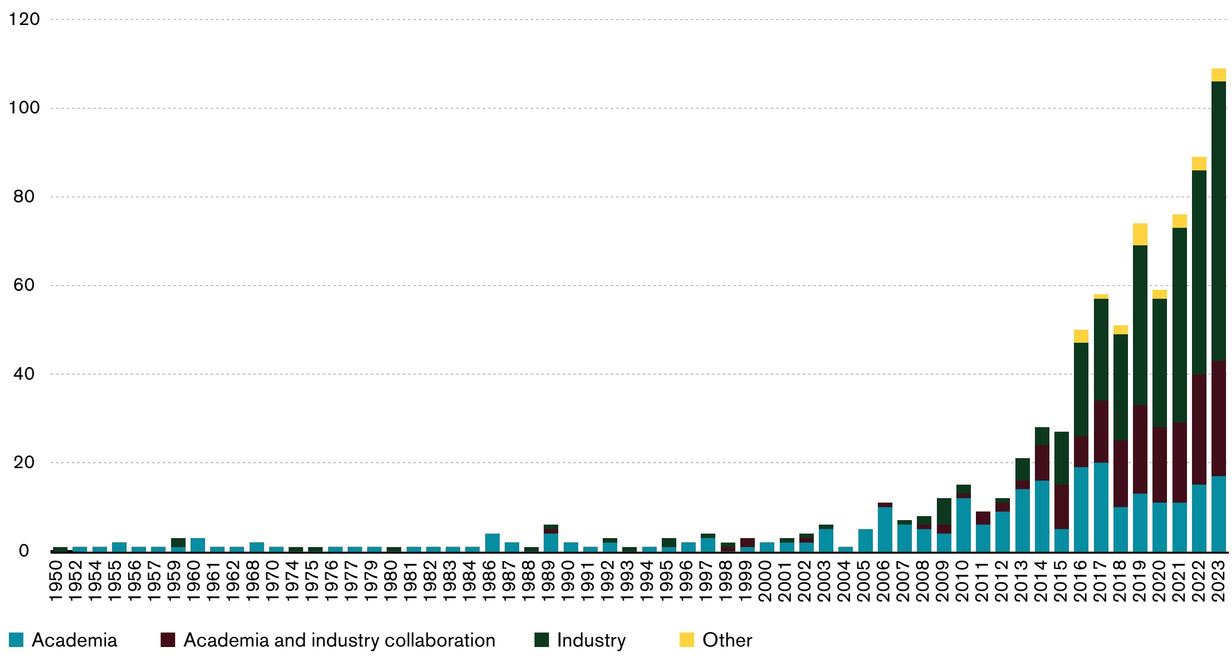
Investment in AI is accelerating rapidly, with the United States leading in private investment. AI funding stems from a variety of sources, including private companies, venture capital firms, government funding, academic institutions, corporate partnerships and angel investors. The United States leads in terms of total AI private investment. In 2023, the US$ 67.2 billion invested in AI in the United States was roughly 8.7 times greater than the amount invested in the next highest country, China (US$ 7.8 billion), and 17.8 times the amount invested in the United Kingdom (US$ 3.8 billion). Since 2022, the United States has experienced a notable increase in private investment in AI (22.1 per cent) (Maslej et al., 2024).

The disparity in private investment in AI becomes particularly pronounced in generative AI. Despite a recent decline in overall AI private investment, funding for generative AI has surged, reaching US$ 25.2 billion in 2023 (Maslej et al., 2024). However, this surge is heavily concentrated in a few economies, with the United States taking the lead. In 2023, the United States surpassed the combined investments of the European Union plus the United Kingdom in generative AI by approximately US$ 21.1 billion. Venture capital investments in generative AI have also been led by the United States, with a steep jump in 2023 to over US$ 16 billion going towards generative adversarial networks (machine learning models that generate new data mimicking a given dataset) for AI training and generative AI for text, image and audio.[4]

The demographics of professionals with AI skills are largely male and located in Europe and North America. According to a developer survey by Stack Overflow, a question-and-answer platform for programmers,[5] 94.24 per cent of data scientists and machine learning professionals are male, and the majority are located in Europe and North America (OECD.AI, 2024). Moreover, data from the Computing Research Association,[6] although limited to the United States and Canada, reveal that the representation of women among new AI and computer science PhDs has remained stagnant at approximately 20 per cent since 2010. This persistent gender gap underscores an ongoing challenge within the field.

This imbalance may be further exacerbated by the race to nurture AI through government subsidies. As discussed in Chapter 3(b), a number of governments are launching domestic initiatives to promote AI, backed by generous state support. However, as most of this support is being provided by high-income economies, it may exacerbate the AI divide among economies. The relative concentration of AI supply chains can also result in trade imbalances in AI-related goods and services.

Figure 3.3: Affiliation of publication research teams, 1950-2022



Source: Epoch (2024).

Beyond the digital divide across economies, industrial concentration is prevalent in AI within economies due to increasing returns and network effects. As discussed in Section 2(b)(iv), as the development of AI models progresses and their development costs escalate, only large firms can afford the substantial up-front investments required. This creates a significant barrier for newcomers and smaller enterprises, making it difficult for them to compete. The high initial costs of developingcutting-edge AI models and the necessity for extensive data and computational resources further consolidate the dominance of established players.

The widespread adoption of AI in markets can heighten the risk of collusion between companies. AI systems integrated into pricing strategies and market analysis can enable companies to monitor competitors' pricing behaviour and adjust their own prices accordingly. While this may optimize profits individually, it can collectively lead to tacit agreements or collusion among competitors to maintain higher prices (Assad et al., 2024; OECD, 2021a). Moreover, AI's ability to process vast data and predict market trends may enhance firms' coordination in pricing strategies, exacerbating market concentration.[7]

The special features of AI present challenges for competition authorities. The opacity of AI algorithms and the sheer volume of data they process can obscure anticompetitive practices such as price collusion, exclusionary behaviour and discriminatory practices. Moreover, AI-driven mergers and acquisitions may raise concerns about market dominance and barriers to entry, as algorithms and data assets become pivotal assets for competitive advantage. Traditional antitrust frameworks may struggle to adapt to the dynamic nature of AI-driven markets, requiring competition authorities to develop new analytical tools, data access mechanisms and regulatory frameworks to effectively safeguard competition and consumer welfare in the AI era (see the opinion piece by Shin-yi Peng).

There is growing scrutiny of mergers in the AI market and growing interest in better understanding the implications of AI on competition.[8] Traditional antitrust policies, which apply after the fact, when market competition has already been impacted, are slow and focus on prices, and are not sufficient to address competition issues raised by AI. The competition challenges raised by AI have led to renewed calls for a collective international approach to regulation and for enforcement of competition in digital markets.

(ii) Preventing further digital trade barriers

Cross-border data flows are essential to AI. As discussed in Section 2(a)(i), amassing vast datasets is vital in order to train algorithms, and data flows are integral to the real-time use of AI technologies. Breadth and variety of data are as important as volume.[9] For AI to be effective and deliver accurate predictions that are not susceptible to bias and discrimination, algorithms need to be built on high-quality, accurate and representative data.

Cross-border data flow restrictions can negatively impact AI innovation and development, and can increase costs for firms. Such restrictions have a general negative impact on productivity, economic growth and innovation domestically and globally (Aaronson, 2019; Goldfarb and Tucker, 2012; Luintel and Khan, 2009; Maskus and Reichman, 2004; OECD, 2016), but are of particular concern for AI innovation and development. Because AI requires vast amounts of good quality data in order to be trained, and this often involves merging different data sources together, cross-border data flow restrictions are likely to affect the quality and accuracy of AI models and the scalability of AI applications significantly. By limiting the ability of foreign firms to access data from a given jurisdiction, such measures could favour domestic firms, but may do so at the expense of overall quality, thereby undermining innovation and the full potential of AI (Goldfarb and Trefler, 2018).[10] Cross-border data flow restrictions also impose extra costs on firms wanting to do business internationally. A recent study on the implications of data flow restrictions on global GDP and trade finds that if all economies fully restricted their data flows, it could result in a 5 per cent reduction in global GDP and a 10 per cent decrease in exports (OECD and WTO, 2024). To comply with data flow restrictions, firms may need to establish a presence and duplicate activities across various jurisdictions and devise a system to ensure that data are not routed internationally. While technically feasible, doing this can be particularly costly, especially for small businesses (Goldfarb and Trefler, 2018).

Box 3.1: AI and consumer protection

AI opens significant opportunities for consumers, but also increases the possibilities of covert influence, raising significant concerns over the exploitation of personal information and violation of privacy, manipulation and disinformation.

For consumers, AI can provide major benefits, such as individualized recommendations and time-saving (e.g., AI voice assistants can order groceries instantly, saving consumers hours of shopping time). The ability of AI models to establish correlations between consumers' data and possible responses to advertisements in order to predict consumers' behaviour provides firms using AI with the unprecedented ability to trigger specific reactions through individualized aps and communications. However, this can also exacerbate asymmetry of information between companies and consumers, and can lead to manipulation and exploitation of consumer behaviour.

The use of algorithms to fix prices can lead to price efficiencies passed on to customers, but can also be used to exploit consumers' willingness to pay a certain price in the interest of the firm.

In addition, while AI technologies can contribute to effective moderation for the benefit of consumers, they can also deliver inaccurate, biased or discriminatory responses that can also harm consumers.

Finally, sellers may not fully take into account potential harm caused to consumers as a result of consumer data misuse due to the difficulty in tracing that harm back to the original data collector. Consumers may not, therefore, challenge data use after the data is collected (Agrawal et al., 2019).

Notwithstanding the fact that traditional consumer protections laws may apply to most scenarios of AI use cases, often providing adequate legal remedies without the need for new regulations, measures to regulate algorithmic harm and protect consumers have emerged in recent years in various jurisdictions. Under the EU General Data Protection Regulation, for example, individuals have the right to contest decisions made by algorithms, request human oversight, and withdraw from personalized advertising driven by algorithmic methods. China has also developed comprehensive regulations to govern algorithm use. Further legislation to harness algorithms and protect consumers is being discussed in various jurisdictions, including the European Union[12] and the United Kingdom (Holmes, 2024).

However, national approaches do not adequately protect consumers in the case of cross-border transactions (Jones, 2023). Obtaining redress in case of harm remains particularly challenging in the event of international transactions. Although some level of international collaboration and regulatory discussions exists among national bodies, this cooperation remains fragmented and does not establish an effective, transparent framework for enforcing consumer rights across borders (Goyens, 2020), leading some experts to call for new forms of international regulation and cooperation to protect consumers, especially against AI harm (Jones, 2023).

Besides potential violations of privacy and personal integrity, disinformation and manipulation, the difficulty of assessing the safety and security of AI-enabled products and services adds to the complexity of protecting consumers in an AI-driven age (see Chapter 3(a)(iii)).

Opinion piece

AI: Amplifying the digital trade issues

Shin-yi Peng

Distinguished Professor of Law, National Tsing Hua University

Many of the challenges brought by digital technologies that the WTO has faced in the past decades are now amplified by AI, including issues associated with classification, non discrimination, data governance and competition policy.

First of all, AI acts as a facilitator for complex products that bundle goods and services, which calls for further thinking about how to adjust the goods/services legal silos under the WTO to address issues stemming from the merging of physical and digital realms. It seems likely that the goods/services dichotomy in applying trade rules will increasingly trigger new levels of inconsistency and legal uncertainty.

Second, more and more AI-based services will be able to compete directly with or substitute human professionals. Questions such as to what extent automated legal advice tools and human attorneys should be considered to be "like services suppliers" may emerge sooner than expected. It remains to be seen how far concepts such as "technological neutrality" or "evolutionary interpretation" can serve to clarify the scope of the GATS commitments of market access and national treatment.

Third, AI presents new challenges for data governance. Digital platforms' advertising algorithms, or, more generally, their overall business models, intensify the perils associated with the data-driven economy. WTO rules can play a more active role in reducing such perils. Data governance in the age of AI requires perspectives that safeguard social values, including privacy, security, free speech, cultural expression and algorithmic ethics.

Finally, competition authorities worldwide are increasingly taking or considering approaches that impose additional obligations on AI-powered big tech companies. Their potential abuses of market power, including self-preferencing practices that promote their own services within search results, algorithmic cartels and other cross-border collusive arrangements, can be more meaningfully addressed through competition disciplines at the international level. To what extent does algorithmic practice constitute a trade barrier to goods or services, and how do anti-competitive market concentrations exclude foreign suppliers from a market? The reactivation of the WTO Working Group on Trade and Competition is more urgent than ever. If a set of general or sector-specific competition disciplines could be established at the WTO, it would be less necessary for competition authorities in developing countries and LDCs to enforce competition law after the fact.

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However, the large datasets required by AI models raise significant privacy concerns. AI introduces new privacy issues for individuals and consumers, leading to a trade-off between the necessity of accessing large amounts of data to train AI models and privacy protection. The continuous tracking and profiling of individuals' online and offline interactions by AI algorithms raise significant concerns about data privacy, consent and control over personal information. Furthermore, as AI algorithms become increasingly sophisticated in their ability to infer insights and predict behaviours based on user data, there is a pressing need for robust privacy regulations, transparent data practices and enhanced user control mechanisms to safeguard individuals' privacy rights and ensure ethical and responsible AI deployment.[11] AI also introduces new privacy concerns for consumers (see Box 3.1), and the use of data as inputs into AI models also raises IP concerns (see Section 3(a)(iv)). As a result, a delicate balance needs to be found between privacy concerns and the need to access large amounts of data to train AI models (see also the opinion piece by Shin-yi Peng).

Restrictions on cross-border data flows also negatively impact trade in AI-enabled products. While there is empirical evidence that AI significantly enhances international trade in digital services, cross-border data regulation can impede such trade. Sun and Trefler (2023) find that restrictions on data flows can reduce the value of AI-enabled apps, making them less attractive to international users.While AI leads to a 10-fold increase in the number of foreign users, the impact of AI on foreign users is halved if the foreign users are in an economy with strong restrictions on cross-border data flows. Thus, economies with strict data regulations may lose out on AI-driven trade opportunities. Striking the right balance between protecting privacy and fostering innovation is therefore crucial for maximizing the benefits of AI for international trade. However, cross border data flow measures, when aimed at protecting privacy, can help to build trust in AI systems and promote their wider use. A study by OECD and WTO (2024) on the implications of data flow restrictions finds that, although removing data flow regulations across all economies would reduce trade costs, it would also undermine trust, leading to reduced consumer willingness to pay for products and a negative effect on GDP.

(iii) Ensuring the trustworthiness of AI without hindering trade

Standards and technical regulations play a key role in ensuring that AI is trustworthy and, through this, in promoting trade in AI-enabled products. There is growing consensus concerning the pivotal role that regulations, standards and other government interventions can play in ensuring that AI is trustworthy, i.e., that it meets expectations in terms of criteria such as reliability, security, privacy, safety, accountability and quality in a verifiable way.[13] Ultimately, this means striking a regulatory balance, whereby the benefits of AI are harnessed while its risks are mitigated. Ensuring trustworthiness is not only important for what happens within economies. It is also relevant for what happens outside economies and between borders. Indeed, the internal regulations that governments adopt to protect their consumers can help to build consumers', importers' and other stakeholders' trust in AI-enabled products, thereby fostering trade in such products.

Striking a balance between regulating AI for legitimate policy reasons and enabling trade to flow as smoothly as possible can be particularly challenging. While the challenge of striking the right balance between regulation and free trade is not new, AI's evolving, opaque and multifaceted nature, and the new types of risks associated with it, are making this balancing act in AI regulation and governance particularly complex (see also the opinion piece by Eduardo Paranhos).

Regulating AI requires regulating a product's "behaviour". As mentioned in Chapter 2, "autonomy" is one of the unique attributes of AI. The fact that AI systems can imbue products with various degrees of "autonomy" means that they may generate new forms of risks stemming, not from problems related to the physical components of the product, but instead from the way AI can make the product "behave".[14] Such risks are not easy to foresee, control or even quantify.[15] As Judge et al (2024) note, a unique, defining technical characteristic of AI is that, unlike all other engineered systems, AI's "behaviour" is not dictated or pre-determined by its programme code; it is an "emergent" property. Therefore, AI-enabled products may generate risks for reasons other than those inherent to the tangible elements in the products themselves. For instance, some consider that the "behaviour" of AI-enabled co-bots (i.e., collaborative or companion robots), if unchecked, could provoke mental health problems in the humans they accompany.[16]

The opacity of the behavioural nature of AI can make regulation even more challenging. Risky "behaviours" of AI-enabled products may be linked to the way their algorithms are designed. AI algorithms are notoriously opaque (Lim, 2021; Lund et al., 2023). As noted in Chapter 2, transparency and explainability are critical for understanding how and why AI systems work and behave the way they do.[17] This challenge is commonly referred to as the AI "black box" problem, which has been described as presenting two dimensions, legal and technical. Addressing the legal dimension requires accessing the source code. This may prove difficult as source codes are normally proprietary, i.e., protected by IP, normally in the form of trade secrets. There are, however, regulatory ways to deal with this challenge, for instance, by allowing forced source code disclosure for regulatory or law enforcement purposes,[18] even if in practice this may not be easy or warranted.[19] To some, the technical dimension of the black box problem may be even more significant, as the opacity of an AI system may persist even when access to the source code is free or has been voluntarily or mandatorily granted. Indeed, there may be instances when AI applications are so complex that even programmers themselves are not able to divine an intelligible explanation from the source code and other proprietary information and data as to why and how certain decisions and classifications were reached by the AI system. For some, this means that, until this technical challenge is satisfactorily addressed, regulatory solutions based on open source disclosure may be "significantly frustrated" (Lin, 2021; Mitchell et al., 2023; Pasquale, 2015).

Adding to the difficulty in pinpointing the source of vulnerability of an AI-enabled product is the fact that their evolving nature may be also triggered by external factors. Such factors include customization: the ability of millions of individuals to "personalize" their AI-enabled products in almost infinite different ways, posing a challenge for regulators to anticipate potential risks associated with each unique customized products. Another factor is connectivity, which may render products vulnerable to cyberattacks or cyberthreats by bad actors that can be located anywhere in the globe. These factors further increase the difficulty for regulators in anticipating and addressing so a wide range of possible unforeseeable and unintended risks over the lifecycle of these products (Lund et al., 2023).

AI's dual use potential may add another layer of complexity. As noted in Chapter 2(a), AI's dual-use nature means that it can be employed for both civil and military purposes. This may add a domestic security and geopolitical dimension to AI's governance, making regulatory interventions and cooperation even more complex (Csernatoni, 2024; Klein and Stewart, 2024; Pouget, 2023; Raul and Mushka, 2024). A related issue concerns policy and regulation in the area of AI and cybersecurity (see Box 3.2).

For goods, "traditional" regulations and standards that normally focus on tangible, visible, static product requirements may not be able to address risks stemming from the integration of AI into "traditional" products. The changeability of AI-enabled products, resulting from the evolutionary nature of AI, makes regulation a perennial moving target. AI systems confer new properties and functions to the products into which they are embedded. As stressed in Chapter 2, these products' properties and functions can be described as "dynamic", i.e., they change overtime as a consequence of constant changes occurring throughout the AI system's lifecycle via software updates or other self-improvements resulting from the algorithmic "learning" process. This contrasts with the "static" properties of more traditional products, which normally remain

Box 3.2: AI, cybersecurity and technical barriers to trade (TBT)

AI's ability to analyse large data sets can help in countering cyber threats and responding to malicious cyber-attacks. However, there are concerns related to potentially biased decision-making, the lack of transparency and explainability of AI systems, and potential misuse or abuse. Bad actors can use AI to create new malware, to design new, sophisticated, or targeted phishing attacks, to identify new avenues of attack, and to create deep fakes. Unsurprisingly, cybersecurity is a core concern expressed not only in domestic AI policies but also in international AI principles and governance discussions.

Cybersecurity vulnerability risks are growing as digital technologies are permeating more and more societies and economies. In response, governments are increasingly adopting cybersecurity-related measures and policies, many in the form of TBT measures, i.e., technical regulations, standards and conformity assessment procedures.

Indeed, cybersecurity-related TBT measures have recently become one of the most prominent digital-technology-related issues discussed in the WTO TBT Committee. To date, more than 90 cybersecurity-related TBT measures have been notified to the Committee, around 65 per cent of these in the last three and a half years. Members have also increasingly raised specific trade concerns (STCs) in the TBT Committee against cybersecurity-related TBT measures: of the 29 STCs raised since 1995, 38 per cent were raised in the last three and a half years alone.

Cybersecurity was the focus, for the first time, of a specific thematic session of the TBT Committee organized in 2023. Given the global nature of the problem, it was argued in that session that unilateral government interventions in this area should be avoided, as they could ultimately undermine global cybersecurity efforts. The need for governments and the private sector to work in a more coordinated and collaborative manner to address rising regulatory fragmentation and divergence in this area and find better ways to fight increasing cybercrime and cyber incidents was also underscored. In this respect, efforts to develop ambitious, fair and inclusive cybersecurity international standards were highlighted.

essentially the same throughout their lifecycle. Many of the constant changes to properties and functions in AI-enabled products are meant to be beneficial improvements (some even call this "evolution").[20] However, this dynamic process means that known risks and concerns may also be constantly changing, or new ones may be emerging. For AI-enabled products, as is the case for most other products, specifications and requirements will continue to be needed to address risks associated with their "physical" aspects (e.g., hazards from defective mechanical components of an autonomous vehicle). However, for some, such "traditional" specifications and requirements may be ill-suited or insufficient to address situations where the root cause of a risk is not a mechanical or "physical" failure, but an algorithmic design flaw or other problem with the AI system embedded in the product and which may cause it to display risky "behaviour" (e.g., an autonomous vehicle that causes injuries to people or damage to property).

AI-enabled products may cause not only material but also immaterial risks. An AI-enabled product may present both material risks, which are easy to quantify and measure (e.g., physical injuries or damage) and immaterial risks (e.g., privacy or other fundamental rights), which are more difficult to quantify and measure. Material and immaterial risks can sometimes even stem from the same situation. For instance, in an AI-enabled autonomous vehicle, mechanical malfunctions and/or algorithmic flaws in its internal and external cameras can both cause injuries (material) and affect the privacy of passengers or pedestrians (immaterial).[21] Likewise, product specifications laid down in one size fits all regulations and standards may be ill-suited for regulating AI-enabled products with different customized solutions (Lund et al., 2023). To address such regulatory challenges, while supporting the deployment of, and trade in, trustworthy AI-enabled products, it has been proposed that regulators think of creative ways to ensure that product requirements and specifications are dynamic and adaptable to the behavioural and evolutionary nature of these technologies, to ensure that they do not become obsolete as AI characteristics, risks and vulnerabilities evolve throughout the product lifecycle.[22]

The constantly evolving nature of AI-enabled products may also necessitate new approaches to certify their compliance with regulatory requirements. Indeed, if an AI-enabled product has successfully undergone testing, verification or other certification procedures prior to being placed on the market, this may not necessarily mean that the product will remain certifiable throughout its lifecycle. AI-enabled products, in particular internet connected IoTs or robotics, may generate new risks after their deployment due to "mutability" factors such as new updates, new data, unforeseen changes of attributes and functions due to user customization, or unforeseen autonomous behaviours (see Box 3.2).[23] As already discussed, assessing the conformity of some AI-enabled products with underlying technical regulations and standards may also require access to source code, which raises IP related issues (see Chapter 3(a)(iv)). Regulators may also face challenges in assessing the compliance of AI-enabled products with various novel regulatory requirements that aim, for example, to assess the quality of data used in such products. In light of such a multiplicity of challenges, some consider that regulators may need to re-evaluate their conformity assessment approaches and come up with methods of ensuring effective continuous compliance of ever-changing AI products with underlying technical regulations and standards (Lund et al., 2023; Meltzer, 2023).[24]

The integration of AI in goods and services has also broadened the scope, number and nature of risks and concerns that regulations and standards need to address. As mentioned above, in addition to "traditional" regulatory concerns, such as interoperability, safety, security, quality, and the protection of human life or health, the use and deployment of AI may also create various "non typical" risks, that some even qualify as "existential" (UNDRR, 2023), and may raise complex ethical and societal questions affecting public morals and human dignity.[25] If AI is trained on biased and skewed datasets, it may perpetuate or exacerbate biases or discrimination against minority groups and infringe upon individual rights and freedoms (see Chapter 2). AI-enabled goods and services are also a cause for significant concern with regard to data privacy, as they involve the collection, processing and storage of vast amounts of user data (see Chapter 3(a)). In addition, as mentioned above, AI is a technology prone to dual use, which may raise complex geopolitical and domestic security issues and lead to further regulatory fragmentation. Finally, both AI "inputs" and "outputs" raise new and complex issues of IP protection and ownership (see Chapter 3(a)(iv)).

These concerns render it challenging to design proper regulatory solutions to ensure the trustworthiness of and support trade in AI and AI-enabled products. As already mentioned, AI raises societal and ethical concerns ("immaterial" risks) that, unlike "traditional" concerns such as health and safety ("material" risks), are not typically a subject for technical regulations and standards. Such "non technical" concerns are more difficult to regulate, monitor and enforce compared to more traditional regulatory objectives, such as product safety or the protection of human health or life, which can be addressed in more "technical" and objective ways. It has been argued that AI governance and regulatory frameworks may require norms, regulations and standards that are perhaps better described not as purely "technical", but instead as "socio technical" instruments, i.e., combining technical issues with broader societal considerations (Dentons et al., 2023; Kerry, 2024; Meltzer, 2023). Pouget (2023) argues that developing socio technical regulations is challenging in situations where both the technology and the harms it can cause are "so complex that it becomes difficult to separate value judgements from technical detail". Some have even questioned whether this could ever be done in practice.[26]

Such non typical or immaterial AI-triggered risks and concerns may also be intrinsically prone to regulatory fragmentation, which could hinder trade. Indeed, it might be difficult for legislators to agree on common international denominators with respect to some AI-related societal values and concerns such as ethics, privacy or human rights, the relative importance of which may vary across economies.[27] Unnecessary or avoidable regulatory fragmentation could, in turn, hamper the opportunities and benefits associated with AI (Bello Villarino, 2023; OECD, 2022a). In particular, it could result in high regulatory compliance burdens and costs, and consequently create non-tariff barriers to trade for AI businesses.

(iv) How AI is shaped by and may reshape IP

AI poses new conceptual challenges for the traditional, human centric approach to IP rights. Balanced IP rights and their enforcement have an important role to play in ensuring both equitable access to AI technology and a fair distribution of economic gains from its use. AI raises several important questions in this respect.

A first question concerns what form of IP protection AI algorithms are granted. If the IP protection is based on the fact that these algorithms are trade secrets – and thus that secrecy is an essential requirement on which to establish IP protection – this raises issues concerning a lack of transparency. Alternatively, new and inventive algorithms may be protected by patents in some jurisdictions, with the patent system's mandatory disclosure mechanism yielding extensive information about AI technologies, which directly passes into the public domain in many economies (WIPO, 2024). However, patent protection may constrain development of algorithms in economies in which patents have been taken out. Copyright, another type of IP protection, can be automatically extended to both source and object code, which may constrain analysis and use of algorithms. As envisaged by the objectives of the international IP system, appropriate exceptions and limitations to IP rights protection are needed to balance the different interests and to ensure appropriate access and dissemination of AI technology. These regulatory tools may have to be adapted for this specific context, and some jurisdictions have taken legislative steps or developed policies to encourage the development of open source AI technologies.[30]

A second question concerns the use of copyright-protected data as AI inputs. Under the current international IP legal framework, materials such as original texts, images and compilations of data may be subject to copyright protection. This may raise the question of whether

Opinion piece

Navigating AI regulation: balancing innovation, risks and regulatory defragmentation

Eduardo Paranhos

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It is not a simple task to determine when a new social or economic phenomenon warrants regulation. Those challenges can be further amplified when the new scenarios take the form of innovative technologies, posing both risks and opportunities. In addressing this, regardless of the nature of the changes, it is important to reflect on a few foundational questions: (i) what risks and opportunities are at stake; (ii) how well understood those new technologies are, so that the tools to tackle the possible risks can be properly balanced; and (iii) which aspects of the technological progress indeed require new rules, vis-à-vis the existing laws.

AI is transforming the way we work, communicate and create content faster than ever before. Fostering the development and implementation of AI solutions has the potential to increase efficiency and job quality, as noted, for example, in recent studies by the International Labour Organization and the consultancy firm McKinsey. Yet, for these benefits to materialize, we should consider which traits of the AI systems should really be regulated and aim to establish a model that, at the same time, is capable of protecting society and promoting – rather than discouraging – research and development.

It is an oversimplification to say that economies are mostly weighing up either context-principle based formats to regulate AI, or prescriptive models with a more detailed set of obligations and sanctions.

In Brazil, the debates around AI regulation have so far examined aspects from each of those possible structures: a prescriptive model, openly inspired by the European regime, and another proposal for a context-based framework anchored on widely recognized principles for governance and risk mitigation – e.g., those of the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Organization for Economic Co-operation and Development (OECD) – reaffirming the role of existing legislation.

Indeed, it is possible that most situations raising concerns about the deployment of AI could be dealt with through existing federal laws, particularly in relation to privacy, product safety, consumer protection and internet regulations, as well as some downstream regulations, such as Brazil's health authority ordinance on software as a medical device (SaMD).[28] For instance, a data breach that occurs as a result of using an AI system is subject to the same controls and remedies provided for in Brazil's privacy law as other breaches that occur without the use of AI. The privacy law also covers the potential misuse of sensitive personal data that generates biased outputs in the same way as similar misuse in offline settings.

However, it is of pivotal importance to map the gaps in the current legislation clearly, so that fresh AI regulations can address that very gap, avoiding overlaps and the resulting legal uncertainty. Another critical point which could make prescriptive models problematic is the emphasis on regulating the "development" of AI, instead of focusing on high-risk "uses" of the technology.

One final consideration refers to the level of preparedness that the upcoming regulations should display to be able to evolve with the technology. It seems more realistic that context-based regulations should gradually progress into stricter forms "if" and "when" needed, than the other way round. Similarly, in the context of trade-related concerns over the adverse effects of regulatory fragmentation, AI regulations that concentrate on high-risk uses – not on the development of the technology – could facilitate the pursuit of a more harmonized approach across markets. Notably, some economies that are global protagonists in investments and implementation of AI[29] have been leaning towards evolutive regulatory formats, balancing AI governance and risk mitigation goals, while helping to raise living standards, creating quality jobs and improving people's lives through responsible innovation.

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their use in training AI amounts to copyright infringement. This question translates into whether such use is now, or should be, automatically permissible under exceptions to exclusive copyright (e.g., for educational use of copyright-protected materials). The application of such limited exceptions to generative AI, in particular, is more complex than in traditional cases, due to factors like the scale of data used and the purpose of the use.

A third set of questions concerns whether AI outputs generated autonomously can be subject to IP protection. An AI output is created based on the patterns and rules learned during the training process, by means of the input data. However, this output (including in the form of content) is not a mere reproduction or recombination of this material. Rather, the output can take the form of novel and creative material, reflecting the AI system's ability to understand and mimic the complexities of human-generated content. Thus, AI output may encompass a wide range of creations and innovations,[31] including artwork, literary works, music, design, films, video games and inventions. As AI is increasingly capable of producing outputs autonomously, the lines between human and AI contributions to creation or inventions are increasingly becoming blurred, making the question of inventorship and authorship more pressing and complex.

Various approaches have been taken, or proposed, for finding balanced and equitable answers to some of the above questions, both in terms of AI inputs and outputs. In terms of AI inputs, proponents of the use of copyrighted material to train AI argue that this constitutes a "transformative" use, as the model does not replicate the copyrighted works, but instead generates new content inspired by the learned patterns. They also argue that such use does not negatively affect the market for the original works and that, in some cases, it could potentially complement that market. This is still an ongoing debate. A balanced approach taking into account both the moral and the economic interests of creators of original works and users of AI needs to be found, and the legal community continues to explore these issues. Approaches to this issue differ significantly across jurisdictions (see Chapter 3(b)).

The question of the protection and ownership of AI generated outputs necessitates a re-evaluation of existing IP legal frameworks. As noted above, AI may generate outputs in the form of a work or invention. This in turn raises questions about whether and/or under which circumstances IP rights can be granted for AI-generated creations or innovations, and if so, who, if anyone, owns the resulting IP, or who is liable if the output violates the IP of others. Is it the developer of the AI tool, the user who prompted the AI output, or neither, since the creator or inventor is not human? Current IP laws attribute authorship and inventorship, as well as resulting economic rights, to humans. In some jurisdictions, AI itself is not recognized as the creator or inventor within the current IP legal framework.[32] In other jurisdictions, the issue is open to judicial interpretation based on existing laws.[33] With the widespread deployment of AI, which can now be used by individuals across the globe, the question of protection and ownership of AI generated outputs becomes a constant and global concern. This question not only challenges the traditional understanding of creativity and ownership, but also urges a re-evaluation of existing IP legal frameworks in the age of AI (see also Chapter 4(f)).

(b) The global race to promote and regulate AI and the risk of fragmentation

The immense potential of AI has prompted governments around the globe to take action to promote its development and use while mitigating its potential risks. However, the increasing number of domestic, regional and international initiatives and their design are fragmenting the policy landscape, with possibly negative consequences for companies trading internationally. The economic costs of fragmentation highlight the importance of mitigating regulatory heterogeneity.

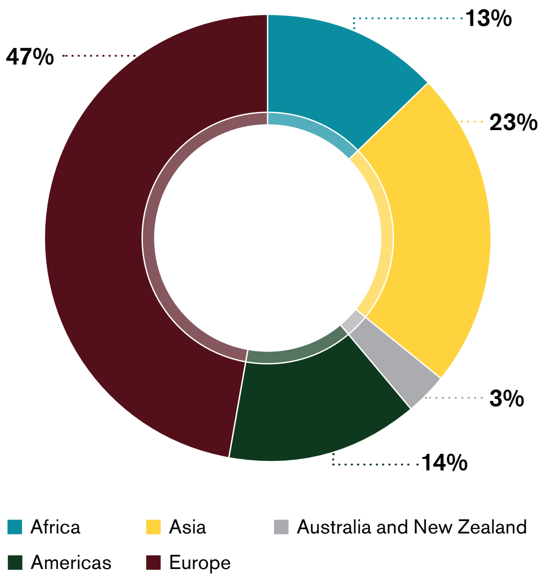
(i) Domestic initiatives

Governments are using a variety of instruments to promote AI and to address and mitigate its risks. These range from AI-specific strategies and policies to sector-specific legislation (including data regulations) and trade policy measures. However, there are already signs that heterogeneity in the design of these measures may be leading to regulatory fragmentation. The sheer number of domestic strategies and policy initiatives related to AI indicates that AI is an area of priority and that a sustained high level of intervention can be expected in the near future, with a potential risk of growing regulatory fragmentation.

AI strategies and policies

An increasing number of jurisdictions is putting in place AI strategies and policies at the domestic level. The number of economies that has implemented AI strategies[34] increased from three in 2017 (Canada, China and Finland) to 75 in 2023. Canada initiated the first domestic AI strategy in March 2017. In 2023 alone, eight new strategies were added by economies in the Middle East, Africa and the Caribbean, showcasing the worldwide expansion of AI policymaking (Maslej et al., 2024). In addition, or as part of domestic AI strategies, governments around the world have taken over 1,000 AI policy initiatives.[35] The majority of AI policy initiatives are concentrated in Europe, followed by Asia, the Americas and Africa (see Figure 3.4). Most AI-related legislation passed since 2016 aims to enhance an economy's AI capabilities, such as establishing a network of publicly accessible supercomputers, as opposed to restrictive legislation, which imposes conditions or limitations on AI deployment or usage (Maslej et al., 2024).

Figure 3.4: Number of AI policy initiatives by region (2024)



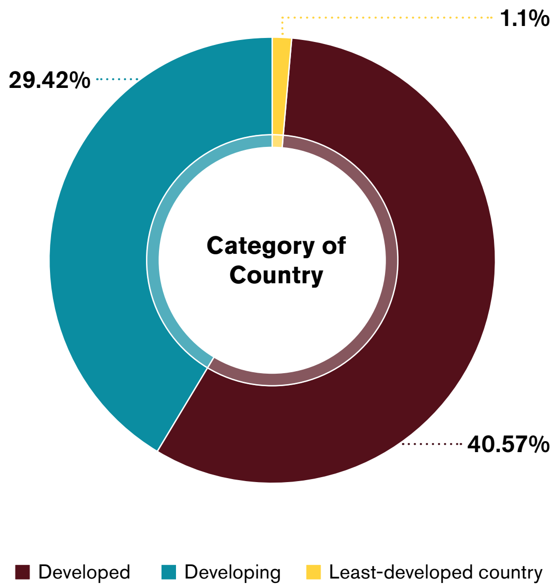
Source: OECD database of domestic AI policies (https://oecd.ai).

The European Union, a WTO member in its own right,[36] has been particularly active, with the adoption of a series of policy measures to support the development of trustworthy AI at the EU level. Policy measures to support the development of trustworthy AI include the AI Innovation Package,[37] the Coordinated Plan on AI,[38] the "Proposal for standard contractual clauses for the procurement of Artificial Intelligence (AI) by public organisations", and the EU AI Act (AIA) (European Union, 2024). The AIA, which was formally adopted in 2024, is the world's first comprehensive horizontal legal framework on AI.[39] The main stated objective of the AIA is to ensure that AI systems within the EU are safe and comply with existing laws on fundamental rights, norms and values.[40] The AIA adopts a risk-based approach to regulating AI systems.[41]

Most domestic AI policy initiatives are implemented by developed economies, reflecting the growing AI divide. While a reasonable share (around 30 per cent) of developing economies have put AI policy measures in place, only one LDC, Uganda, has done so, with two sector-specific policies and one general policy on AI governance (see Figure 3.5). The increasing attention being paid to AI in policymaking can also be seen in references to AI in legislative proceedings, which have increased almost tenfold across the globe since 2016, and nearly doubled between 2022 and 2023 (Maslej et al., 2024).

Domestic AI policy initiatives can be classified into four broad categories: governance, financial support, guidelines and regulations, and AI enablers. As of March 2024, more than a third (36 per cent) of AI policy initiatives listed by the OECD Artificial Intelligence Policy Observatory[42] concerned governance of AI. Governance aspects usually focus on the establishment of frameworks for AI development and deployment, including vertical and horizontal coordination, AI's integration into public sector, public consultation and evaluation mechanisms, and the creation of regulatory bodies or committees to oversee AI-related activities. Close to 19 per cent of domestic AI policy initiatives aim to provide financial support and incentives for AI research, development and adoption.[43] Around 18 per cent of these initiatives include the development of guidelines and regulations (on issues such as data privacy, algorithmic transparency, bias mitigation and safety standards to promote the responsible and ethical development and use of AI technologies), the establishment of regulatory oversight and ethical advice bodies to provide guidance and supervision in navigating these regulations effectively, and the development of standards and certification processes to facilitate the development and adoption of AI technologies in compliance with regulatory requirements and ethical principles. Finally, a large number of domestic AI policy initiatives (around 27 per cent) focus on fostering an environment conducive to AI innovation and adoption (i.e., AI enablers). These include initiatives to enhance AI-related skills and education to attract talent, public awareness campaigns to raise awareness about AI, and the establishment of collaborative platforms, to bring together stakeholders within the innovation ecosystem, and business advisory services, to support innovation and entrepreneurship (Maslej et al., 2024). Some of these initiatives, like the 2023 US "Executive Order on the

Figure 3.5: Number of AI policy initiatives by level of development (2024)



Source: OECD database of domestic AI policies (https://oecd.ai).

Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence", contain measures to support AI-related hardware, such as computing infrastructure, as well as competition and innovation in the semiconductor industry.

Governments seem to be preparing or adopting an increasing number of detailed rules and regulations related to implementing and enforcing AI legislation. According to Stanford University's 2024 "AI Index", the number of AI related regulatory measures has risen significantly in the United States and the European Union over the past few years. There were 25 AI related regulatory measures adopted in the United States in 2023, including three related specifically to international trade and international finance, compared to just one in 2016. The total number of AI related regulatory measures grew by 56.3 per cent in 2023 alone to reach 83. As for the European Union, it has passed almost 130 AI-related regulatory measures since 2017, including 13 led by the Directorate-General for Trade and the Directorate-General for Competition (Maslej et al., 2024). Several economies are also developing strategies or putting in place specific initiatives to develop AI standards (see Box 3.3).

Environmental concerns are currently high on the policy agenda. Governments are therefore also starting to draft regulatory frameworks to address the potential negative environmental impacts of AI and to harness its many benefits. For example, one of the EU's AIA objectives is to assure the "environmental protection against harmful effects of [AI] systems in the Unionand supporting innovation."[54] See also Box 2.1 on AI's environmental impacts.

An increasing number of jurisdictions are also putting in place AI-related "sandboxes". The objective of these is to test new economic, institutional and technological approaches and legal provisions under the supervision of a regulator for a limited period of time.[55] About a dozen jurisdictions, including Colombia, Estonia, the European Union, France, Germany, Lithuania, Malta, Norway, Singapore and the United Kingdom have such structures in place (OECD, 2023).

Some jurisdictions are also developing "govtech" tools (digital tools used to optimize public services) to address the new regulatory challenges raised by AI and to promote trustworthy AI. A notable example is Singapore's "AI Verify" tool, developed by the Infocomm Media Development Authority and Personal Data Protection Commission.[56] AI Verify is an open source software tool to assess the trustworthiness of AI systems according to a set of criteria and factors. The tool, which is at minimum-viable-product stage,[57] aims to automate transparency assessment of AI systems, which would allow companies to see whether new AI systems comply with relevant international standards and regulations (see the case study on Singapore's approach to AI in Box 3.4).

Box 3.3: Domestic standards on AI[44]

Standards play an important role in domestic AI policy approaches and several economies are developing strategies or putting in place specific initiatives to develop AI standards.[45] Some economies even recognize AI as one of the priority areas in their general standardization strategies.[46]

As of July 2024, almost 170 standards are being developed or have already been published by various domestic standards-setting bodies (such as BSI, CEN, CENELAC, NIST).[47] Most of such domestic standards seem to be of horizontal application, while others seem to be sectorial, i.e. only covering specific industries and sectors such as transportation, healthcare or energy. AI related standards cover a variety of broad topics, most often those related to data management, quality, processing and protection, as well as risk management, safety and security, interoperability, and organizational governance. These standards address specific technical requirements such as process, management and governance, measurement and test methods, terminology, interface and architecture specifications, and product and performance requirements.[48]

One common feature across various domestic standardization approaches is the recognition of the importance of engagement and cooperation on AI standardization at the international level (Kerry, 2024).[49] For instance, Australia's AI Action Plan reflects Australia's intention to participate in international standards-setting processes,[50] while China's Global AI Governance Initiative encourages international cooperation for developing AI standards based on broad consensus.[51] In the same vein, the US Executive Order on Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence mandates relevant agencies to cooperate with standards development organizations to drive the development of AI related consensus standards.[52]

In this respect, as in other regulatory areas, domestic standardization efforts on AI will tend over time to rely on international standards-setting work.[53]

Box 3.4: Case study: Singapore's approach to AI

For Singapore, AI is a necessary means to overcome natural constraints, such as a small labour force on a small landmass, and to raise the productivity and strengthen the competitiveness of its industries, both in globally tradable sectors, such as trade, finance, and in domestic services, such as retail and food and beverages.

For example, Singapore has leveraged AI in order to continue to act as a global hub facilitating trade and connectivity. Singapore's Changi Airport, which handled more than 59 million travellers last year, uses AI to screen and sort baggage, and to power facial recognition technology for seamless immigration clearance. The Port of Singapore, which handled cargo capacity of 39 million twenty-foot equivalent unit (TEUs) in 2023, uses AI to direct vessel traffic, map anchorage patterns, coordinate just-in-time cargo delivery, process registry documents, and more. To facilitate communications and business exchanges across a linguistically diverse region of 680 million people who speak over 1,200 different languages, Singapore has also invested in developing the world's first large language model tailored to Southeast Asia's languages and cultures; this open-source model is dubbed SEA-LION, short for Southeast Asian Languages in One Network.

In 2019, Singapore issued a framework for responsible AI use. The Model AI Governance Framework provides detailed and practical guidance to address key ethical and governance issues when deploying AI solutions. In 2024, Singapore further extended the Model Framework beyond traditional AI to address generative AI and the novel risks it poses. Within the Association of Southeast Asian Nations (ASEAN), Singapore has spearheaded the development of an ASEAN Guide of AI Governance and Ethics. At the United Nations, Singapore convenes the Forum of Small States (FOSS), a grouping of 108 small economies, and introduced a Digital Pillar in 2022, which provides baseline capacity-building for issues including AI, most recently through the AI Playbook for Small States, which was co-developed with Rwanda and launched at the UN Summit of the Future in September 2024.

Singapore works closely with a range of partners, bilaterally and in various groupings, on guidelines for AI developments and innovations. With the United States, Singapore has deepened information-sharing and consultations on international AI security, safety, trust and standards development through collaborations in AI, including the US-Singapore Critical and Emerging Technologies Dialogue. With China, Singapore is enhancing mutual understanding of approaches to AI governance, such as under the inaugural Singapore-China Digital Policy Dialogue. Singapore also participates in the G7 Hiroshima Process, the AI Safety Summit series, the OECD AI Principles, the Global Partnership on AI (GPAI) and the World Economic Forum's AI Governance Alliance.

In 2022, Singapore launched AI Verify, an AI governance testing framework and a software toolkit, which contains baseline standardized tests, covering core principles of fairness, explainability and robustness. In 2024, Singapore launched AI Verify Project Moonshot, which broadens the original toolkit to cover generative AI and return intuitive results on the quality and safety of large language models. Given that the science of AI testing and governance is still nascent, Singapore has also set up the AI Verify Foundation to harness the collective power and contributions of the global open-source community to jointly develop AI Verify testing tools. The Foundation has grown to more than 110 members and includes companies such as Google, IBM, Microsoft, Red Hat, Meta and Salesforce.

Source: Based on inputs from the Ministry of Digital Development and Information, Singapore.

The heterogeneity of domestic initiatives may lead to unintended fragmentation. Analysing eleven AI rulebooks from seven jurisdictions (i.e., Argentina, Brazil, Canada, China, the European Union, the Republic of Korea and the United States), Fritz et al. (2024) find that governments prioritize different objectives with their AI regulation, use substantially different regulatory requirements to achieve the same priorities, and choose different scopes and formulations to achieve the same regulatory requirement for a shared priority, leading to unintended fragmentation at the level of priority, requirement and scope.

Unintended fragmentation extends to non AI specific, sector-specific legislation, such as AI-relevant IP and data regulations. Approaches to copyright "fair use", for example, differ significantly across jurisdictions (see Chapter 3(a)(iv)). While Japan modified its Copyright Act in 2018 to allow machine learning models to use copyrighted works for any purpose, including commercial use, without needing explicit permission from copyright holders,[58] the EU AIA is much less permissive. According to the EU AIA, the provider of a generative AI model, whether open source or closed, must establish a policy to respect EU copyright law,

Box 3.5: The challenge of navigating AI regulations: The case of Canvass AI

Invited to speak at a WTO workshop on regulatory cooperation on digital products, Humera Malik, CEO of Canvass AI, a startup that provides industrial AI solutions to enhance operational efficiency, profitability, and sustainability, explained that the diverse approaches to regulate AI make achieving global reach difficult. Divergent regulations strain resources, make the navigation of rules without specialized knowledge difficult, and impact market entry. Moreover, data protection regulations impose additional restrictions, affecting AI development and cross-border market entry. She added that "minimizing complexity and promoting convergence would greatly ease compliance efforts".

Source: https://www.wto.org/english/tratop_e/tbt_e/tbt_2006202310_e/tbt_2006202310_e.htm.

including the EU Directive 2019/790 on Copyright and Related Rights in the Digital Single Market (CDSM). Under the CDSM, research organizations are permitted to reproduce and extract copyrighted works for text- and data-mining purposes without requiring the authorization of the copyright-owner, provided that these research organizations have lawful access to the works, and that the use is for the purposes of scientific research. The use of copyrighted materials for text- and data-mining for any reason is also permitted beyond scientific research, but in this context, copyright-owners have the option explicitly to reserve their rights and thereby prevent the use of their works for text- and data-mining without their approval (European Parliament, 2024). Similarly, the AI Bill pending adoption in the Brazilian Congress provides, for example, for a limited copyright exception when the extraction, reproduction, storage and transformation taking place in data- and text-mining processes are carried out by research and journalism organizations and institutions, museums, archives and libraries. As for the United States, while there is still no legislation or regulation on this issue, a high profile ongoing litigation case was filed by the New York Times against OpenAI for the unauthorized use of its content in December 2023. Another example is the diverging approaches to algorithmically authored works (see Chapter 3(a)(iv)). While the United Kingdom protects algorithmic creations, albeit without recognizing AI itself as an author,[59] Australia and the United States make it clear that a human author is needed (Liu and Lin, 2020). Finally, some jurisdictions provide expansive protection to trade secrets, applying proprietary protection to source code, algorithms, training materials and datasets used to train AI models, while others do not provide them with exclusive IP protection (Kilic, 2024). Beyond IP, data regulations are also marked by a high level of fragmentation.

The design of some measures may affect market competitors in other economies and have trade-distortive effects, leading to further fragmentation. The significant economic potential of AI is leading political authorities in various jurisdictions to put in place measures to promote the development of AI. These include the creation of "AI factories", to give AI start-ups and small businesses access to supercomputers on which to build their own models, research initiatives to connect researchers and educators to computational, data and training resources to advance AI research and research that employs AI, and subsidies for firms that purchase domestically produced AI chips. Some of these measures appear to limit opportunities to domestic entities or to provide incentives on the condition that domestic products are used (Aaronson, 2024b).

The economic costs of regulatory fragmentation highlight the importance of mitigating regulatory heterogeneity. The impact of fragmentation can be felt at various levels, including lost trade opportunities, diminished productivity gains and stifled innovation, with potentially important economic consequences for vendors of AI-enabled goods and services (Fritz and Giardini, 2024). As AI technologies become increasingly embedded in goods and services across a wide range of sectors, in the absence of efforts to mitigate regulatory heterogeneity, the resulting costs and other negative impacts are likely to grow significantly. The impact is likely to be particularly important for small businesses, which are already struggling to navigate through divergent regulatory approaches on AI (see Box 3.5).

Data regulations

Regulating data stands high on policy agendas. With the rise of digital technologies, including AI, initiatives promoting access to data to foster domestic innovation and competition, protecting privacy and controlling the flow of data across borders stand high on policy agendas. However, what is emerging is a landscape of measures that is not only fragmented, but that may also have trade-distortive impacts beyond fragmentation.

Open government data and data-sharing initiatives to foster innovation and competition

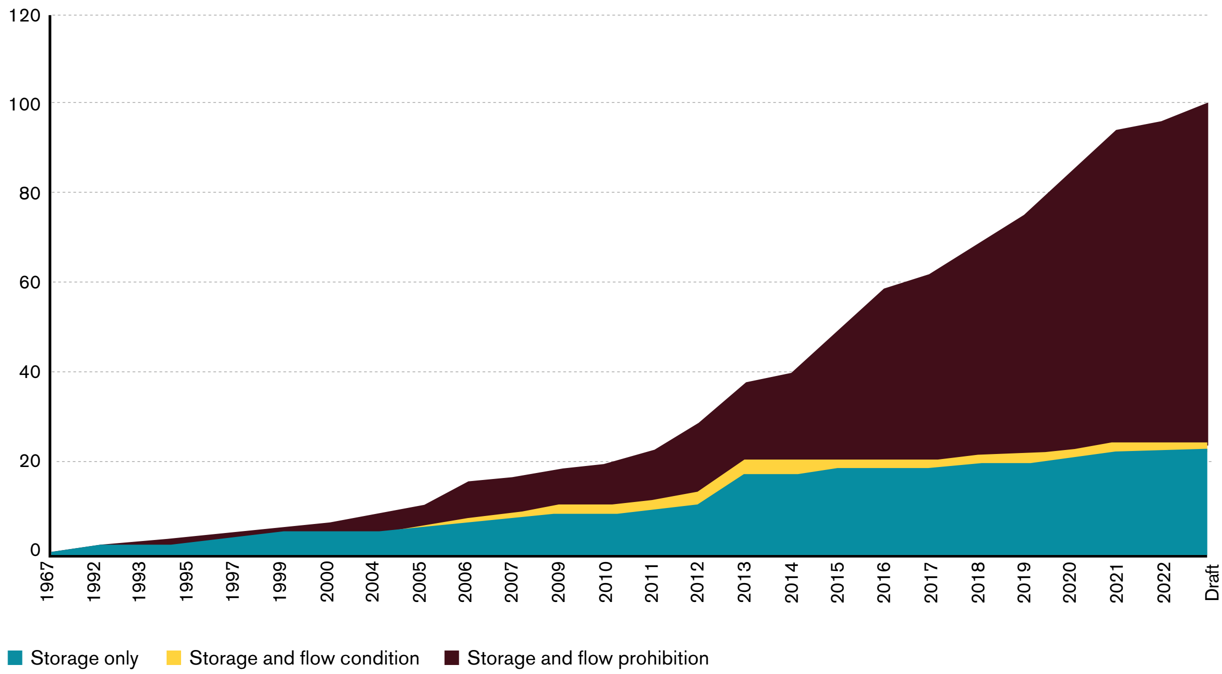
An increasing number of jurisdictions is taking initiatives to promote open government data to foster business creation and innovation and to increase competition in domestic markets. Recognizing the value of data as a public good, some jurisdictions, both in developed and developing economies,[60] are pursuing open government data initiatives to promote business creation and innovation and stimulate the domestic digital and AI economy by encouraging the use, reuse and free distribution of government datasets under open data licences. Examples include the EU's Open Data Directive, India's Open Government Data platform[61] and Singapore's "Smart Nation" initiative.[62] These initiatives come in addition to ex ante competition regulations put in place in some markets to better address competition issues raised by the digital economy.[63] Open government data is a goal that is also being pursued at the regional and international levels, including in the context of the WTO Joint Statement Initiative on E-commerce (see Chapter 4(a)(v)).

Other approaches aim to promote data-sharing across sectors to foster innovation or to mandate it to counterbalance winner-takes-all dynamics in the digital economy. The EU Data Governance Act (DGA), for example, seeks to increase trust in data-sharing and data availability. It entered into force in 2023 and supports the setup of trustworthy data sharing systems – called Common European Data Spaces – in strategic domains, involving both private and public players. Training AI systems is listed as one of the key benefits of the initiative (European Commission, 2024b). The EU Data Act, which entered into force in January 2024, complements the DGA and creates the processes and structures to facilitate data-sharing by companies, individuals and the public sector (European Commission, 2024a). The Act protects EU businesses in data-sharing contracts from unfair contractual terms that may be imposed unilaterally by one contracting party on another; the aim is to enable small businesses, in particular, to participate more actively in the data market. Other economies that have put in place data-sharing initiatives include Colombia, Japan and the Republic of Korea. Some jurisdictions, such as Australia and the European Union, are also experimenting with legally mandated data-sharing to foster a competitive environment in which AI startups also have access to large datasets (Mayer-Schönberger and Ramge, 2018; Prüfer, 2020).

The extent to which open government data and data-sharing initiatives support innovation and level the playing field both within and across economies remains unclear. There are concerns that such initiatives may in fact disproportionately benefit large AI firms, as these have the capacity to collect open data and to correlate it with the "closed data" they possess and control to generate new data. As a result, large AI firms stand to gain more than those who lack such capabilities and have to rely on open data entirely, which could amplify the growing AI divide

Figure 3.6: Data localization is growing and becoming more restrictive

(number of measures)



Source: Del Giovane et al. (2023).

between companies (see Chapter 3(a)). Such policies could also have geopolitical implications, as those operating out of relatively big, closed digital economies are able to capture open data elsewhere in addition to the data they collect domestically without much external competition, which could result in further imbalances across economies (Streinz, 2021).

In addition, while some-data sharing initiatives are clearly open to foreigners, uncertainty remains concerning other initiatives. These could raise potential most-favoured-nation (MFN) issues and result in trade-distortive effects. Japan, for example, announced in 2024 that its data spaces would be open to foreigners, but the programmes of some other jurisdictions seem designed to support data-sharing within the jurisdiction concerned, which could have a trade-distortive effect (Aaronson, 2024).

Privacy and data protection

Over the last decades, many governments have enacted regulations for personal data protection to address growing concerns over privacy. According to UN Trade and Development (UNCTAD), more than 70 per cent of jurisdictions – 137 out of 194 – adopted legislation to secure the protection of data and privacy in 2021, with significant differences across levels of development (UNCTAD, 2021a). The share of jurisdictions having passed such legislation is lowest in LDCs (48 per cent). The most well known of these is the EU's General Data Protection Regulation, which became effective in May 2018.

AI raises new privacy concerns for individuals and consumers. This is leading to an increasingly complex trade-off between the need to access large amounts of data to train AI models and privacy concerns. As seen in Chapter 2, AI's reliance on large amounts of data, including personal data, and its capacity to process and analyse vast datasets and to correlate data can lead to privacy breaches and information spillovers, introducing new privacy challenges.

Privacy and personal data protection regulations differ markedly across jurisdictions, affecting the flow of data. Most governments have introduced data protection laws, but these regulations vary significantly from one jurisdiction to another. Whereas some economies, like the United States, primarily rely on the industry to self-regulate the protection of personal data, others follow different approaches that focus on state intervention to defend state sovereignty, citizens' rights, security or domestic development (Bradford, 2023; Jones, 2023; Mitchell and Mishra, 2018; UNCTAD, 2021b). These include limitations on the international transfer of personal data, aimed at maintaining jurisdictional oversight. These different approaches to data governance are creating distinct "data realms" that are fostering a new digital divide between these jurisdictions and others that are rule-takers, creating regulatory uncertainty and barriers to the flow of data across borders (Aaronson and Leblond, 2018; Jones, 2023). The divergence in regulatory approaches between the European Union and the United States has been a particular case in point, with two data privacy agreements brought down by the European Court of Justice of the European Union.[64]

Cross-border data flow restrictions and data localization requirements

Cross-border data flow restrictions aim to limit the flow of data, and measures to control where data is stored or processed are on the rise. Motivations behind cross-border data flow restrictions and data localization requirements (i.e., explicit requirements that data be stored or processed domestically) vary, ranging from concerns over sensitive data, related to national security, to privacy considerations. Such measures are sometimes seen as an incentive to boost local competitiveness (Aaronson, 2024b; McKinsey, 2022). By early 2023, there were 96 data localization measures across 40 economies in place, with nearly half of the identified measures having emerged after 2015 (see Figure 3.6). Not only has the number of data localization measures increased, but the measures themselves are also becoming more restrictive, with more than two-thirds of identified measures involving not only a storage requirement but also a prohibition for data to flow from one economy to another (Del Giovane et al., 2023). These data regulations apply to different types of data, including personal data, and to different sectors. As noted in Chapter 3(a), striking the right balance between fostering AI innovation through access to data and protecting privacy is crucial for maximizing the benefits of AI for international trade.

The global fragmentation of data flow regulations underscores the need for increased international cooperation. While there are legitimate reasons for diversity in regulation, the current landscape is increasingly complex and fragmented, imposing additional costs on firms, especially those located in small markets, creating uncertainty, and hindering the cross-border flow of data that plays such an essential role in AI development and innovation, in particular for small economies. The economic costs of the fragmentation of data flow regimes along geo-economic blocks are potentially sizeable, amounting to a loss of more than 1 per cent of real GDP, according to an OECD-WTO study (OECD and WTO, 2024). A global approach that balances the need for robust data oversight and protection of privacy, while ensuring that data can be accessed and can flow freely across borders, is needed (Jones, 2023).

Border measures

Many of the hardware components and raw materials crucial to AI systems face increasing export restrictions. Export restrictions applied to industrial raw materials, many of which play a critical role in the manufacturing of advanced chips needed to power AI systems and in communications equipment, increased more than five-fold between 2009 and 2020 (OECD, 2023b). More recently, the race to dominate AI development, combined with broader economic, geopolitical and security considerations linked to the dual-use nature of AI systems, has led a growing number of advanced economies to impose export restrictions on advanced chips central to AI systems and on the tools used to manufacture them.[65] In reaction, China, one of the main targets of these measures, requested consultations under the WTO Dispute Settlement Understanding (DSU) in December 2022[66] and imposed export restrictions on two metals used in chipmaking and communications equipment in July 2023.

There is a risk that these restrictions will affect the global development and deployment of AI technologies and increase economic and, potentially, technical fragmentation. In the short term or when limited alternatives are readily available, restrictions can impact access to the technology by importing economies. A longer-term effect may be that new technological developments will be postponed due to a lack of access to advanced technology, compounding risks of economic and technical fragmentation.

(ii) Bilateral and regional cooperation initiatives to address AI

The increasing number of bilateral and regional cooperation initiatives on AI governance focusing on different priorities adds to the risk of creating multiple fragmented approaches.

Bilateral cooperation initiatives that touch upon issues relevant to AI and trade prioritize different issues. Cooperation between the United States and the European Union in the context of the Trade and Technology Council (TTC), which was established to promote EU-US cooperation, focuses primarily on aligning terminology and taxonomy and on monitoring and measuring AI risks (NIST, 2021). The first AI-related outcome of the TTC was the launch, in December 2022, of a Joint Roadmap on Evaluation and Measurement Tools for Trustworthy AI and Risk Management. The Joint Roadmap aims to guide the development of tools, methodologies and approaches to AI risk management and trustworthy AI, to develop a common understanding of key terms, to support and lead development of international standards, and to monitor and measure existing and emerging AI risks. In May 2023, the TTC adopted the "EU-US Terminology and Taxonomy for Artificial Intelligence – First Edition", which builds on existing standards such as International Organization for Standardization (ISO) standards to define key AI related terms, but does not define AI.[67] In April 2024, the European Union and United States launched a Research Alliance in AI for the Public Good. The Research Alliance aims to foster scientific cooperation to better harness AI for the benefit of the environment, energy optimization, disaster reduction and emergency responses.[68]

Other bilateral initiatives in which the United States is involved focus more on collaboration to promote alignment in general terms. In October 2023, the United States and Singapore launched a Critical and Emerging Technology Dialogue,[69] which establishes a bilateral AI governance working group focused on advancing shared principles for safe, trustworthy and responsible AI innovation, and calls for strengthened collaboration through joint research and educational funding and for exploring reciprocal certification programmes for American and Singaporean AI professionals on the basis of shared standards, tests and benchmarks. The Dialogue includes cooperation on standard development and a mapping exercise between domestic standard-setting bodies to align approaches. And in April 2024, the United States and Uruguay signed a Memorandum of Understanding (MoU) to foster cooperation on certain critical and emerging technologies, such as semiconductors, AI, data flows, telecommunications and cybersecurity, including by identifying opportunities to support the development and use of relevant international standards and by encouraging interoperability and global compatibility, as well as greater cooperation in multilateral and international organizations.

China's bilateral initiatives prioritize AI safety and governance, as well as development issues. Dialogue between China and the United States primarily focuses on AI safety and governance. Announced in November 2023, the first dialogue took place in May 2024 (The White House, 2023b; Murgia, 2024). Global governance of AI is also of high importance in China's discussions with African leaders in the context of the China-Africa Internet Development and Cooperation Forum. The last forum, which took place in April 2024, called for more representation of developing economies in the regulation of AI. Beyond the above-mentioned examples, agreements to maintain bilateral dialogues on AI have also been included in some regional trade agreements (RTAs) and digital economy agreements (see Chapter 3(b)(iii).

Approaches to AI governance initiated at the regional level take different forms. Various regional initiatives have emerged in Africa, Asia and Latin America. Some of these take the form of ministerial declarations, such as the November 2023 Southern Common Market (MERCOSUR) Ministerial Declaration on the principles of human rights in the field of artificial intelligence,[70] the October 2023 Santiago Declaration to Promote Ethical Artificial Intelligence in Latin America and the Caribbean,[71] and the May 2018 Declaration on AI in the Nordic-Baltic Region by the Nordic Council of Ministers.[72] Others take the form of guides, such as the February 2024 Association of Southeast Asian Nations (ASEAN) Guide on AI Governance and Ethics (ASEAN, 2024), or strategy documents, such as the 2024 African Union Development Agency-New Partnership for Africa's Development (AUDA-NEPAD) White Paper,[73] which led to the adoption, on 17 June 2024, of the African Continental Artificial Intelligence Strategy.[74]

Some regional initiatives prioritize human rights and ethics, while others focus on economic development and growth. The MERCOSUR Declaration strongly emphasizes human rights and transparency, stressing the importance of avoiding discrimination, and of privacy and the integrity of information for democracy and the preservation of culture, while the Santiago Declaration focuses on human rights and ethics. The ASEAN Guide encourages alignment on AI governance and ethics standards based on seven guiding principles,[75] but does not list inclusive growth, sustainable development and well-being – as per Principle 1 of the OECD AI Principles[76] – as a key principle. The ASEAN Guide includes recommendations for both domestic and regional initiatives[77] that governments in the ASEAN region can take to ensure the responsible design, development, and deployment of AI systems. Meanwhile, the AUDA-NEPAD White Paper and the African Union Continental Artificial Intelligence Strategy focus mainly on harnessing the potential of AI for economic development and growth, while promoting ethical use, minimizing potential risks and leveraging opportunities. The white paper stresses the importance of promoting innovation and building African multilingual tools through AI to support a "pan-African renaissance with AI" and lists five pillars of action: human capital development for AI, infrastructure and data, enabling environments for AI development and deployment, AI economy and encouraging investment in AI, and building sustainable partnerships. The Continental Strategy, adopted in June 2024, identifies four priority sectors: agriculture, healthcare, education and climate change adaptation. Likewise, the Arab AI Working Group focuses primarily on cooperation to reduce the digital divide and encourage capacity-building.

(iii) Regional trade agreements and digital economy agreements

AI-specific provisions have started to be incorporated into regional trade agreements (RTAs) and digital economy agreements,[78] but mainly take the form of soft – i.e. non-binding – provisions. While their incorporation into these agreements is positive, such provisions will not be sufficient to prevent regulatory fragmentation. Six agreements include AI-specific provisions. These are the United Kingdom-Australia Free Trade Agreement, the United Kingdom-New Zealand Free Trade Agreement, and the recently signed digital economy agreements between Australia and Singapore (SADEA), between Chile, New Zealand and Singapore (DEPA), between Singapore and the United Kingdom (UKSDEA), and between the Republic of Korea and Singapore (KSDPA), as well as a recently signed free trade agreement between Ukraine and the United Kingdom, which has not yet come into force.

AI provisions essentially take the form of best-endeavour clauses (i.e., which require parties to do everything possible to achieve the desired result). AI-specific provisions typically recognize the increasing importance of AI within the global economy and include best-endeavour clauses to either "collaborate and promote"[79] the development of governance frameworks to promote trusted, safe and responsible use of AI or "to develop"[80] such frameworks taking into account international guidelines, with the UK-Australia and UK-New Zealand agreements specifically referring to the 2019 OECD Principles (OECD, 2019a) (see Chapter 3(b)(iv)). Some agreements, in particular those signed by the United Kingdom, also recognize the importance of a risk-based and outcome-based approach and of the principles of technological interoperability and technological neutrality,[81] and include various cooperation provisions on exchanging information and sharing experiences and good practices on laws, regulations, policies, enforcement and compliance;[82] ethical use, human diversity and unintended biases, industry-led technical standards and algorithmic transparency;[83] research;[84] and playing an active role in international fora,[85] with the UK-Australia and UK-Ukraine agreements explicitly referring to cooperation in the development of international standards, regulations and conformity assessment procedures.

Several AI-specific provisions explicitly refer to trade. Three agreements – United Kingdom-Ukraine,[86] United Kingdom-Singapore[87] and United Kingdom-Australia[88] – explicitly recognize the role of AI in promoting competitiveness and facilitating international trade. The United Kingdom-Australia agreement also encourages activities aimed at facilitating and promoting trade in emerging technologies, and the agreements between the United Kingdom and Ukraine and between the United Kingdom and Singapore encourage active participation in international fora "on matters concerning the interaction between trade and emerging technologies".

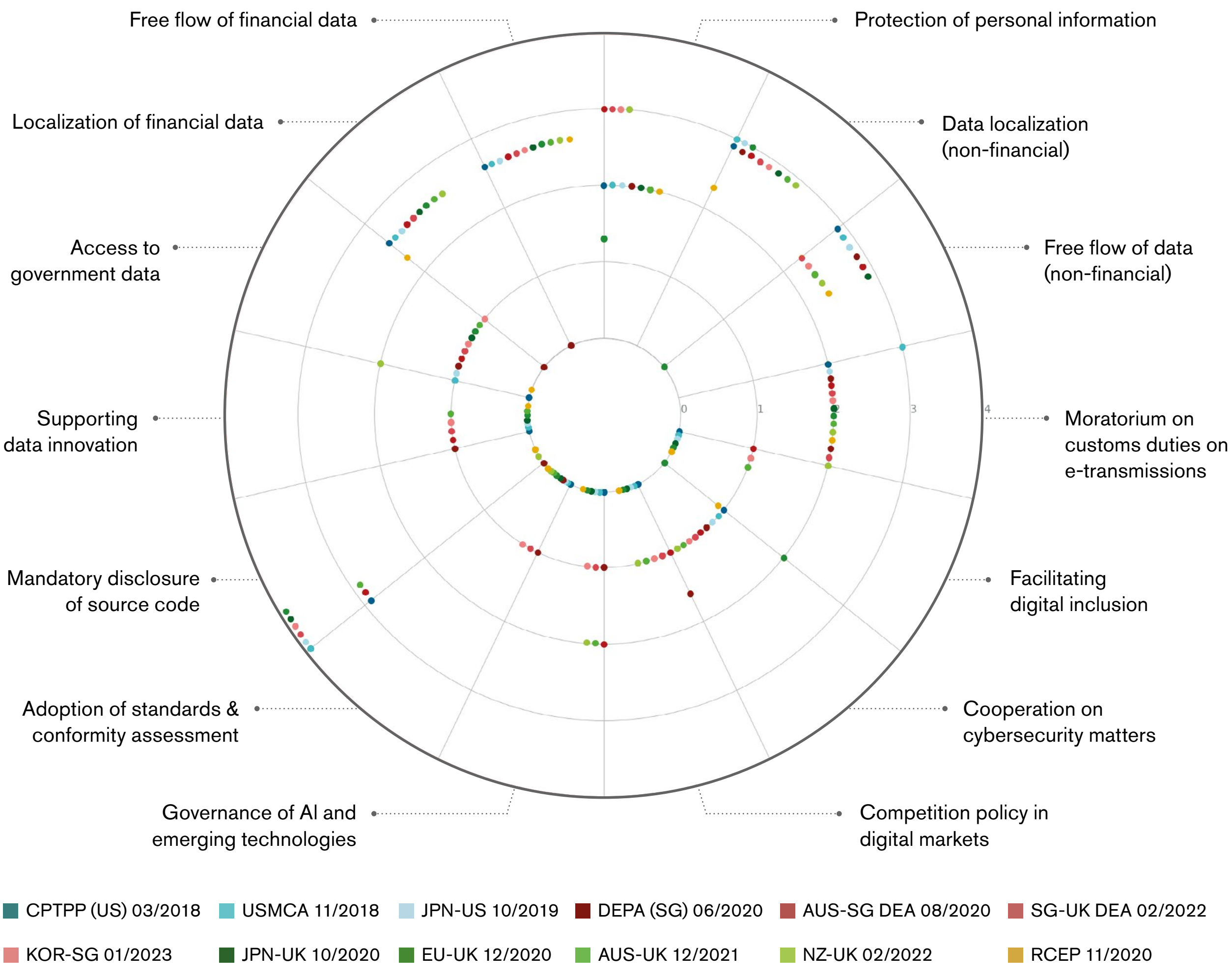
Digital trade provisions included in RTAs are also important for AI development and use. The number of RTAs with digital trade provisions has been growing steadily since the early 2000s. The first digital trade provision can be found in the 2000 Jordan-United States Free Trade Agreement. By the end of 2022, 116 RTAs – representing 33 per cent of all existing RTAs – had incorporated provisions related to digital trade (López-González et al., 2023). These provisions typically include provisions on data flows, data localization, protection of personal information and access to government data, which, as seen in previous sections, play an important role in determining access to data needed to train AI models. Provisions that ban measures mandating disclosure of source code, software and algorithms have also been included in a number of trade agreements, most notably agreements led by the United States. Such provisions typically aim to protect technology firms from government measures requiring trade secrets to be disclosed as a prerequisite for operating in certain industries (Jones et al., 2024). Access to source code can, however, be important to assess the trustworthiness of AI systems (see Chapter 3 (a)(iii)). In addition, prohibitions on disclosure of source code can impact technology access and market competition, and limit the availability of open-source software (Jones et al., 2024). Provisions on source code can, therefore, have a significant impact on the development and use of AI and on promoting AI trustworthiness.

Other provisions related to the adoption of standards and conformity assessment can also play a critical role in promoting trustworthy AI (see Chapter 3(a)(iii)), while provisions on competition in the digital market are important to address the market concentration power of AI (see Chaper3(a)(i)). Finally, provisions on customs duties on electronic transmissions have been important in fostering an environment conducive to digital trade (IMF-OECD-UN-WBG-WTO, 2023).

The depth of digital trade provisions included in RTAs varies significantly, reflecting diverging approaches. Analysing the digital trade provisions of 12 agreements concluded between March 2018 and January 2023, Jones et al. (2024) find a high degree of heterogeneity between the agreements (see Figure 3.7). For example, while most agreements contain binding obligations on the free flow of data, the United Kingdom-European Union RTA does not contain any provision on non-financial data flows. Regarding personal data protection, agreements led by the United States consider voluntary undertakings by private companies as sufficient to safeguard personal data, which contrasts with the European Union's comprehensive approach to data protection under the EU General Data Protection Regulation. Language on open government data takes theform of best-endeavour language in agreements led by the United States and digital economy agreements, while the United Kingdom-New Zealand Free Trade Agreement includes binding but non-specific language. As for disclosure of source code, agreements led by the United States and digital economy agreements include extensive and binding protection of source code, although digital economy agreements do not mention algorithms. In contrast, agreements signed by New Zealand and the Regional Comprehensive Economic Partnership (RCEP) do not include such provisions.[89]

Few developing economies and LDCs have negotiated digital trade provisions. The inclusion of detailed digital trade provisions tends to be more common in RTAs negotiated by high-income and certain middle- to upper middle-income economies. Only a handful of LDCs have engaged in RTAs that contain provisions related to digital trade (IMF-OECD-UN-WBG-WTO, 2023).

Figure 3.7: The depth of digital trade provisions included in RTAs varies significantly



Source: Authors' visualization based on Jones et al. (2024).

Notes: The value "0" (inner circle) means that the agreement does not contain a provision on a given issue. The value "1" means that the agreement contains a provision couched in purely hortatory, or exhortatory, language. The value "2" means that the commitment made is binding but non-specific. The value "3" means that commitments are binding and specific, with actions to be taken (or not taken) described in clear and precise language. The value "4" means that the commitments are binding and specific, with obligations that are more extensive in scope and very detailed. Points located between two lines correspond to the higher value in terms of commitments, but with flexibilities. The greater the flexibilities, the closer the point is to the lower-value inner circle.

Disciplines on trade in services in RTAs are also an important channel through which governments' trade policies and trade obligations can affect the policy environment for AI. However, the level of commitments undertaken differs significantly across economies. Services RTAs provide significantly higher levels of market access and national treatment commitments than under the WTO General Agreement on Trade in Services (GATS) for different modes of supply and services sectors, including for digital and AI-related services. For example, in the context of computer services, all WTO members from Europe, the Middle East and North America have undertaken some market access commitments on data processing services under the GATS and/or RTAs, and most WTO members have done so in Latin America and the Caribbean (88 per cent) and in Asia (91 per cent). However, in Africa, 26 per cent of WTO members have market access commitments on data processing services, whether under the GATS or RTAs, although that proportion will increase when the services commitments of the African Continental Free Trade Area (AfCFTA) enter into force and are notified to the WTO (Roy and Sauvé, forthcoming).[90]

(iv) International initiatives to address the challenges raised by AI

Policy initiatives

The last few years have witnessed a wave of various initiatives related to AI. This impetus has been driven by the realization that the inherently international nature of the risks and benefits associated with AI require discussion, cooperation and solutions that are also international in nature (see Figure 3.8).[91]

These initiatives involve different stakeholders and take different forms. International initiatives involve a broad range of stakeholders, including governments, intergovernmental organizations, international standard-setting bodies and businesses. Most of these initiatives take the form of high level principles, guidance, voluntary recommendations, scientific reports, codes of conduct, or lists of policy examples, while others take the form of international standards. In May 2024, the first binding treaty on AI – the Council of Europe Framework Convention on Artificial Intelligence and human rights, democracy and the rule of law[92] – was adopted.

There are elements of complementarity among such initiatives, and alignment on core principles, but different initiatives prioritize different aspects of AI governance. Some of the common themes across various international initiatives include, for instance, promoting safe, secure, trustworthy, "human-centric", ethical, transparent, accountable and interoperable AI, and identifying and mitigating AI-triggered risks through various actions, domestic policies and international cooperation.[93] However, in certain instances, international initiatives appear to prioritize these themes differently. Some initiatives focus on issues like human rights and the ethics of AI, such as the United Nations Educational, Scientific and Cultural Organization (UNESCO) Recommendation on the Ethics of AI, while others are centred around safety, security, the trustworthiness of AI or its interoperability, such as the Bletchley Declaration on AI Safety.

A number of initiatives also contain various common elements that have an important trade and WTO angle. These include:

- the recognition of the role of regulations and standards (including certification procedures) in governing AI and the importance of interoperability between such tools;
- the need to avoid regulatory fragmentation by using international standards to govern AI;
- the importance of an appropriate and balanced approach to protecting and enforcing IP rights;
- the importance of privacy, personal data protection and data governance;
- the importance of international cooperation, coordination and dialogue.

Importantly, explicit references to the WTO were included in the Final Report of the UN AI Advisory Body. The Final Report stresses the need for "proper orchestration" and coordination among the many international processes and organizations producing key documents related to AI governance, to enable a "shared normative foundation for all AI-related efforts", expressly referring to various WTO agreements, such as the General Agreement on Tariffs and Trade (GATT), the General Agreement on Trade in Services (GATS), the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), the Technical Barriers to Trade (TBT) Agreement, the Information Technology Agreement (ITA) and the Trade Facilitation Agreement (TFA) (paragraph 76 and Figure 9 of the Final Report). The Final Report also notes the pivotal role of international standards and regulatory cooperation and recognizes the key role of the WTO in this area (paragraph 121).[94] Finally, it recommends the creation of a "Global AI Data Framework" involving a variety of key actors, including economies and relevant international organizations, including the WTO (paragraph 170). More detail can be found in Annex 3.

Several of these initiatives also address the environmental impacts of AI. This is the case, for example, for the OECD AI Principles, the G20 AI Principles, the New Delhi Leaders' Declaration,[95] the UNESCO AI Recommendation, the G7 Guiding AI Principles and the G7 AI Code of Conduct, the Bletchley Declaration on AI Safety, and the UN Advisory Board on AI in the United Nations. Further, the International Organization for Standardization (ISO)/International Electrotechnical Commission (IEC) Joint Technical Committee (JTC) and subcommittee (SC) (ISO/IEC JTC 1/SG) is currently developing an international standard specifically about "environmental sustainability aspects of AI systems." AI policy was a key issue at the G20 Summit in Rio de Janeiro in November 2024, with a focus on the use of AI for sustainable development; in the G7 Trieste Ministerial Declaration adopted in 2024, G7 economies also expressed their desire to participate in the G20 AI and sustainability discussions.

However, there is still no global alignment on AI terminology. Global agreement over key AI terminology and definitions may be a particularly important trade-related element, as it may help to ensure coherence and interoperability and to avoid fragmentation across various domestic AI regulatory regimes (Meltzer, 2023). As explained in this report, regulatory fragmentation can itself represent an important trade barrier, in particular for developing economies and micro, small and medium-sized enterprises (MSMEs). In this respect, the OECD AI Principles[96] contain various AI definitions, of which the definitions of an "AI system"[97] and an "AI system lifecycle"[98] are key for the implementation of any domestic AI strategy or policy and, in particular, for regulation. The Council of Europe Framework Convention on Artificial Intelligence and human rights, democracy and the rule of law[99] also contains a definition of an "AI system" which is virtually identical to that in the OECD Principles.[100] The ISO/IEC JTC 1/SG 42, which is dedicated to AI standard-setting, adopted in 2022 a document[101] containing a wide range of detailed definitions and terminology in the field of AI. It included a definition of an "AI system", which shares some similarities but also includes some differences with the definition in the OECD Principles. Finally, while the G20 AI Principles[102] have more or less integrated all of the OECD Principles, they do not expressly endorse the definitions, including that of an "AI System". Unlike OECD and ISO/IEC, the UNESCO Recommendation on AI Ethics does not define AI.[103]

Some initiatives seem to be moving beyond general principles or guidance into implementing more targeted or specific actions. For instance, in order to foster their knowledge on existing approaches and practices, the G20 launched the "Examples of National Policies to Advance the G20 AI Principles",[104] and the G20 "Policy Examples on How to Enhance the Adoption of AI by MSMEs and Start-up".[105] In 2024, the G7 announced plans to advance its 2023 Hiroshima AI process. The planned actions include expanding outreach to partner governments to broaden support for the G7 AI Guiding Principles and Code of Conduct, intensifying efforts to encourage adherence to these two instruments, and intensifying cooperation across multilateral forums to promote the G7 vision for advanced AI systems.[106] In addition, following up on the 2023 Bletchley Declaration on AI Safety, governments have agreed to convey a panel of experts to produce an Intergovernmental Panel on Climate Change (IPPC)-like "State of the Science" Report,[107] which will aim to review the latest cutting-edge research on the risks and capabilities of frontier AI models. The interim *International Scientific Report on the Safety of Advanced AI* was published in May 2024[108] and summarizes the best of existing research, while identifying areas of research priority. It does not make policy or regulatory recommendations, but instead aims to inform both domestic and international policymaking. The final report is expected to be published ahead of the next AI summit which is expected to be held in February 2025 in France (see also Annex 3).

The significant overlap between initiatives, the differing priorities and the lack of agreement on key terminology could create implementation challenges. This may limit efforts to prevent fragmentation. Alignment on core principles does not guarantee alignment on how such principles can be implemented in practice. In the absence of strong coordination, current international initiatives may not be sufficient to prevent regulatory fragmentation at the global level. The need to improve coordination was acknowledged in the Final Report (2024) of the UN AI Advisory Body (AIAB) published in September 2024 and the Global Digital Compact adopted by the UN General Assembly in September 2024. The Final Report identifies three "global AI governance gaps" to be addressed: a "representation" gap, a "coordination" gap and an "implementation" gap. The WTO is relevant for all three, and as noted above, specific references to the WTO are included in various places of the Final Report. As for the Global Digital Compact, it includes a commitment by UN members to initiate a Global Dialogue on AI governance involving governments and all relevant stakeholders (paragraph 56).

International initiatives to close the AI divide

Increasingly, international organizations are developing courses on AI and are integrating AI in their technical assistance activities, some of which have a trade component. The International Telecommunication Union (ITU), for example, offers an online course titled "The governance of artificial intelligence" and, in partnership with 40 other UN agencies, the ITU launched "AI for Good," an action-oriented global platform on AI to identify practical applications of AI to advance the UN Sustainable Development Goals (SDGs).[109] AI for Good includes a year-round online programme of webinars, with an annual in-person AI for Good Global Summit. Other specialized UN agencies have developed projects focused on their own areas of expertise. UNESCO, for example, has a developed a Readiness Assessment Methodology to support its members in their implementation of the UNESCO Recommendation on the Ethics of AI, and is providing targeted technical assistance in this context through projects such as its "AI needs assessment in African countries" programme.[110] Meanwhile, the United Nations Industrial Development Organization (UNIDO) has been organizing dialogues on "Empowering SMEs in Developing Countries through Artificial Intelligence"[111] to promote AI adoption by MSMEs in developing economies, to enhance their competitiveness and sustainability through shared conversations. A related publication by UNIDO includes practical recommendations and tools to help MSMEs navigate challenges and leverage AI for various business functions and production areas. As for the World Bank, two notable projects with an AI dimension are the "Machine learning in Algeria" project, which aims to enhance efficiency and integrity in customs operations using machine learning, and "Fraud analytics in Kenya using AI applications", which aims to improve revenue collection through anti-fraud measures.[112] And the United Nations Interregional Crime and Justice Research Institute (UNICRI) has developed a course for law enforcement agencies to equip them with the necessary resources to institutionalize responsible AI, ensuring its alignment with human rights and ethics.[113]

Figure 3.8: Key international policy initiatives in the area of AI

May 2019
OECD, AI Principles

June 2019
G20, AI Principles

November 2021
UNESCO, Recommendation on the Ethics of AI

May 2023
G7, Hiroshima Process on Generative AI

October 2023
G7, AI Guiding Principles, AI Code of Conduct

November 2023
AI Safety Summit, "Bletchley Declaration" on AI Safety

March 2024
UN General Assembly, AI Resolution

May 2024
International Scientific Report on the Safety of Advanced AI (interim report)

May 2024
Council of Europe, Framework Convention on AI, Human Rights, Democracy and the Rule of Law

May 2024
At Seoul Summit, agreement to launch an international network of AI Safety Institutes*

September 2024
Publication of the Final Report of the UN AI Advisory Body

September 2024
Adoption of the UN Global Digital Compact.

* Signatories include Australia, Canada, the European Union, France, Germany, Italy, Japan, the Republic of Korea, Singapore, the United Kingdom and the United States.

The UN AI Advisory Body (AIAB) has called for the establishment of a global fund for AI. Published in September 2024, the Final Report of the UN AIAB recommends the creation of a global fund for AI to "put a floor under the AI divide". Managed by an independent governance structure, the fund would receive financial and in-kind contributions from public and private sources to facilitate access to AI enablers, such as shared computing resources for model training, sandboxes and curated data sets "to catalyse local empowerment for the SDGs".[114] The Global Digital Compact,[115] which was adopted by the United Nations General Assembly in September 2024 after the publication of the UN AIAB report, calls for "innovative voluntary financing options for artificial intelligence capacity-building that take into account the recommendations of the High-level Advisory Body on Artificial Intelligence on a Global Fund on AI".

Endnotes

1 See https://ourworldindata.org/extreme-poverty-in-brief.

2 See https://eto.tech/.

3 See https://eto.tech/.

4 See https://oecd.ai/en/data.

5 See https://stackoverflow.com/.

6 See https://ourworldindata.org/grapher/share-new-artificial-intelligence-cs-phds-female.

7 At the same time, AI also holds procompetitive potential. For instance, it empowers consumers to utilize abundant data for personalized products and transactions, and guides them in navigating complex or uncertain markets to select the best offers based on preferences. This may lead to the emergence of "algorithmic consumers", whose decision-making is partially automated through algorithms (Gal and Elkin-Koren, 2017).

8 Various competition enforcement cases were recently launched against AI companies. For example, the US Federal Trade Commission (FTC) went to court to block a proposed acquisition of Arm Ltd. by Nvidia, one of the leading producers of advanced chips powering AI, which resulted in the latter abandoning the deal(see https://www.ftc.gov/news-events/news/press-releases/2022/02/statement-regarding-termination-nvidia-corps-attempted-acquisition-arm-ltd). The European Commission, like the UK Competition Markets Authority and the FTC, also started looking into whether the investment of Microsoft in OpenAI constituted a merger (European Commission, 2024a). Cognizant of the risks that AI poses for competition, the competition authorities of the European Union, the United Kingdom and the United States of America issued in July 2024 a Joint Statement on Competition in Generative AI Foundation Models and AI Products laying out various principles for protecting competition in the AI ecosystem (see https://www.gov.uk/government/publications/joint-statement-on-competition-in-generative-ai-foundation-models-and-ai-products).

9 An example of this is the fact that the Google search engine can outperform that of Microsoft because the former has wider access to rarer queries. Having a variety of data and, in particular, its ability to capture more rare events are also important for making better predictions (Goldfarb and Trefler, 2018).

10 However, advancements such as federated learning, which allows entities in various locations to build machine learning models collaboratively, without exchanging data (it is the algorithm that is transferred, not the data itself), and data trusts, a system and legal entity that manages someone's data on their behalf, could mitigate the challenges linked to cross-border data flows (Bonawitz et al., 2019; World Economic Forum, 2020a).

11 AI can turn even non-personal enterprise and operational data, such as stock inventory, into privacy risks. These data, stored within corporate networks, can inadvertently reveal information about personnel involved in data collection or analysis. In addition, metadata in online communications, such as phone numbers, emails or IP addresses, can make users identifiable even if the data do not directly reveal personal identities (Lee-Makiyama, 2018).

12 See https://www.consilium.europa.eu/en/press/press-releases/2024/10/10/eu-brings-product-liability-rules-in-line-with-digital-age-and-circular-economy/#:~:text=The%20EU's%20product%20liability%20regime,caused%20the%20injury%20or%20damage and https://eur-lexeuropa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022PC0496.

13 Trustworthiness is mentioned in international AI principles and declarations as a key attribute that an AI system should possess. See, for example, https://www.gov.uk/government/publications/ai-safety-summit-2023-the-bletchley-declaration/the-bletchley-declaration-by-countries-attending-the-ai-safety-summit-1-2-november-2023,https://www.mofa.go.jp/policy/economy/g20_summit/osaka19/pdf/documents/en/annex_08.pdf, Organisation for Economic Co-operation and Development (2019a) and United Nations Educational, Scientific and Cultural Organization (2021). In AI terminology, "trustworthiness" means the "ability to meet stakeholder … expectations in a verifiable way" (e.g., via certification against technical specification in a regulation or standard). More specifically, the trustworthiness of an AI system relates to its ability to meet various expectations, for example in terms of its "reliability", "availability", "resilience", "security", "privacy", "safety", "accountability", "transparency", "integrity", "authenticity", "quality" and "usability". See ISO/IEC standard 22989:2022, sub clause 3.5.16 (Trustworthiness - definition) and clause 5.15 (Trustworthiness - concept). See also ISO/IEC TR 24028:2020. While the composite term "safe and trustworthy" AI is frequently used, given that "safety" is subsumed into the above definition of trustworthiness, in this report, for simplicity, we will only refer to trustworthy AI.

14 For instance, certain risks may be associated with AI enabled autonomous vehicles that stem not from the physical components of the vehicle. Instead, the AI algorithm (and how it has been trained), may lead the vehicle to "behave" in a risky manner, causing not only material harms (e.g., physical injuries to the driver, passengers or pedestrians) but also, uniquely, immaterial harms (e.g., privacy, cybersecurity, etc.). See UK Parliament House of Commons' Report on Self-Driving Vehicles (HC 519, 15 Sep 2023), paragraph 66 (noting studies warning that "fleets or models of self-driving vehicles could be targeted by 'malicious, possibly terrorist, systemic hacking'"). Regulatory solutions to such immaterial risks may also present complex ethical questions, e.g., the famous "trolley problem", whereby an autonomous vehicle has to "choose", for example, between colliding with an elderly person and colliding with a mother and her young child. (e.g., Wells (2023); Lin (2021)).

15 "Injury to pedestrians due to the malfunction of an autonomous vehicle AI system would be tangible physical harm. Some harms, however, such as psychological harms, may not be as tangible or quantifiable. Other aspects of harm that may be intangible or difficult to directly observe include bias or discrimination that may disproportionately and negatively impact particular communities but be difficult to observe at the level of the individual. Violations of the fundamental right to privacy may also be intangible, such as the non transparent use of an employee monitoring AI system". OECD Working Party on Artificial Intelligence Governance: Stocktaking for the development of an AI incident definition, document EP/AIGO(2022)11/FINAL (21 Oct 2023).

16 See, e.g., Report from the European Commission to the European Parliament, the Council and the European Economic and Social Committee on "The Safety And Liability Implications of Artificial Intelligence, the Internet of Things and Robotics", COM(2020) 64 final (19 February 2020), page 8.https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0064

17 See https://www.iso.org/committee/6794475/x/catalogue/p/1/u/0/w/0/d/0.

18 The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) addresses inter alia the protection of trade secrets, including imposing certain conditions when proprietary information ("undisclosed tests and other data") is accessed and used by governments for regulatory purposes, albeit only in the context of "marketing approval" (e.g., conformity assessment procedures such as product certification and approval) of pharmaceuticals and agricultural chemical purposes (Article 39.3). Similarly, the Technical Barriers to Trade (TBT) Agreement requires that WTO members ensure that the confidentiality of information in the context of conformity assessment procedures (e.g. product certification and approval) is (i) respected for imported and national products "in the same way" and (ii) respected "in such a manner that legitimate commercial interests are protected." (Article 5.2.4).

19 Mitchell et al. (2023) contains a detailed analysis of circumstances when regulating AI can be performed without need to access source code ("white box" testing for low-risk AI systems), and of circumstances when the need for a deeper understanding and explanation of the AI system's decisions and recommendations is needed (high risk AI systems) and justifies requiring access to the code ("black box" testing).

20 "Evolution" in the sense that some AI systems allow the product to better perform, adapt and finetune overtime for a given circumstance or for a given user, as it works in practice and receives and crunches more data; a sort of "personalized AI product" similar to the idea of "personalized medicine" (e.g., using knowledge of a patient's genetic profile to select "the proper medication or therapy and administer it using the proper dose or regimen" – see https://www.genome.gov/genetics-glossary/Personalized-Medicine). In fact, AI can be a driver and enabler for advancing personalized medicine in the area of genomics medicine. See Cesario et al. (2023); World Health Organization (2021).

21 In this respect, the EU AI Act (2024a), for instance, notes in its preamble (recital 5), that "AI may generate risks and cause harm to public interests and fundamental rights" and that "[s]uch harm might be material or immaterial, including physical, psychological, societal or economic harm." (italics added).

22 Lund et al. (2023) present a useful example of this tension with respect to medical devices, explaining that one of the "main obstacles of using AI in healthcare, and therefore AI-based medical software" is "How to address continuous change i.e., locked algorithms vs non-locked autonomous systems is a challenge. The strength and advantages with AI/ML are the ability to train and improve the system based on new real-world data. However, the system also needs to be continuously safe for patients and other users, as well as comply with the applicable regulations regarding, for example, validation".

23 For instance, "[c]ustomisation makes traceability and enforcement of product safety and cybersecurity more challenging – many products (or properties) are changing constantly" (Lund et al. 2023).

24 The EU AI Act (2024a), for instance, seems to contain certain provisions on this issue, as it requires that AI systems be re certified if, after deployed, they present unforeseen "substantive modifications" (as defined in Article 1.5(23)), i.e., "… whenever a change occurs which may affect the compliance of a high risk AI system with this Regulation (e.g. change of operating system or software architecture), or when the intended purpose of the system changes, that AI system should be considered a new AI system which should undergo a new conformity assessment." However, "changes occurring to the algorithm and the performance of AI systems which continue to 'learn' after being placed on the market or put into service (i.e., automatically adapting how functions are carried out) should not constitute a substantial modification, provided that those changes have been pre-determined by the provider and assessed at the moment of the conformity assessment". The EU AI Act also foresees that ex post marketing surveillance over AI products may: "ensure that the possible risks emerging from AI systems which continue to 'learn' after being placed on the market or put into service can be more efficiently and timely addressed".

25 ISO/IEC TR 24368 (2022) gives examples of areas in which there is an "increasing risk for undesirable ethical and societal outcomes and harms", e.g.,: "financial"; "psychological"; "physical health or safety"; "intangible property (for example, IP theft, damage to a company's reputation)"; "social or political systems (for example, election interference, loss of trust in authorities)"; and "civil liberties (for example, unjustified imprisonment or other punishment, censorship, privacy breaches)".

26 Commenting on the fact that the AI Act's implementation may involve the adoption of technical standards for addressing both material (e.g., heath) and immaterial risks (e.g., fundamental rights), Smuha and Yeung (2024), observe that: "… unlike risks to safety generated by chemicals, machinery or industrial waste, all of which can be materially observed and measured, fundamental rights are, in effect, political constructs. These rights are accorded special legal protection so that an evaluation of alleged interference requires close attention to the nature and scope of the relevant right and the specific, localized context in which a particular right is allegedly infringed. We therefore seriously doubt whether fundamental rights can ever be translated into generalized technical standards that can be precisely measured in quantitative terms, and in a manner that faithfully reflects what they are, and how they have been interpreted under the European Charter on Fundamental Rights and the European Convention on Human Rights".

27 See also WTO official document number G/TBT/GEN/356, available at https://docs.wto.org/.

28 RDC n° 657/2022 – Anvisa https://antigo.anvisa.gov.br/documents/10181/5141677/RDC_657_2022_.pdf/f1c32f0e-21c7-415b-8b5d-06f4c539bbc3.

29 Such as Israel, Japan, the Republic of Korea, Singapore, the United Kingdom and the United States. The Global AI Index 2024 published by Tortoise Media, which ranks economies by their AI capacity at the international level: https://www.tortoisemedia.com/intelligence/global-ai/.

30 See, for example, the European Union's Artificial Intelligence Act (AIA) (https://artificialintelligenceact.eu/), under which all providers of "general purpose AI models" are mandated to create technical documentation that details the training and testing processes, establish a copyright policy, and provide a sufficiently detailed summary of the content used for training. In contrast, free and open AI models are only obliged to establish a copyright policy and submit a summary of training content.

31 While copyright protects creation of the (human) mind, patent protection is available for technical innovations (by humans).

32 US Copyright Registration Guidance: Works Containing Material Generated by Artificial Intelligence, available at https://copyright.gov/ai/ai_policy_guidance.pdf; US Court of Appeals for the 9th Circuit, Naruto v. Slater, https://cdn.ca9.uscourts.gov/datastore/opinions/2018/04/23/16-15469.pdf; US District Court for the District of Columbia, Thaler v. Perlmutter, https://ecf.dcd.uscourts.gov/cgi-bin/show_public_doc?2022cv1564-24.

33 CJEU, Infopaq International A/S v Danske Dagblades Forening, Case C-5/08 (Intellectual Property Repository, 2023; Zhou, 2019).

34 Strategies articulate the government's vision regarding the contribution of science, technology and innovation (STI) to the social and economic development of an economy. They set priorities for public investment in STI and identify the focus of government reforms, for instance in areas such as funding public research and promoting business innovation (OECD, 2016b).

35 See OECD AI database. https://oecd.ai/en/dashboards/overview

36 Although not a country, the European Union has the power to adopt EU-wide trade-related legislation within the parameters set by its founding treaties.

37 See https://ec.europa.eu/commission/presscorner/detail/en/ip_24_383.

38 See https://digital-strategy.ec.europa.eu/en/policies/plan-ai.

39 Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 laying down harmonised rules on artificial intelligence and amending regulations (EC) No 300/2008, (EU) No 167/2013, (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1139 and (EU) 2019/2144 and Directives 2014/90/EU, (EU) 2016/797 and (EU) 2020/1828 (Artificial Intelligence Act). AIA was published in the EU Official Journal on 12 July 2024 and entered into force 20 days later. However, most of AIA's rules are only applicable 24 months after its entry into force, although it provides for shorter applicability periods with respect to certain rules (e.g., bans on "prohibited practices" that are listed as posing "unacceptable risks" will already apply six months after entry into force), as well as longer periods for others (e.g., 36 months for certain "high risk systems" covered by existing EU harmonization legislation and for general purpose AI systems on the EU market before the Act applies to them).

40 In the notification in 2021 of a draft of the AIA (document G/TBT/N/EU/850), the European Union explained that this proposal was meant to provide: "… a set of recommendations intended to help the organization develop, provide, or use AI systems responsibly in pursuing its objectives and meet applicable requirements, obligations related to interested parties and expectations from them. It includes the following: approaches to establish trust in AI systems through transparency, explainability, controllability, etc.; engineering pitfalls and typical associated threats and risks to AI systems, along with possible mitigation techniques and methods; and approaches to assess and achieve availability, resiliency, reliability, accuracy, safety, security and privacy of AI systems. This document is applicable to any organization, regardless of size, type and nature, that provides or uses products or services that utilize AI systems".

41 However, some experts argue that some important provisions of the AI Act do not follow a purely risk based approach (Ebers, 2024).

42 See https://oecd.ai/en/.

43 For example, the UK has committed £100 million toward building a "public foundation model" to support academic, small business and public sector applications (see https://www.gov.uk/government/news/initial-100-million-for-expert-taskforce-to-help-uk-build-and-adopt-next-generation-of-safe-ai), and the US National Artificial Intelligence Research Resource is working in a similar direction (see https://new.nsf.gov/focus-areas/artificial-intelligence/nairr).

44 Standards are one of the three types of technical barriers to trade (TBT) measures that establish product specifications. They differ from technical regulations, however, as standards are voluntary documents. It is also not uncommon for standards adopted by governments to be made mandatory later on, thus becoming technical regulations. Standards can be developed by different entities within WTO Members, including both governmental and non-governmental bodies (WTO, 2021).

45 See, e.g., Kerry (2024). For instance, in 2024, China issued draft Guidelines for AI Standardisation which proposes to form more than 50 national and industry-wide standards and more than 20 international standards for AI by 2026 (see https://www.reuters.com/technology/china-issues-draft-guidelines-standardising-ai-industry-2024-01-17/ and https://mmlcgroup.com/miit-ai/). The European Commission mandated European standardisation organizations to develop AI-related standards taking into account that standards will play an important role in fulfilling requirements under the EU AI Act (https://ec.europa.eu/transparency/documents-register/detail?ref=C(2023)3215&lang=en).

46 For example, China's standards strategy of 2021 identified AI as one of the key areas. See Kerry (2024).

47 This is based on the data from the AI Standards Hub and is provided for illustration purposes only. This data is presented without prejudice, and should not be understood as a position, on whether these documents are "standards" within the definition of Annex 1 of the TBT Agreement. See AI Standards Search - AI Standards Hub.

48 See the AI Standards Hub at https://aistandardshub.org.

49 For example, the WTO Technical Barriers to Trade (TBT) Agreement requires that WTO members use relevant international standards as a basis of their domestic standards, technical regulations and certification procedures (see Chapter 4).

50 See https://webarchive.nla.gov.au/awa/20220816053410/https://www.industry.gov.au/data-and-publications/australias-artificial-intelligence-action-plan.

51 See http://gd.china-embassy.gov.cn/eng/zxhd_1/202310/t20231024_11167412.htm.

52 See https://www.whitehouse.gov/briefing-room/presidential-actions/2023/10/30/executive-order-on-the-safe-secure-and-trustworthy-development-and-use-of-artificial-intelligence/. See also NIST "A Plan for Global Engagement on AI Standards" (final, July 2024 - available at: https://nvlpubs.nist.gov/nistpubs/ai/NIST.AI.100-5.pdf) and US Government National Standards Strategy for Critical and Emerging Technology presented at the TBT Committee meeting held on 21-23 June 2023 (https://docs.wto.org/dol2fe/Pages/SS/directdoc.aspx?filename=q:/G/TBT/M90.pdf&Open=True, paragraph 6.32).

53 For example, Australia has been actively engaged in the work of the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) Joint Technical Committee (ISO/IEC JTC1/SC42) and, in 2024, Australia announced the adoption of one of the ISO/IEC JTC1/SC42 standards (see https://www.standards.org.au/news/standards-australia-adopts-the-international-standard-for-ai-management-system-as-iso-iec-42001-2023).

54 EU AI Act, Preamble, Recital (176).

55 While there is no globally agreed definition, the European Parliament Research Service notes in its paper on "Artificial Intelligence Act and Regulatory Sandboxes" (https://www.europarl.europa.eu/RegData/etudes/BRIE/2022/733544/EPRS_BRI(2022)733544_EN.pdf) that "regulatory sandboxes generally refer to regulatory tools allowing businesses to test and experiment with new and innovative products, services or businesses under supervision of a regulator for a limited period of time. As such, regulatory sandboxes have a double role: 1) they foster business learning, i.e. the development and testing of innovations in a real-world environment; and 2) support regulatory learning, i.e. the formulation of experimental legal regimes to guide and support businesses in their innovation activities under the supervision of a regulatory authority".

56 See https://aiverifyfoundation.sg.

57 i.e., the initial version of a product that includes only the core features necessary to meet basic user needs and gather feedback for future improvements.

58 WTO official documents IP/N/1/JPN/36, IP/N/1/JPN/C/6 and IP/C/M/92/Add.1, available at https://docs.wto.org/.

59 The UK Copyright, Designs and Patents Act 1998 provides that authorship is attributed to "the person by whom the arrangements necessary for the creation of the work are undertaken", paragraph 9(3). Other common law jurisdictions such as India (copyright Act 1957 paragraph 2(d)), Ireland (Copyright and Related Rights Act 2000 21), New Zealand (Copyright Act 1994 5(1)) and South Africa (Copyright Act 1978 1(iv)) follow the UK approach.

60 For more information on developing economies pursuing open government data policies see Verhulst and Young (2017).

61 See https://data.gov.in/.

62 See https://perma.cc/JAX3-55U8.The OECD recently launched an Open Government Data project to map practices across economies and assess the impact of open government data (OECD, 2019b).

63 Unlike anti-trust policies, ex ante regulations apply at an industry or sectoral level and attempt to define how the largest companies must compete in the market. One such set of regulations is the European Union Digital Markets Act (DMA), which entered into force in November 2022 and became applicable, for the most part, on 2 May 2023. The DMA is designed to address the market power of major digital platforms, referred to as "gatekeepers". It aims to ensure fair competition and innovation in the digital market by preventing gatekeepers from imposing unfair conditions on businesses and consumers (European Commission, 2022). The DMA includes specific obligations for these gatekeepers, such as allowing third parties to interoperate with their services and prohibiting them from favouring their own services. The UK Digital Markets, Competition and Consumers Bill is another example of new ex ante approach to digital markets. The Bill encourages the most powerful firms in dynamic digital markets to work with regulators to ensure that competition is maintained on an ongoing basis. See https://www.gov.uk/government/news/changes-to-digital-markets-bill-introduced-to-ensure-fairer-competition-in-tech-industry#:~:text=The%20Digital%20Markets%2C%20Competition%20and,in%20and%20innovate%20new%20technology.

64 The Safe Harbour Privacy Principles, which were developed between 1998 and 2000 to prevent private organizations within the European Union or United States that store customer data from accidentally disclosing or losing personal information, were brought down by the European Court of Justice (ECJ) in 2020 after Max Schrems, an Austrian activist, lawyer and author brought a case against Facebook for its privacy violations, including violations of European privacy laws and the alleged transfer of personal data to the US National Security Agency (NSA) as part of the NSA's PRISM data-mining programme. The Safe Harbour Privacy Principles were replaced with the Privacy Shield until 2020, when the ECJ once again brought it down. A new agreement was reached in July 2023 to allow data flows based on the "adequacy decision" mechanism of the EU General Data Protection Regulation.

65 The United States initiated export controls on semi-conductors in 2022, and these restrictions were broadened over time. In 2023, the Netherlands imposed restrictions on high end chipmaking. The United Kingdom, Canada and Japan followed with their own restrictions. See Financial Times (2022) and Wolff (2022).

66 See https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds615_e.htm.

67 See https://digital-strategy.ec.europa.eu/en/library/eu-us-terminology-and-taxonomy-artificial-intelligence.

68 See https://digital-strategy.ec.europa.eu/en/library/ai-public-good-eu-us-research-alliance-ai-public-good.

69 See https://www.whitehouse.gov/briefing-room/statements-releases/2023/10/12/u-s-singapore-critical-and-emerging-technology-dialogue-joint-vision-statement/.

70 See https://www.raadh.mercosur.int/wp-content/uploads/2024/04/DECLARACION-SOBRE-LOS-PRINCIPIOS-DE-DERECHOS-HUMANOS-EN-EL-AMBITO-DE-LA-INTELIGENCIA-ARTIFICIAL.pdf.

71 See https://minciencia.gob.cl/uploads/filer_public/40/2a/402a35a0-1222-4dab-b090-5c81bbf34237/declaracion_de_santiago.pdf.

72 See https://www.stjornarradid.is/library/04-Raduneytin/ForsAetisraduneytid/Framtidarnefnd/AI%20in%20the%20Nordic-Baltic%20region.pdf.

73 See https://dig.watch/resource/auda-nepad-white-paper-regulation-and-responsible-adoption-of-ai-in-africa-towards-achievement-of-au-agenda-2063.

74 See https://au.int/en/pressreleases/20240617/african-ministers-adopt-landmark-continental-artificial-intelligence-strategy#:~:text=The%20Continental%20AI%20Strategy%20provides,potential%20risks%2C%20and%20leveraging%20opportunities.

75 The seven guiding principles are transparency and explainability, fairness and equity, security and safety, robustness and reliability, human-centricity, privacy and data governance, and accountability and integrity.

76 See https://www.oecd.org/en/topics/sub-issues/ai-principles.html.

77 National recommendations include nurturing AI talent and upskilling the workforce, supporting the AI innovation ecosystem and promoting investment in AI start-ups, investing in AI research and development, promoting adoption of useful tools by businesses to implement the ASEAN Guide on AI Governance and Ethics, and raising awareness among citizens on the effects of AI in society. The regional recommendations are:

to establish an ASEAN Working Group on AI Governance consisting of representatives from member states to drive and oversee AI governance initiatives in the region; to adapt the AI Guide to address the governance of generative AI; and to compile a compendium of use cases demonstrating practical implementation of the AI Guide by organizations operating in ASEAN.

78 Digital economy agreements are a new type of agreement. They aim to regulate digital trade, data flows and emerging technologies like AI. Digital economy agreements reflect governments' response to the need for regulatory frameworks tailored to the complexities of digital trade and the digital economy. To date, four digital economy agreements have been signed and have entered into force: the Singapore-Australia Digital Economy Agreement (SADEA), signed in 2020; the Digital Economy Partnership Agreement (DEPA) between Chile, New Zealand and Singapore, signed in 2020; the United Kingdom-Singapore Digital Economy Agreement (UKSDEA), signed in 2022; and the Republic of Korea-Singapore Digital Partnership Agreement (KSDPA), signed in 2022. Others under negotiation include the ASEAN Digital Economy Framework Agreement (DEFA) and the EFTA-Singapore Digital Economy Agreement.

79 KSDPA, DEPA and United Kingdom-Australia.

80 United Kingdom-Australia, United Kingdom-New Zealand and United Kingdom-Singapore (the latter specifies "where appropriate").

81 United Kingdom-Ukraine, United Kingdom-Singapore and United Kingdom-New Zealand

82 United Kingdom-Ukraine, KSDPA, United Kingdom-Singapore and United Kingdom-New Zealand.

83 United Kingdom-Ukraine, United Kingdom-Singapore and United Kingdom-New Zealand.

84 United Kingdom-Ukraine, United Kingdom-Singapore, SADEA and United Kingdom-Australia.

85 United Kingdom-Ukraine and United Kingdom-New Zealand.

86 Article 132-V.

87 Article 8.61-R.

88 Article 20.4.

89 New Zealand decided to exclude provisions on source code from its agreements following a November 2021 decision of the Waitangi Tribunal, which found the source code provision in the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) to be in breach of the Treaty of Waitangi after Māori tech experts argued that there was a risk of biased assumptions in algorithmic design or training data. See Jones (2024).

90 The analysis in Roy and Sauvé (forthcoming) is based on 142 RTAs notified under GATS Article V.

91 See, for example, the Bletchley Declaration (2023b), which states that, "[m]any risks arising from AI are inherently international in nature, and so are best addressed through international cooperation".

92 See https://www.coe.int/en/web/artificial-intelligence/the-framework-convention-on-artificial-intelligence.

93 While, so far, AI global governance initiatives have, on the one hand, "yielded similarities in language, such as the importance of fairness, accountability, and transparency", on the other hand, approaches on defining AI are less coordinated and coherent (UN Interim AI Report, 2023).

94 i.e., calling for a "AI Standards Summit" involving key internation standard-setting bodies (e.g., International Telecommunication Union (ITU), the International Organization for Standardization (ISO)/ International Electrotechnical Commission (IEC) and the Institute of Electrical and Electronics Engineers (IEEE)) and expressly indicating that the WTO should be involved in these discussions.

95 See https://www.mea.gov.in/Images/CPV/G20-New-Delhi-Leaders-Declaration.pdf.

96 See https://www.oecd.org/en/topics/sub-issues/ai-principles.html.

97 See the OECD revised definition of "AI system": an "AI system" is "a machine-based system that, for explicit or implicit objectives, infers, from the input it receives, how to generate outputs such as predictions, content, recommendations, or decisions that can influence physical or virtual environments. Different AI systems vary in their levels of autonomy and adaptiveness after deployment".

98 An "AI system lifecycle" involves the: "i) 'design, data and models'; which is a context dependent sequence encompassing planning and design, data collection and processing, as well as model building; ii) 'verification and validation'; iii) 'deployment'; and iv) 'operation and monitoring'. These phases often take place in an iterative manner and are not necessarily sequential. The decision to retire an AI system from operation may occur at any point during the operation and monitoring phase" – see OECD AI Principles (2019), section 1.I.

99 See https://www.coe.int/en/web/artificial-intelligence/the-framework-convention-on-artificial-intelligence.

100 So far, some domestic AI regulations, such as the EU's AIA and Brazil's draft Senate Bill n. 2338/2023, seem to have adopted, almost verbatim, the OECD Principles definitions, including that of "AI system".

101 See ISO/IEC 22989:2022 (available at https://standards.iso.org/ittf/PubliclyAvailableStandards/index.html).

102 See https://wp.oecd.ai/app/uploads/2021/06/G20-AI-Principles.pdf.

103 It states in this respect that it "does not have the ambition to provide one single definition of AI, since such a definition would need to change over time, in accordance with technological developments. Rather, its ambition is to address those features of AI systems that are of central ethical relevance" Yet, the Recommendation does provide a broad understanding of what "AI systems" mean, i.e., "systems which have the capacity to process data and information in a way that resembles intelligent behaviour, and typically includes aspects of reasoning, learning, perception, prediction, planning or control" (paragraph 2). For UNESCO, such broad understanding is "crucial as the rapid pace of technological change would quickly render any fixed, narrow definition outdated, and make future-proof policies infeasible" (UNESCO, 2023).

104 See http://www.g20.utoronto.ca/2020/2020-g20-leaders-declaration-1121.html#:~:text=We%2C%20the%20G20%20Leaders%2C%20meeting,century%20for%20all%20by%20empowering

105 See http://www.g20italy.org/wp-content/uploads/2021/11/Annex1_DECLARATION-OF-G20-DIGITAL-MINISTERS-2021_FINAL.pdf

106 See https://www.digital.go.jp/assets/contents/node/basic_page/field_ref_resources/390de76d-d4f5-4f45-a7b4-f6879c30c389/0fbffe8a/20231201_en_news_g7_result_00.pdf.

107 See https://www.gov.uk/government/publications/ai-safety-summit-2023-chairs-statement-state-of-the-science-2-november/state-of-the-science-report-to-understand-capabilities-and-risks-of-frontier-ai-statement-by-the-chair-2-november-2023.

108 See https://assets.publishing.service.gov.uk/media/66f5311f080bdf716392e922/international_scientific_report_on_the_safety_of_advanced_ai_interim_report.pdf.

109 See https://aiforgood.itu.int/.

110 See https://unesdoc.unesco.org/ark:/48223/pf0000375322/PDF/375322eng.pdf.multi

111 See https://aiforgood.itu.int/about-ai-for-good/un-ai-actions/unido/.

112 See https://aiforgood.itu.int/about-ai-for-good/un-ai-actions/wbg/.

113 See https://aiforgood.itu.int/about-ai-for-good/un-ai-actions/.

114 See https://www.un.org/sites/un2.un.org/files/governing_ai_for_humanity_final_report_en.pdf

115 See https://www.un.org/techenvoy/global-digital-compact.

4 What role for the WTO?

The WTO has an important role to play in AI governance. As seen in Chapters 2 and 3, AI can have a significant impact on trade and can open up many opportunities, but it also creates various trade-related policy challenges. An increasing number of initiatives has emerged at the domestic, bilateral, regional and international levels to address risks associated with AI and to harness its benefits, but these are creating a fragmented policy landscape. The WTO, as the only rules-based global body dealing with trade policy, can play an important role in supporting governments to foster the growth of AI. In this respect, WTO rules may be crucial in facilitating trade in AI-related goods and services, promoting global convergence, fostering access to and innovation in AI, avoiding discrimination, minimizing international negative spillovers, helping to address and prevent trade tensions, and building capacity in AI. However, the rise of AI may also challenge some WTO rules, principles and processes.

(a) Promoting global convergence

Addressing the challenges raised by AI requires global coordination and cooperation to promote regulatory convergence. If widely different, or even conflicting, domestic regulatory approaches on AI are developed, unnecessary regulatory fragmentation may ensue, and this could hamper opportunities and benefits associated with AI and undermine public trust in this transformative technology. As seen in Chapter 3, discussions on the global governance of AI have accelerated significantly over the past few years. However, the different approaches are raising growing concerns about regulatory fragmentation and its potentially damaging impact on cross-border economic activities. For example, discussions on the risk of regulatory fragmentation dominated discussions at the OECD Global Forum on Trade on 3 October 2023. Similarly, WTO members recently expressed concern with regulatory fragmentation in this area, which they considered could block opportunities and benefits associated with such novel products, as well as undermining public trust and leading to an enlargement of the digital divide. Among other issues, they stressed the role of closer international cooperation in building inclusive global digital governance.[1] As governments recognized in the 2023 Bletchley Declaration: "[m]any risks arising from AI are inherently international in nature, and so are best addressed through international cooperation".[2] This was echoed again in the recent 2024 Final Report of the UN AI Advisory Body. Indeed, when it comes to trade, regulatory cooperation at a global level can help build trust, avoid unproductive trade frictions, and prevent unnecessary negative trade impacts without compromising legitimate public policy objectives (OECD and WTO, 2019).

The rise of AI increases the importance of the WTO, and its transparency and deliberative functions, as forum for cooperation and regulatory alignment to avoid regulatory fragmentation. WTO rules and processes promote global convergence through transparency, discussion and exchange of good practices, regulatory harmonization and non-mandatory policy guidance, as well as through the negotiation and implementation of new trade rules.

(i) Promoting transparency

Transparency, a key function of the WTO, provides WTO members with the opportunity to be kept abreast of the latest regulatory developments. All WTO agreements integrate transparency provisions, including in some cases requirements that WTO members publish and promptly notify new, or any changes to existing, laws, regulations or administrative guidelines that significantly affect trade in the areas covered by WTO agreements. Members are also required to establish enquiry points responsible for responding to questions that stakeholders from any WTO member may have on rules and regulations related, for example, to services, TBT or intellectual property (IP), all of which play an important role in AI governance

The transparency mechanism of the TBT Agreement[3] goes further in promoting global convergence and coherence by requiring that members notify regulatory measures at a draft stage to the TBT Committee.[4] Early notifications can help governments and other stakeholders to be kept abreast of proposed AI-related regulations more quickly, and gives members the opportunity to voice questions and concerns regarding upcoming regulatory measures in a timely manner. It also helps to ensure that comments can be taken into account well before measures are finalized, which can lead to better quality regulations and lower trade costs, and it fosters understanding of members' regulatory approaches and promotes more effective and globally coordinated, coherent regulatory outcomes. For example, in 2021, a developed member notified a proposal for AI regulation to the TBT Committee (the EU AI Act)[5], which was later also discussed in the Committee in the context of a "specific trade concern" (STC).[6] In April 2024, for the first time, a developing member notified an AI-specific regulation, ("KS 3007:2024 Information technology – Artificial Intelligence – Code of Practice for AI Application"), to the Committee.[7] More broadly, the TBT Committee has been receiving an increasing number of notifications of a wide range of digital-technology-related regulatory measures, including concerning the Internet of Things, 5G, 3D printing, drones and autonomous vehicles.[8] Transparency may also help members to "emulate more efficient regulatory examples" made widely available in WTO notifications (Mavroidis, 2016).

An important transparency tool is the ePing SPS and TBT Platform.[9] This publicly and freely available tool includes an email alert service on notifications covering products and markets of interest, including AI-related notifications. All interested stakeholders, including businesses of any size, can register on the platform and track regulatory developments about products and markets of interest to them, and communicate with other stakeholders.

The WTO Trade Policy Review Mechanism (TPRM) also contributes to enhancing the transparency of members' trade policies. All WTO members are subject to periodic reviews of their domestic trade policies. The TPRM aims to improve members' adherence to WTO rules, disciplines and commitments, through greater transparency in, and understanding of, WTO trade policies and practices.[10] In fact, the subject of AI has been raised in the context of various recently concluded trade policy reviews (TPRs).[11]

(ii) Promoting dialogue and exchange of good practices

The WTO provides a global forum for constructive discussions, exchange of good practices and cooperation. In this context, governments can discuss how best to design nuanced, flexible and adaptable regulatory solutions to address the goods, services and IP-related aspects of AI in a coordinated manner. Global alignment starts with dialogue, and WTO bodies provide fora to which members can bring trade-related issues they wish to explore and discuss. Given AI's fast changing and complex nature, nurturing dialogue and an exchange of good practices on an open, inclusive and ongoing basis is critical.

Various WTO bodies have organized thematic discussions on AI trade-related topics to exchange experiences and identify good practices. Among them are the Council for Trade-Related Aspects of Intellectual Property Rights (TRIPS Council) and the TBT Committee. For instance, in 2023, South Africa called for a revitalization of discussions on e-commerce-related IP matters in the TRIPS Council and proposed a structured dialogue based on specific questions, including what measures members are adopting to improve access to AI technologies.[12] In the same year, a group of "Friends of IP and Innovation", including Australia, Canada, the European Union, Japan, Singapore, Switzerland, Chinese Taipei and the United States, proposed that, due to the immense benefits of cross-border cooperation among IP offices and the unclear application of existing IP systems to advanced technologies, such as AI and the metaverse, it would be useful for IP offices to engage in global discussions on suitable IP protection in these technology fields, and to share domestic experiences and best practices. The TBT Committee, on its side, recently held five thematic sessions on digital issues and related regulatory measures with the aim of improving global regulatory cooperation between members in these areas. The thematic sessions covered intangible digital products (including AI), cybersecurity, conformity assessment issues with respect to products sold via e-commerce, digital solutions for performing conformity assessment, and the use of digital technologies and tools in members' regulatory processes.[13] In addition, under the currently ongoing "Tenth Triennial Review of the operation and implementation of the TBT Agreement", proposals have been made to discuss AI specifically, or at least certain AI-related issues, in the TBT Committee.[14]

Since 1998, multilateral discussions under the WTO Work Programme on e-commerce have considered how WTO rules apply to e-commerce. These discussions intensified following the Ministerial Decision on the E-commerce Moratorium and Work Programme,[15] which was adopted at the 12th Ministerial Conference (MC) in 2022 and provides a platform for experience-sharing and mutual learning. Issues relevant to AI discussed under the work programme include consumer protection, legal and regulatory frameworks, and digital industrialization. Discussions also covered the important issue of the digital divide.

Experience-sharing on AI is also slowly emerging in other WTO bodies. For instance, the Committee on Sanitary and Phytosanitary Measures (SPS Committee) recently held a thematic session to explore the utilization of technological solutions, including AI and machine learning, in the field of SPS.[16] In addition, Australia recently submitted a proposal that the future agenda of discussions and experience-sharing of the SPS Committee put a "strong focus" on the potential application of AI technologies in regulatory frameworks that govern agri-food trade.[17]

The WTO can provide a platform for governments to brainstorm on how best to design nuanced, flexible, coordinated regulatory solutions to address the trade-related aspects of AI. Issues flagged by scholars that could be discussed include: how to ensure that possible regulatory solutions do not become obsolete as AI rapidly evolves; how to ensure a lifecycle compliance of AI and AI-embedded products with relevant requirements under standards and technical regulations; how to ensure post-market surveillance of AI and AI-enabled products; and how to improve the WTO's engagement with other relevant bodies and organizations that are currently discussing and elaborating policies, guidance and international standards relevant for AI regulation and global governance.[18] Such discussions would help members to become aware of each other's different systems and to understand better the similarities and divergences in their regulatory approaches. This, in turn, could provide a solid basis for further considering, in a multilateral setting, how to ensure better regulatory coherence in the area of AI. A notable example of this positive role of the WTO is the recently adopted 2024 TBT "Guidelines on Conformity Assessment Procedures" (CAP Guidelines) (WTO, 2024b). The CAP Guidelines not only recognize the importance of digital technologies to improve the way governments certify products in terms of safety and quality, but also stress the importance of ensuring "flexibility and agility in the face of uncertainty", including due to "rapidly changing technological, societal, geopolitical and economic trends", by ensuring conformity assessment procedures are "adaptive, responsive, and remain relevant".

WTO committees also serve as fora for information-sharing and discussions between WTO members

and standard-setting organizations. Standard-setting organizations have observer status in various WTO committees, including the TBT and SPS Committees. WTO committees can therefore provide a valuable opportunity for constructive dialogue between members and standard-setting organizations to identify needs and gaps in standards development from an international trade perspective. For example, in the June 2024 TBT Committee meeting, the ISO noted that, together with the International Electrotechnical Commission (IEC), it had published the joint international standard ISO/IEC 42001, which it claimed to be "the world's first AI management system standard", laying down "the foundation for ethical, safe, and innovative use of AI across its many applications and promoted trust by effectively managing AI-related risks."[19] At that same meeting, the United Nations Economic Commission for Europe (UNECE) informed members about the work being undertaken by its Working Party on Regulatory Cooperation and Standardization Policies on adopting relevant guidance on "technical regulations of products/services with embedded artificial intelligence".[20] In addition, during a recent Thematic Session held by the SPS Committee, relevant work on the use of digital technologies, including AI, was presented by various international standard-setting bodies including the World Health Organization (WHO), the Food and Agriculture Organization of the United Nations (FAO) Codex Alimentarius, the World Organization for Animal Health (WOAH) and the International Plant Protection Convention (IPPC).[21]

(iii) Promoting regulatory harmonization and coherence through international standards, mutual recognition and equivalence

International standards play an important role in promoting global regulatory alignment and coherence. The development and use of international standards in the area of AI can provide a common benchmark when governments design and adopt standards or regulations on AI systems and AI embedded products. This can help to reduce unnecessary differences across economies. Addressing such fragmentation is also trade facilitating, as it avoids unnecessary compliance costs for companies, in particular micro, small and medium-sized enterprises (MSMEs), when engaging in international trade. International standards can be beneficial in other ways. For instance, they can facilitate the free flow of digital solutions, ensure interoperability, foster innovation by codifying and disseminating best practices in technology (see also Section 4(b)(v) on technology transfer in WTO agreements), shorten the regulatory cycle – as each regulator does not have to start its own process again from scratch, but can benefit from the experience of other regulators – and help small companies improve their regulatory compliance.

While the WTO does not itself develop international standards, some of its agreements explicitly encourage their use. The TBT Agreement is a particular case in point, as it encourages members to engage in regulatory harmonization by requiring them to use relevant international standards as a basis of their domestic standards, technical regulations and certification procedures. This requirement is strengthened by a presumption that a regulation does not create an unnecessary obstacle to international trade – which must be avoided – if it is prepared "in accordance with" such standards. At the same time, the TBT Agreement recognizes that there may be legitimate reasons for an international standard not to be used as a basis for a given regulation. Members, in particular developing-economy members, are thus allowed to deviate from these standards under certain conditions.[22]

To harmonize technical regulations on as wide a basis as possible, the TBT Agreement strongly encourages members to "take a full part" in the elaboration and development of international standards.[23] Active participation in international standard-setting work increases the chances that a member will be a standard-maker rather than merely a standard-taker. This can make international standards more inclusive, legitimate and useful as benchmarks for the promotion of regulatory harmonization and coherence, including in AI regulation and standardization. However, it should be noted that active engagement in the development of numerous – and usually simultaneous – international standards could be particularly problematic for developing-economy members in light of their scarce resources and lack of relevant expertise; this is especially the case when the standardization process involves new technological fields that are complex and fast evolving. In this context, the TBT Agreement requires members to advise developing-economy members, upon request, and to grant them technical assistance regarding participation in international standardizing bodies[24] (see also Chapter 4(e)).

However, certain aspects of international standardization in the area of AI may be challenging. Indeed, it might be difficult, or, to some, even inappropriate (Pouget, 2023), to agree on a common international denominator with respect to certain AI-related societal values and concerns such as ethical or moral values, the relative importance of which may vary across economies and societies. Some argue that in certain circumstances these so called "socio-technical" standards may be even implausible, if not impossible (Lin, 2021; Smuha, 2024).[25] However, others consider that such difficulties are not necessarily or always insurmountable and, depending on the specific context and purpose, can be overcome (Ebers, 2024; Kerry, 2024; Meltzer 2023). They argue, for instance, that "foundational" international standards (i.e., those addressing topics such as terminology, definitions and concepts) may be less challenging to discuss and adopt than those addressing substantive or "normative" topics. Indeed, some foundational AI international standards have already been adopted.[26] Some also note that it may also be possible for AI standards to address substantive socio technical issues (such as certain ethical values that an AI system needs to respect), but only to an extent, that is, not by prescribing in detail specifically what ethical AI specifications should be in all cases, for example, but instead more generally reflecting only general principles that are widely shared across nations (e.g., those reflected in certain international conventions and declarations, such as the UN Universal Declaration of Human Rights).[27]

In addition to international standards, some WTO agreements, such as the TBT Agreement also promote other regulatory coherence tools, such as "mutual recognition agreements" (MRAs) and "equivalence". These tools can be useful in facilitating international trade even when standards, regulations and certification procedures between trading partners are different or not fully harmonized. Mutual recognition agreements can streamline conformity assessment procedures, allowing economies to acknowledge each other's testing and certification results, thereby reducing redundancy, cutting marketing costs and accelerating product dissemination. These agreements can help enhance competition and regulatory efficiency, particularly by opening new markets to foreign access. Such gains can be significant – a recent study (Cernat 2023) indicates that "the existence of an MRA tends to increase the value of exports by 15-40% and the probability of firms to export new products to new markets by up to 50%", and states that recent surveys indicate increasing interest in economies in tools such as mutual recognition agreements "in areas where domestic developments across the globe lead to new regulatory requirements", including in "digital standards, cybersecurity, 5G, interoperability of electronic invoices and other topics related to the digital transformation". The TBT Agreement, for instance, encourages members to rely on equivalence and mutual recognition agreements (Articles 2.7 and 6). Mutual recognition agreements have been described as important instruments to ensure that unnecessary duplication of certification procedures does not become itself a barrier to trade on AI-related products (Meltzer, 2023).[28]

(iv) Providing voluntary committee guidance

The WTO also promotes regulatory coherence not only through the rules of agreements but also through "soft law". An important example is the TBT Committee's guidance with respect to international standards. Bearing in mind the fact that the manner in which international standardsare set can have a decisive impact on the extent to which those standards are actually used as a basis for convergence, in 2000, the TBT Committee agreed on a set of Principles for the Development of International Standards, Guides and Recommendations (the "Six Principles").[29] The Six Principles provide guidance in the areas of transparency, openness, impartiality and consensus, effectiveness and relevance, coherence, and development dimension.[30] Principle 5, on coherence, for example, stresses the importance of avoiding duplication and overlap between the work of international standardizing bodies and calls for cooperation and coordination. Such "soft law" instruments can help ensure international standards are better and more appropriately prepared so that they can be a basis for designing regulations that can fully attain their policy goals, while at the same time not causing unnecessary obstacles to trade. In addition, such decisions and recommendations support deeper cooperation. The Six Principles are widely followed by standard-setting bodies seeking international relevance, and are also recognized in various international and regional fora, as well as in many regional trade agreements (RTAs) (McDaniels et al., 2018).[31]

Another example that may be particularly relevant for AI regulation concerns committee guidance on conformity assessment (certification). As noted above, AI trustworthiness depends on its ability to meet stakeholders' expectations in a "verifiable way", for example via certification against technical specifications in a regulation or standard. Conformity assessment procedures are, therefore, likely to be key elements in AI regulatory frameworks.[32] In this respect, the TBT Committee's 2024 CAP Guidelines (WTO, 2024b) stress the need to ensure that conformity assessment procedures are "adaptative, responsive, and remain relevant", which will be instrumental in ensuring safe and trustworthy international trade in ever changing AI-enabled products. Mutual recognition agreements, which as discussed above can help to avoid creating unnecessary trade barriers from duplicative testing and other certification procedures, have also increasingly been the focus of TBT Committee debates and guidance, including in the CAP Guidelines. The CAP Guidelines build on the guidance that the TBT Committee has developed over the years on "a range of approaches that governments might choose to apply across different sectors to ease the burdens associated with duplicative testing and certification", mutual recognition agreements and equivalence being among such approaches.[33] In addition, under the Tenth Triennial Review on the operation and implementation of the TBT Agreement, a proposal was made for members to discuss and exchange experiences on the importance and benefits of mutual recognition agreements, including on how they "may contribute to addressing future global challenges".[34]

(v) A global forum for negotiating new rules

The WTO also promotes global alignment through the negotiation of new binding rules on trade. New trade rules are negotiated and agreed to by all WTO members and approved domestically. The goal is to ensure that the rules based international trade system is kept fit-for-purpose, and that it provides a level playing field for all, thus contributing to economic growth and development.

Various issues negotiated under the so called "Joint Statement Initiative on E-commerce" matter for AI. The Joint Statement Initiative was launched in January 2017 to respond to the changing nature of trade and create a modern set of rules to facilitate digital trade and address challenges within the digital economy. Topics discussed over the years have included several issues of key importance for AI, including personal data protection, open government data, access to and use of the internet, cybersecurity, telecommunications, consumer protection, customs duties on electronic transmissions, data flows, data localization and source code. The negotiations also cover the important issue of capacity-building and technical assistance for developing economies. As of June 2024, 91 WTO members, including many developing economies and several least-developed countries (LDCs), were involved in these negotiations.[35]

(b) Facilitating trade in AI-related goods and services for AI growth and development

The WTO is the cornerstone of global efforts to facilitate trade in services and in goods that enable or are enabled by AI. The expansion and development of AI, and its increasing use by firms and individuals around the world require a facilitating trade and investment environment. WTO agreements encourage policies contributing to a sound environment for investment and cross border trade in AI-related products and technologies. Various aspects of the WTO rulebook can contribute to promoting the development of and access to AI.

(i) Obligations and specific commitments on trade in services

The obligations of the General Agreement on Trade in Services (GATS) play an important role in shaping a policy environment that facilitates the development and uptake of AI. AI is relevant for trade in services – including trade in services for AI – in three key ways. First, while AI has many different applications, the development and implementation of AI is, at its core, a computer service. In the sectoral classification system used under the GATS, computer services comprise a wide range of services relating to the design and development of computer systems and software.[36] Computer services under the GATS also include data processing and database services, which are key functions associated with AI, given its high level of reliance on access to, and treatment of, data. Second, telecommunications services play a fundamental role in enabling and promoting AI. AI relies on efficient communications infrastructures to provide the levels of connectivity it requires to function, including by facilitating the transmission of data within and across borders. Third, AI is used as an input in the supply of an increasingly wide range of services, including translation, education, financial and health services. Services that use or rely on AI are often, at least in part, supplied through electronic means. As a result of technological advancements, a wide range of services can more easily than previously be traded across borders as digitized information flows, and AI has further increased the tradability of services under mode 1 of the GATS, which refers to the cross-border supply of services.[37] The use of AI by services suppliers may expand supply capacity and reduce costs. Trade in services also stimulates the development and uptake of AI, as access to international markets is a key channel to expand AI-enabled services, monetize the technology and drive investment.

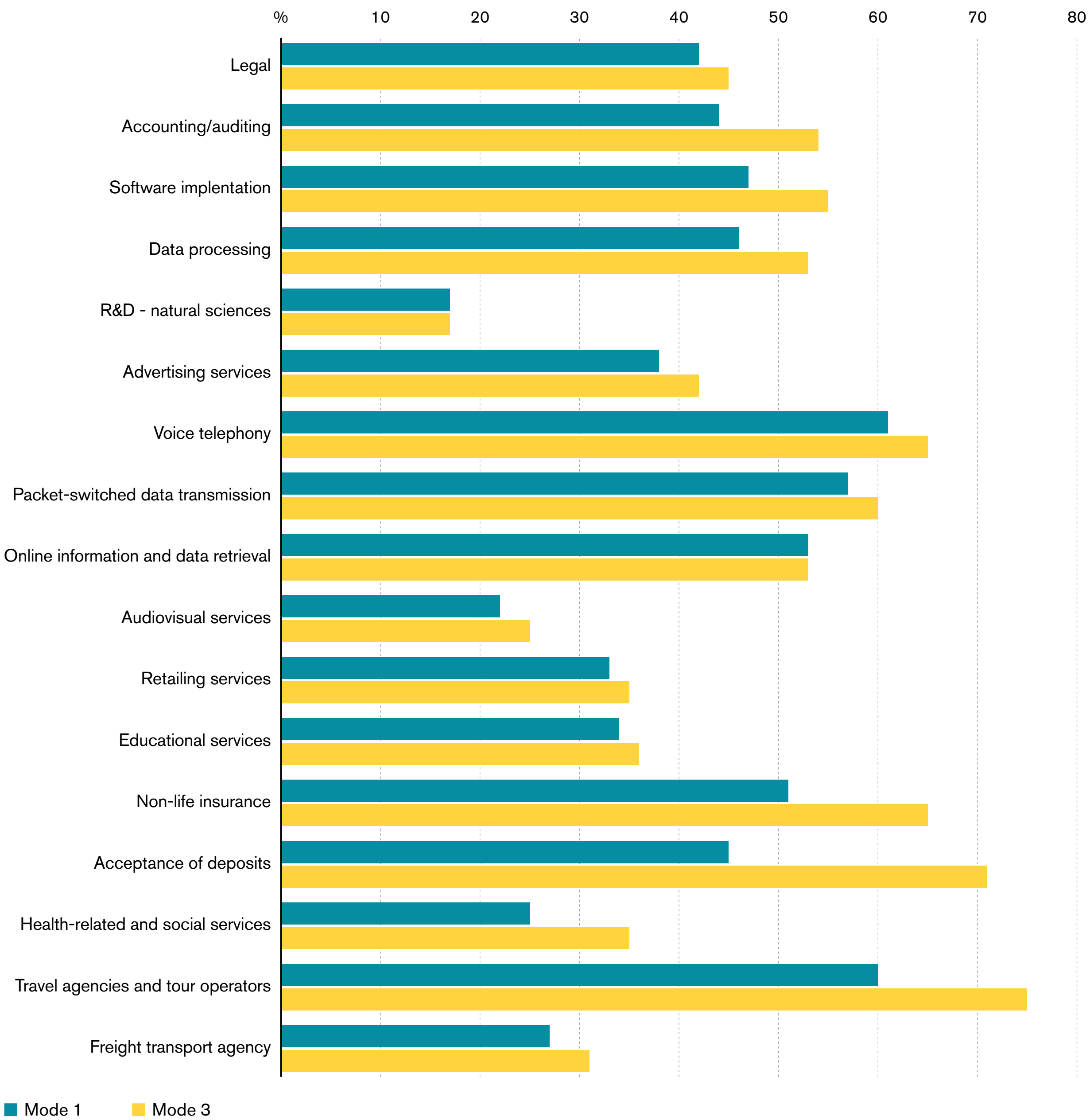
Rules of the GATS carry relevance for AI in these three key ways. The GATS applies to all services sectors with the exception of governmental services (referred to as services supplied in the exercise of governmental authority) and most of the air transport sector. Measures affecting services supplied through different technological means – e.g., electronically or with the assistance of AI – are all covered by the GATS.[38] While certain obligations of the GATS apply to all services within its scope (e.g., the obligation to publish measures of general application), some of the principal obligations do not apply to all services covered. For example, market access (Article XVI) and national treatment (Article XVII), the two obligations that aim to guarantee a level of openness to international competition, only apply to those services sectors that are listed in the schedule of specific commitments of each WTO member, and in accordance with limitations listed for particular modes of supply.

Most WTO members have made specific commitments on market access and national treatment for computer services. Out of the WTO's (counting the European Union as 1) 141 schedules of commitments, 84 (or 60 per cent) contain commitments on computer services, but only 53 contain specific commitments covering the totality of the sector as defined in the GATS classification system.[39] In addition, the level of treatment bound for each mode of supply varies. Of specific commitments in the different sub-sectors of computer services, 67 per cent were unrestricted (i.e., without sector-specific limitations) for cross-border supply (GATS mode 1), in comparison with 74 per cent for consumption abroad (GATS mode 2), and 64 per cent for commercial presence (GATS mode 3).[40] For their part, commitments on GATS mode 4 are typically limited to certain categories of natural persons, notwithstanding the sector.

Subsectors of telecommunication services have a higher number of commitments. A total of 100 schedules contain commitments in the sector (including 43 that include commitments across all subsectors),[41] but those tend to be subject to a higher number of limitations for both modes 1 and 3. For example, 67 per cent of commitments on data transmission are subject to limitations or are "unbound" with respect to mode 1, and the proportion of commitments with limitations reaches 79 per cent for mode 3.

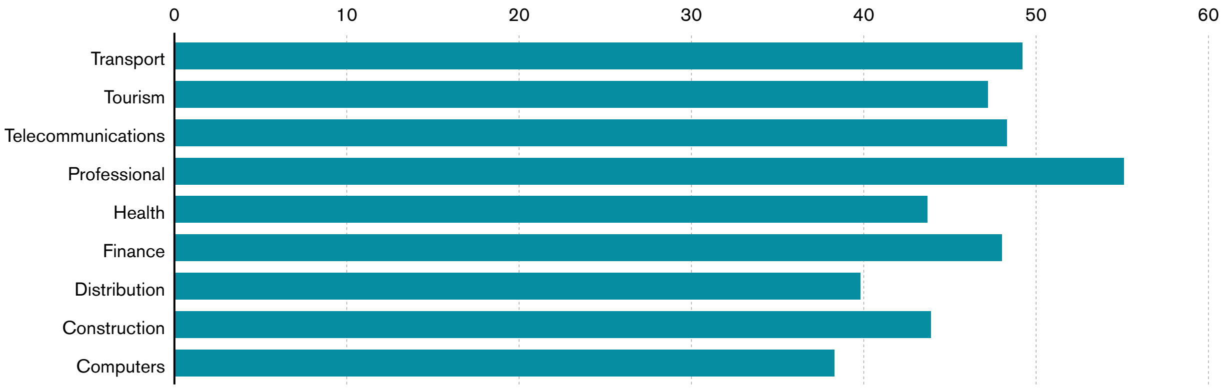
However, commitments in other sectors remain limited, making for a less predictable and transparent trade environment in these sectors. As noted above, AI is used as an input in the supply of a wide range of services, where commitments have relevance, including under mode 1. Overall, commitments under the GATS are limited, as most sectors attract fewer commitments than the computer and telecommunications sectors. Indeed, a majority of WTO members have not scheduled commitments in most of the sectors covered by the GATS. On average, WTO members' schedules have specific commitments in roughly a third of all services subsectors. In addition, even when commitments are undertaken, many services subsectors have been left unbound (i.e., free to limit both market access and national treatment) for mode 1. This is illustrated in Figure 4.1, which shows the proportion of schedules with specific commitments under mode 1 for a sample of subsectors. The absence of specific commitments means that no guarantees of access are provided, and this makes for a less predictable and transparent trade environment for the relevant sectors, as new trade-restrictive measures may be imposed at any time. The limited multilateral commitments in different sectors also represent a lost opportunity to encourage lower levels of services trade restrictiveness. Indeed, some of the services sectors of greatest relevance for AI remain subject to significant trade restrictions, applied by different governments around the world.

Figure 4.1: Proportion of GATS schedules with specific commitments in modes 1 (cross-border supply) and 3 (commercial presence) in selected sectors



Source: WTO using I-TIP Services (https://itip-services-worldbank.wto.org/).

Figure 4.2: Services trade restrictiveness in selected sectors



Source: WTO using I-TIP Services (https://itip-services-worldbank.wto.org/).

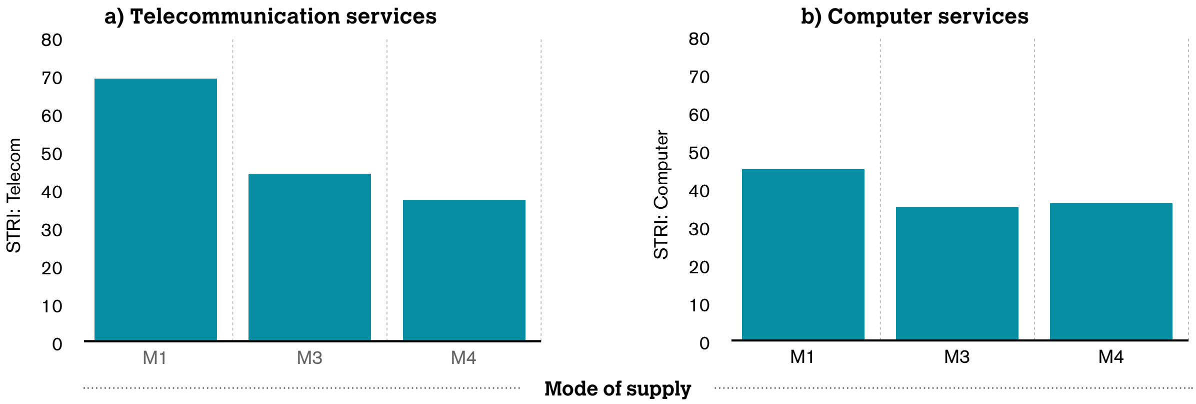
Note: This chart depicts the average level of restrictiveness in the applied regimes of 133 economies in nine broad sectors. The index quantifies applied services trade policies on a scale from 0 (fully open) to 100 (most trade-restrictive).

Aside from the level of treatment guaranteed by commitments, barriers to services trade actually applied by governments remain high in overall terms. However, these barriers display significant variations across sectors, modes of supply, regions and levels of development (see Figure 4.2). Sectors such as professional and transport services, for example, tend to be more restricted than telecommunications, computer or distribution services.

Services sectors particularly crucial to AI, such as computer services and telecommunications services, still face significant trade restrictions in a large number of economies. With respect to computer services, 24 economies (out of a sample of 133) have services trade restrictiveness scores of 50 or above on a scale from 0 (fully open) to 100 (most trade-restrictive). In addition, 58 economies have Services Trade Restrictiveness Index (STRI) scores of 50 or above for either mobile or fixed-line telecommunications. Restrictions are also important in a number of services sectors that use AI, including financial services, which thereby limits capacity to supply AI-intensive services and impacts growth opportunities.

Restrictions in computer and telecommunications services are highest for mode 1 (cross-border supply) and significant for modes 3 (commercial presence) and 4 (movement of natural persons) (see Figure 4.3). Restrictions in mode 1 may affect the cross-border supply of consultation services relating to computer systems and software, which are important for the development of AI and its implementation and use in companies. Mode 1 restrictions on computer and telecommunications services can limit

Figure 4.3: Services trade restrictiveness by mode of supply



Source: World Bank and World Trade Organization (2023).

Note: Figure 4.3(a) and (b) depict average Services Trade Restrictiveness Index (STRI) scores by mode of supply for 133 economies. The STRI quantifies applied services trade policies on a scale from 0 (fully open) to 100 (most trade-restrictive). M1: GATS mode 1 – cross-border supply; M3: GATS mode 3 – commercial presence; M4: GATS mode 4 – movement of natural persons.

the transmission of data and cross border data processing and storage activities. Mode 3 restrictions have particular significance, as they include measures that affect the capacity of foreign suppliers to establish a commercial presence abroad, and to supply services through such commercial presence. When applied to computer services, restrictions to mode 3 impede foreign companies from investing and being active in the local market for AI and related services. Restrictions to mode 3 in telecommunications services limit investment in the digital infrastructure that is critical to enable the movement of data and the electronic supply of a wide range of services, including those relying on AI. As for limitations to mode 4, these encompass measures that affect the capacity of experts who work on the development of AI systems and software to temporarily go abroad to supply these computer services.

Overall, services trade restrictions raise trade costs and limit trade and investment. They carry negative economy-wide consequences and worsen the performance of the specific sectors targeted (World Bank and WTO, 2023). In the case of telecommunications services, for example, trade restrictions have been associated with lower penetration, higher prices and lower-quality services (Borchert et al., 2017; ITU and UNESCO, 2013; Nordås and Rouzet, 2017). Meanwhile, trade restrictions in relation to digitally supplied services limit an economy's capacity to take advantage of trade opportunities created by AI and technological developments, and can also reduce companies' incentives to invest in digital technologies and in information and communications technology (ICT).

In addition to the market access and national treatment obligations, the GATS contains other obligations which generally aim to facilitate services trade. These obligations can affect the trade policy environment for AI and the propensity of AI to increase services trade. In addition to the most-favoured-nation obligation (Article II) and transparency requirements (Article III), Article VI contains obligations on domestic regulation that require, among other things, the reasonable, objective and impartial administration of measures in sectors in which specific commitments are undertaken. Several WTO members have also included additional commitments on domestic regulation in their schedules by means of a reference paper containing disciplines that seek to mitigate the unintended trade-restrictive effects of measures relating to licensing requirements and procedures, qualification requirements and procedures, and technical standards.

The telecommunications sector – a key enabler of AI, data flows and digitally delivered services using AI – is also the focus of two additional sets of competition-related rules under the GATS. These rules are the Annex on Telecommunications, which applies to all WTO members, and the Reference Paper on Regulatory Principles on Basic Telecommunications, which has been incorporated into the Schedules of Commitments of 103 WTO members. By promoting competitive conditions and good regulatory practices in the sector, the two instruments help to foster the extension of affordable and efficient infrastructure for services contributing to, or using, AI. For example, the Annex provides for access to public basic telecommunications services on reasonable and non discriminatory terms and conditions for the supply of services in all committed sectors. It also mandates that suppliers from other members should be able to use public basic telecommunications services to enable the flow of information within and across borders.

Newly agreed disciplines on services domestic regulations and investment facilitation, which aim to improve the business environment, can also help to facilitate the development and use of AI. The disciplines on services domestic regulation, which entered into force in February 2024, facilitate authorization procedures that businesses engaged in AI-related or AI-enabled services may have to comply with before supplying their services in various jurisdictions (WTO, 2024). A total of 72 governments, representing 92.5 per cent of global services trade, have committed to implementing these new disciplines, which will be applied on a "most-favoured-nation" basis, meaning they will benefit all WTO members. WTO members that have adopted the disciplines on services domestic regulation have embraced good regulatory practices on stakeholder involvement: these practices foresee the advance publication of draft laws and regulations relating to licensing, qualifications and technical standards. They also foresee that interested persons are given reasonable opportunity to comment on such draft regulations, and the consideration of such comments by the regulators. In addition, the recently completed Agreement on Investment Facilitation for Development, concluded by close to 130 members, aims to improve the investment and business climate and make it easier for investors to conduct their day-to-day business and expand their operations. Although this is a plurilateral agreement, its benefits would extend to all members. With incorporation into the WTO architecture, this agreement will also help to attract more and higher-quality investment in digital connectivity infrastructure. Such infrastructure forms the backbone for deploying digital technologies, including AI.

(ii) Customs duties on ICT equipment and electronic transmissions

Tariffs, especially on ICT equipment, can limit access to and increase the cost of hardware essential to develop and power AI applications. They can thereby constitute an obstacle for the deployment and adoption of AI technologies. Acknowledging the growing importance of ICT products to promote competitiveness in the digital economy, a subset of WTO members negotiated an agreement – the Information Technology Agreement (ITA) – to eliminate tariffs on such products. Beyond tariffs, WTO rules also provide a vehicle to determine the value for AI-enabled goods (see Box 4.1).

Box 4.1: AI and customs valuation

The incorporation of advanced digital technologies, including AI, into products creates challenges for governments seeking to determine the value of those products for tariff and other purposes. For decades now, customs agencies have grappled with how to determine value for imported goods that bundle hardware and software elements. Customs valuation is primarily concerned with the transaction value of physical goods, from which accompanying services or elements may be excluded. While there is some scope for determining the value of certain intangibles associated with imported products, determining whether declared value accounts, or should account, for these imported products can entail complex considerations and can lead to exchanges between customs agencies and importers to verify certain elements of the transaction. This has been a persistent challenge for government officials and traders alike in valuing goods, and growth in AI-enabled products could potentially add to the uncertainty relating to national valuation practices and the extent of revenue collection at the border.

Customs valuation rules can be a vehicle to capture the value of the AI-enabled features of imported goods. The WTO Customs Valuation Agreement allows WTO members, under specified circumstances, to value certain intangibles embedded in imported products. The transaction value of goods can be augmented with such elements in certain instances, for example, where there are IP royalties or licence fees (e.g., patents, copyrights and trademarks) related to the goods and tied to their sale (Article 8.1(c) of the Customs Valuation Agreement), or where the production of imported goods has been dependent on such items such as the cost of engineering, development and design work, if supplied by the buyer and not undertaken in the importing country (Article 8.1(b)). These provisions could be relevant when determining the value of AI-enabled products. Moreover, WTO members may elect whether to include the value of software in certain "carrier media" (i.e., physical devices bearing the software), although this discretion is limited to devices that exclude integrated circuits or semiconductors and therefore may not extend to certain advanced digital technologies that feature AI.[42] The challenge of mapping existing rules onto new market developments could be particularly acute when dealing with the fast-changing developments in AI-enabled products (see Chapter 4(f)).

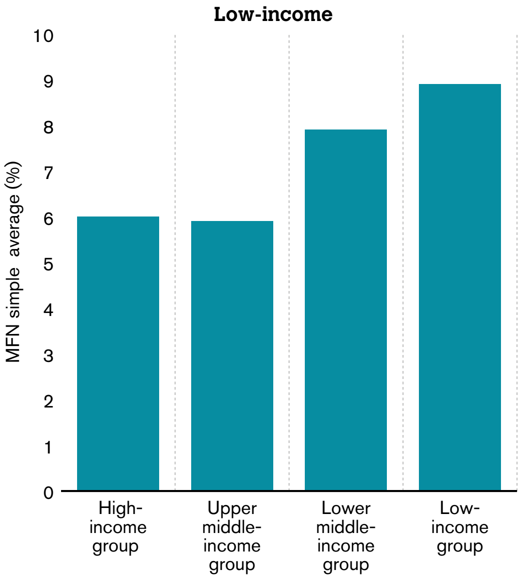
At the same time, the use of AI, including predictive AI models, has significant potential to change the work of customs officials when valuing imported products (see Chapter 2(b)).

The ITA aims to increase worldwide access to high-tech goods, such as semiconductors, which are essential to AI, by eliminating tariffs on ICT products covered by this Agreement. Participation in the original ITA has increased from 43 WTO members in 1996 to 84 today, representing about 97 per cent of world trade in IT products. In 2015, over 50 WTO members, including China and the United States, concluded the expansion of the original agreement (ITA II), which covers an additional 201 products. ITA commitments to provide duty-free access to ICT products are applied on a most-favoured-nation (MFN) basis, that is, to all WTO members, including non-ITA participants. The value of products covered by the ITA II reached US$ 2.1 trillion in 2021. The elimination of tariffs on products such as semiconductors promotes access to hardware that is essential to power AI systems. As noted in Chapter 2, demand for AI hardware components, such as CPUs, GPUs and specialized AI chips, has been rising sharply. ITA II also contains a commitment to keep the list of covered products under review to determine whether further expansion may be needed to reflect future technological developments.

Tariff rates on ICT products by non-ITA participants are highest for low-income and lower middle-income economies. This limits the capacity of these economies to leverage AI for development. Tariffs rates vary significantly across levels of development. While they average 6 per cent in high-income and upper middle-income economies, they reach almost 8 per cent in lower middle-income economies and 9 per cent in low-income economies (see Figure 4.4).

Beyond the ITA, the WTO moratorium on customs duties on electronic transmissions can contribute to promoting access to AI. The moratorium, which ensures that no tariffs are imposed on electronic transmissions, and has been periodically renewed since 1998, ensures that additional costs are not imposed on electronic transmissions in the form of customs duties. The last extension of the moratorium was agreed in March 2024 at the WTO's 13th Ministerial Conference (MC13). WTO members agreed to renew the moratorium until the 14th Session of the Ministerial Conference or 31 March 2026, whichever is earlier. The Ministerial Decision notes that "the moratorium and the

Figure 4.4: Tariffs on ICT products by non-ITA participants (2023)*



*2022 for Saint Kitts and Nevis, Democratic Republic of the Congo, and Haiti; 2019 for Yemen; and 2016 for Djibouti (latest year available).

Source: WTO Analytical Database.

Note: Product codes S04, T03, T04 and T05 of the multilateral trade negotiations product categories.

Work Programme will expire on that date".[43] Members have expressed differing views concerning the renewal of this temporary moratorium.[44] The non imposition of customs duties on electronic transmissions is part of the Joint Statement Initiative on E-commerce text (see above).

(iii) Technical Barriers to Trade (TBT) Agreement

Governments, civil society and economic operators broadly agree on the pivotal role of mandatory technical regulations, voluntary standards and conformity assessment procedures in ensuring that AI systems are trustworthy.[45] This is essential to promote the deployment of AI. Technical regulations and standards are used to set out specifications and requirements on the production, importation and sale of products. As such, when adopted and applied appropriately, they can provide an essential regulatory framework for the development and use of trustworthy AI systems, and can ensure that risks associated with AI are addressed and that its benefits are harnessed. To ensure that the policy goals pursued by such measures are fully attained in practice, economies also need to subject AI systems, including AI-enabled products, to conformity assessment procedures in order to assess whether relevant requirements for ensuring trustworthiness have been fulfilled.

Technical regulations, standards and conformity assessment procedures are subject to the WTO TBT Agreement. This agreement supports better regulatory systems, which are essential for ensuring AI trustworthiness, and, through this, the deployment of AI. The TBT Agreement provides a framework of disciplines related both to procedural (transparency) and to substantive (product specifications and certification) dimensions of regulatory processes, which are aimed at eliminating unnecessary or discriminatory technical barriers to trade, while safeguarding the right to regulate to address legitimate policy objectives (see also chapters 4(a), 4(c), 4(d), and 4(e)). TBT-compliant regulatory measures are important for the conduct of international trade, including trade in AI systems and AI-enabled products, because they can increase consumers', importers', and other stakeholders' trust in the safety and quality of the traded products. This can help to ensure that trade flows smoothly, while respecting the right of governments to regulate for legitimate policy reasons. This trust does not however arise spontaneously. Instead, "behind the scenes", trust is supported by an "invisible chain" of institutions working together to deliver what is referred to as the National Quality Infrastructure (NQI), a normative and institutional framework composed of a combination of regulations, standards and certifications, as well as agencies, laboratories and other facilities that are responsible for applying these measures (WTO, 2021; 2024b). As trust increasingly underpins AI deployment and use, the role of the NQI will also increase in this area.[46]

(iv) Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement)

The WTO TRIPS Agreement, the most comprehensive multilateral agreement on IP, directly impacts the development, deployment and commercialization of AI technologies. Established in 1994, the TRIPS Agreement sets down minimum standards of protection and enforcement for IP rights across WTO members. It outlines the obligations of members to protect IP, including with regard to copyrights, patents, trademarks, industrial designs and trade secrets, all of which are relevant to AI technologies and AI-generated creations and innovation.

The TRIPS Agreement envisages a balanced IP system that not only incentivizes innovation but also promotes access to and dissemination of technology. By means of this system, the enforcement and protection of IP rights contribute positively to technological innovation and to the mutual benefit of both producers and users of technological knowledge, thereby supporting social and economic welfare. This objective is fundamental for the development and application of AI in the future.

The minimum requirements for IP protection required by the TRIPS Agreement can serve to address certain IP challenges arising from the development and applications of AI, albeit with some limitations and challenges. As set out in Chapter 2(b), IP rights are relevant to the development of AI, including the use of its inputs and the protection of its outputs. Disclosure requirements under international patent rules can result in a positive contribution to transparency in the development of AI technology. Under the TRIPS Agreement, patent applications require the applicant to disclose the invention in a manner sufficient to enable a person with the relevant skills to replicate the invention.[47] Where jurisdictions provide patent protection for software or computer-implemented inventions, this disclosure requirement yields significant expert information on patented technologies generally and can be used to address the "black box" problem that may arise with AI (see Chapter 2(a)), at least to a certain extent.

Under Article 10 of the TRIPS Agreement, computer programmes, whether in source or object code, are protected as literary works under the Berne Convention (1971). This robust protection for software under copyright may provide a further incentive for transparency and to publish AI algorithms rather than keeping them protected as trade secrets. Nevertheless, the TRIPS Agreement also requires WTO members to protect undisclosed information, including trade secrets, under legislation against unfair competition (Article 39 of the TRIPS Agreement). Ultimately, the attribution of IP rights in principle does not determine whether their exercise is restrictive or permissive, and open-source solutions may be encouraged by regulation if deemed desirable by policymakers.

IP rights also provide the legal framework to determine the rights of creators whose works and/or databases are used as input to train AI. Regarding exceptions to IP rights, including "fair use", the TRIPS Agreement introduces a three step test[48] that establishes the criteria for members to follow when they establish exceptions and limitations to IP protection, such as text and data mining for training and developing AI models.

Finally, with regard to the issues of AI output, the TRIPS Agreement establishes minimum standards. While it is based on the traditional, human-centric approach to IP, it does not preclude members from addressing issues arising from new technologies in their domestic legislation. In addition, the flexibilities included in the TRIPS Agreement allow WTO members to implement their obligations in a manner consistent with their own legal system and developmental needs. The TRIPS Agreement can, therefore, be used to address AI-related IP issues in tailored approaches.[49]

(v) Technology transfer in WTO agreements

Various WTO agreements include provisions to promote technology transfer, which can play an important role in promoting the development of AI. The TRIPS Agreement as a whole pursues the objective that the protection and enforcement of IP rights should contribute to the promotion of technological innovation and to the transfer and dissemination of technology (Article 7), as a balanced and reliable IP system can provide the legal infrastructure through which intangible assets and knowledge can be traded. In addition, Article 8 of the TRIPS Agreement underscores the principle that such IP protection is not inconsistent with members pursuing public interest considerations. Article 8 also acknowledges that members may need to take appropriate measures to prevent the abuse of IP rights by right-holders or the resort to practices which unreasonably restrain trade or adversely affect the international transfer of technology. The TRIPS Agreement also mandates developed members to provide incentives to their enterprises and institutions for the purpose of promoting and encouraging technology transfer to LDCs.[50] The TBT Agreement, which encourages the use of international standards as a basis of regulations, expressly recognizes "the contribution which international standardization can make to the transfer of technology from developed to developing countries."[51] Article IV of the GATS encourages the increasing participation of developing economies in world trade through the negotiation of specific commitments to build domestic capacity, efficiency and competitiveness, including through access to technology on a commercial basis. And a Working Group on Trade and Transfer of Technology was established at the Doha Ministerial Conference in 2001 with the aim of examining the relationship between trade and transfer of technology from developed to developing economies and ways to increase this flow of technologies.[52]

Several technology transfer programmes relevant for AI have been reported in recent years. Since 2019, in the context of the TRIPS Council, a few developed economies, including Canada, the European Union, Switzerland and the United States, have reported that they adopted several relevant AI technology transfer programmes in order to fulfil their commitments to incentivize local enterprises to promote and facilitate technology transfer to LDCs, with the aim of helping these LDCs establish a sound and viable technological base.[53]

However, the extent to which technology transfer provisions have been used is a subject of debate. Research indicates that the implementation of Article 66.2 of the TRIPS Agreement has been uneven and that the reporting by developed economies on their obligations has often been inadequate or lacking in detail (Moon, 2008). Developed economies argue that, in most cases, IP is in the hands of the private sector, which makes it difficult to transfer technology. Developing WTO members, on their side, question the extent to which these provisions have effectively encouraged technology transfer and benefited developing economies.[54] It has also been noted that the best endeavour formulation of these provisions, which do not set any clear mechanisms or tools for technology transfer, hinders the implementation of the disciplines (Mishra, 2024).[55]

(vi) Agreement on Government Procurement (GPA)

The rules of the WTO GPA 2012 promote access to internationally available new AI technologies. The GPA 2012 aims to open up, to the extent agreed by parties to the Agreement, government procurement markets to suppliers from other GPA parties, and to make government procurement more transparent and predictable. It provides legal guarantees of non-discrimination for the goods, services and suppliers of GPA parties with regard to government procurement covered by the Agreement, including of AI tools, as the case may be. The Agreement does not contain any direct references to AI. However, it does require that GPA parties, where appropriate, set out technical specifications in terms of performance, and functional requirements and base technical specifications on international standards, where such standards exist, or otherwise on domestic technical regulations or recognized domestic standards. Moreover, AI technologies can be used to implement the GPA, such as by identifying red flags that might point to corrupt practices or conflicts of interest or collusion, and by collecting the relevant statistical data. Reflecting the growing importance of AI tools procurement, some GPA parties, including the European Union, have published standard contractual clauses to be used by its procuring entities when purchasing AI tools.

(c) Minimizing negative international spillovers

The WTO rulebook includes various principles, provisions and guidelines that can support the deployment of AI, as well as trade in AI systems and AI-enabled products, by minimizing negative international spillovers. For example, non-discrimination, a key principle of the WTO, is meant to prevent discriminatory treatment of foreigners and trading partners.[56] Another example is the Agreement on Trade Related Investment Measures, which recognizes that certain investment measures can restrict and distort trade and states that WTO members may not apply any investment measure that discriminates against foreign products or that leads to quantitative restrictions.

The TBT Agreement provides that regulatory intervention shall not be discriminatory, nor more-trade restrictive than necessary to achieve the intended policy objectives. When it comes to technical regulations, voluntary standards and certification procedures, which play a critical role in ensuring AI systems are trustworthy, the TBT Agreement aims to ensure that regulatory measures are prepared, adopted and applied in such a way that they can both fully attain their legitimate policy objectives – related, for example, to health, environment or safety – without creating unnecessary or discriminatory technical barriers to trade. The TBT Agreement therefore provides ample policy space to regulate AI, while preferring interventions that are non discriminatory and are the least trade-restrictive possible to fully achieve the stated legitimate policy objectives. Attaining this regulatory balance can help to ensure that trade flows smoothly, while respecting governments' right to regulate for legitimate policy reasons. This can also be important in ensuring that discriminatory or unnecessarily burdensome standards and regulations do not hamper interoperability of AI systems and products (Lim, 2021).[57]

The principle of a periodic review of standards, regulations and certification procedures enshrined in the TBT Agreement is particularly suitable for fast evolving technologies such as AI. The TBT Agreement requires that regulations shall no longer be maintained, or that they shall be updated, in light of changes in the circumstances that gave rise to their adoption.[58] Members are encouraged to evaluate their regulations periodically so as to ensure that they are fit-for-purpose as technological and other circumstances evolve over time. For instance, new scientific or technical evidence on the risks and challenges of AI, or other circumstances that led to the adoption of an AI standard or regulation may become available after their adoption. Depending on the nature and extent of such new developments, this may require updating and recalibrating the measure accordingly. Regulations may also need to be revised to take account of any a new or revised relevant international standards.[59] As already noted, the TBT Agreement requires standards and regulations to be based on relevant international standards. The importance of periodically evaluating and revising international standards in light of relevant changes, such as new scientific and technological developments, to prevent them from becoming obsolete, is expressly mentioned in the TBT Committee's Six Principles (Principle 4). The principle of periodic review is also underscored in the TBT 2024 conformity assessment procedures (CAP) guidelines (WTO, 2024b). Building on TBT Agreement provisions on this issue,[60] the CAP guidelines expressly note that "the choice of the conformity assessment procedures should not be seen as permanent. It should benefit from regular review as the elements that influenced the original choice of conformity assessment procedure may change over time."

Such approaches are important from both a policy and trade perspective. Regularly updating standards, regulations and certification procedures helps to maintain their effectiveness in addressing their intended policy goals (such as health or safety) even when the features, characteristics and risks of what they regulate, including AI, evolve over time. But this can also be beneficial from a trade perspective when changes in the circumstances giving rise to the adoption of a regulation open new alternatives for re designing it so that it can still fully attain its policy objectives, but in a less burdensome, trade restrictive way (Lim, 2021).[61]

Work has also been carried out on how "undue trade distorting effects" of non-tariff measures (NTMs) in ICT products could be reduced or eliminated to prevent such measures potentially offsetting ICT tariff market access gains. Such NTMs include technical regulations, certification procedures and labelling requirements. In November 2000, the ITA Committee approved a work programme on this topic that resulted in the adoption, in February 2005, of the Guidelines for Electromagnetic Compatibility (EMC) and Electromagnetic Interference (EMI) Conformity Assessment Procedures ("EMC/EMI CAP Guidelines").[62] Following adoption of these guidelines, the WTO Secretariat was asked to compile information on the different types of conformity assessment on EMC/EMI. This information has since then been updated regularly (WTO, 2017).[63]

WTO disciplines on subsidies in the Agreement on Subsidies and Countervailing Measures (SCM Agreement) can also play a crucial role in navigating the dual aspects of AI development: promoting technological innovation while preventing negative spillovers in international trade resulting from government financial support. As outlined in Chapter 3(b), an increasing number of governments is implementing AI strategies with significant financial components and putting in place strategies to promote access to data. The relevance and applicability of the WTO subsidies disciplines to prevent negative spillovers relating to government financial support for AI or to the provision of data by government as an input depend on numerous elements. First is the nature of the traded product and whether it is considered a good or a service. The SCM Agreement does not apply to services or IP as such, but instead exclusively applies to goods. Consequently, it is essential to distinguish hardware components and AI-enabled products that are classified as goods (to which the SCM Agreement would apply) from AI software itself. To the extent that the AI component in any given good – for example, the AI in an autonomous vehicle or in advanced robotics – benefits from subsidies coveredby the SCM Agreement (the SCM Agreement defines a subsidy as a financial contribution by a government or public body or any form of income or price support that "confers a benefit" on the recipient), further analysis may be required to determine whether these subsidies could be attributed to those goods, and thereby could become the subject of counteractions under the SCM Agreement.

Subsidies may be challenged in WTO dispute settlement under the SCM Agreement. If the subsidy in question is a prohibited subsidy (such as an export subsidy, or a subsidy for the use of domestic goods rather than imported goods), or if it causes serious prejudice or other specified adverse effects to another member's trade interests, a multilateral remedy to offset the harm can be authorized through the WTO. In cases of prohibited subsidies, the remedy requires the withdrawal of the subsidy. For actionable subsidies, the remedy involves either the withdrawal of the subsidy or the removal of its adverse effects. Subsidized products can also be the subject of countervailing measures applied by an importing member, if the subsidized imported goods are found to cause injury to the importing member's domestic industry producing the same or similar goods.

Where the product incorporating AI is a good, the SCM Agreement and the actions and remedies described above apply only to subsidies that are specific. A subsidy may be considered "specific" if access to it is explicitly limited to a particular enterprise, industry, group of enterprises, group of industries, or a specific region. This fact could be pertinent for broad AI initiatives that, at least to some extent, involve goods. In particular, it is important to consider whether a government financial support programme for AI is available to a wide range of economic activities or is more narrowly targeted at particular sectors or enterprises. For instance, it could be challenging to identify specificity in a government subsidy intended for general AI development and which could be utilized in diverse sectors, such as healthcare diagnostics and autonomous driving systems.[64] Such a subsidy might appear to support broad technological advancement (thus, potentially non specific), while in practice it disproportionately benefits certain industries or companies engaged in specific commercial activities involving goods that incorporate AI (thus, potentially specific). The specificity analysis also may be complicated by the rapid evolution and dual-use nature of AI technologies. Such ambiguities make it difficult to generalize; any assessment of specificity necessarily depends on the particular facts of a given situation. The ambiguities regarding specificity can lead to differing views among trading partners as to the actionability of certain subsidies, where some trading partners may be concerned that subsidies provided by others are unfairly distorting international competition.

Subsidies directed toward the production of AI integrated hardware or AI-enabled goods may present less ambiguity regarding their specificity. For example, a subsidy might be provided for the production of advanced sensors that are explicitly used in both commercial drones and military surveillance equipment. The targeted nature of such a subsidy to the production of a certain limited set of goods could make it easier to identify the subsidy as specific under the SCM Agreement. A further aspect of specificity, as mentioned above, is that the SCM Agreement deems as specific the two categories of prohibited subsidies: those contingent on export performance, and those contingent on the use of domestic goods over imported ones, commonly referred to as import substitution subsidies. It should be noted here that while import substitution subsidies are prohibited, subsidies supporting exclusively domestic production are not prohibited. Nevertheless, to the extent that a subsidy of the latter type is specific, it could be the subject of counter actions provided for in the SCM Agreement, i.e., through WTO dispute settlement or the application of countervailing measures. These points highlight the need for awareness of the rules of the SCM Agreement when designing subsidy programmes for AI.

(d) Helping to address and prevent trade tensions and frictions

The practice of raising specific trade concerns (STCs) and the requirement to notify technical regulations at a draft stage can help to defuse potential trade tensions. Members commonly use WTO bodies to raise specific trade concerns with respect to laws, regulations, or practices by their trading partners which may affect their trade (see Box 4.2). Since 1995, members have devoted an increasing amount of time and attention to discussing STCs. These discussions can help to ease trade tensions by providing members with further information and clarification on the rationale behind other members' regulations, enabling them to work towards mutually satisfactory solutions and helping to build trust (see the opinion piece by Dan Trefler). As noted in Chapter 4(a)(ii), the TBT Agreement also requires members to notify draft regulatory measures. This requirement can help to defuse tensions at an early stage, before a measure is adopted (Lim, 2021; Possada et al., 2022).

Members have been using the STC practice in the TBT Committee to discuss regulations and conformity assessment procedures on various digital technologies, including AI. For instance, cybersecurity, an increasingly important consideration in AI regulations and policies (see Box 4.3), is a common theme of various STCs. More directly on AI, from March 2022 to June 2023, the TBT Committee discussed a concern raised with respect to the EU AI Act (AIA), the first broad regulatory measures on AI systems (be they standalone or embedded into physical products, e.g., a toy). Among other matters, this concern entailed issues related to the scope and meaning of the definition of "AI system" and the possibility that regulatory authorities could be granted access, as part of the certification process, to source code of AI systems.[65] Beyond AI, STCs have also been raised in relation to other technologies, such as IoT and robotics, which are often used in tandem with, or may embed, AI (see Box 4.3).

The WTO also serves as a global forum to settle trade related disputes. One of the key functions of the WTO is to ensure the integrity and respect of trade rules by providing a formal system for handling the settlement of trade disputes among WTO members. A member may bring a dispute to the WTO's Dispute Settlement System to seek the redress of a violation of obligations or other nullification or impairment of benefits under the WTO agreements or an impediment to the attainment of any objective of the WTO agreements.[66] Reports by adjudicators specifically selected for a given dispute (called "panels") are considered for adoption by the Dispute Settlement Body (DSB), that is, all WTO members. These reports are limited to the specific legal and factual issues raised in the dispute. Many disputes are settled through consultations even before any decision is rendered.[67]

Box 4.2: The practice of specific trade concerns

STCs, which drive the detailed, technical deliberations on specific measures that have, mostly, not yet entered into force and are therefore not yet entrenched in domestic law, can contribute to an improved understanding by members of the rationale underlying other members' regulations. They can also present an opportunity to question the appropriateness or effectiveness of trade measures, including in terms of their scientific or technical basis or the evidence for them, use of international standards, transparency, and possible regulatory alternatives.

Raising concerns via an open, multilateral platform can help members to reduce potential trade tensions effectively, and in a cooperative, non-litigious manner. This practice thus creates opportunities for regulatory cooperation centred on a "peer to peer learning" process, in which critiques are presented, suggestions are posited, technical, legal and policy arguments are made, and regulatory experiences are exchanged on specific regulations addressing real life issues. This provides a collaborative "space for learning from differences" (OECD/WTO, 2019), which can ultimately lead to more effective regulatory outcomes (Horn et al., 2013; Karttunen, 2020; Lim, 2021; World Trade Organization, 2020b).

Evidence suggests this model works. While, since 1995, around 56,000 regulatory measures have been notified to the TBT Committee, only around 830 STCs been raised and discussed, with even fewer formal disputes (11) involving TBT measures having been adjudicated.[68] Even if it is not perfect, and there is room for further improvement (Holzer, 2019), the practice of raising and discussing TBT STCs is generally accepted to be a success (Karttunen, 2020) – one that could be expanded into other WTO committees (Possada et al., 2022).

Box 4.3:
TBT, AI, the Internet of Things and robotics

In view of the significant benefits and challenges that the Internet of Things (IoT) and robotics can engender, in particular when enabled by AI systems (Suleyman and Bhaskar, 2023), they have increasingly become the object of governmental regulatory interventions and policies. In this respect, a growing number of IoT and robotics related measures have been notified to the TBT Committee.

These notifications are part of a broader context, in which WTO members are increasingly notifying a wide range of regulations on digital technologies to the TBT Committee (Lim, 2021). To date, at least 71 TBT notifications concern this broader group of digital technologies, i.e., measures addressing IoT and "smart functionality" (19),[69] autonomous vehicles (18),[70] robotics (16)[71] and industrial automation (18).[72] In addition, under this broader group, five STCs have been raised concerning IoT/robotics related measures.[73]

Interoperability, which is key for connecting infrastructures and systems and deploying IoT and robotics (WTO, 2018), is among the issues addressed in some of these notifications and STCs. As it is the case with most digital technologies, including AI, there is general consensus around the pivotal role that international standards can play in ensuring interoperability.[74] Specific discussions on IoT and robotics related standards and policies are taking place in international bodies and organizations, such as ASTM International, the International Electrotechnical Commission (IEC), the International Organization for Standardization (ISO), the International Telecommunication Union (ITU), the Organisation for Economic Co-operation and Development (OECD) and the United Nations Economic Commission for Europe (UNECE), most of which are observers to the TBT Committee.

The importance of enforcing legally binding rules on AI at a global level has been highlighted in international initiatives. For example, ensuring compliance and accountability based on norms is one of the seven institutional functions identified in the UN AI Advisory Body interim report (UN, 2023). This report stresses the need for a dispute resolution system that could be facilitated by global forums and explicitly refers to the WTO Dispute Settlement System as an example of dispute resolution "facilitated through global forums".

While, to date, no disputes on AI measures have been brought before the WTO Dispute Settlement System, there have been various disputes related to aspects of the digital economy. For example, disputes have arisen in relation to the tariff treatment of new technologies and multifunctional products,[75] digitally delivered services methods of transmission or delivery,[76] and whether existing commitments of WTO members cover new products (e.g., whether terms in specific commitments under the GATS should be interpreted solely according to the meaning they had at the time of entry into force – i.e., sound recording distribution services).[77] Of particular interest is a WTO dispute which raised issues related to the so called "digital divide", which, as noted above, is a concern mentioned in various international initiatives on AI governance. The dispute involved a governmental programme which was arguably aimed at "bridging the digital divide" within that economy. Adjudicators confirmed that, as a general proposition, "the objective of bridging the digital divide and social inclusion and access to information is a reasonably important policy objective" and found that the measure at issue was at least "designed" to protect "public morals" within the meaning of the general exception under Article XX(a) of the General Agreement on Tariffs and Trade (GATT).[78] Ultimately, however, adjudicators concluded that the measure was not justified because it had not been demonstrated that the aspects of the measure found to be inconsistent with provisions of the GATT were "necessary" to achieve social inclusion and access to information (digital divide) within the meaning of Article XX(a).[79]

(e) Promoting inclusiveness through special and differential treatment and technical assistance

WTO agreements recognize the constraints faced by developing economies. They therefore include various special and differential treatment (S&D) provisions tohelp them implement WTO rules and participate more effectively in international trade. These provisions aim to increase trade opportunities for developing economies and require members to safeguard the interests of developing

Opinion piece

Building global chains of trust

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During the Industrial Revolution, living standards in a small group of economies broke free of past growth trends. Driven on by innovations that systematically mobilized science, incomes and public health rapidly improved. It was the epoch of the "invention of innovation".

That epoch is about to be repeated: AI represents a major re-invention of innovation, positioning humanity to revolutionize fields such as healthcare, agriculture and material efficiency. However, AI also introduces unprecedented levels of distrust in the goods and services it creates and powers. Addressing this distrust is where the WTO can play a crucial role, by developing and enforcing international AI regulations.

Trust is fundamental in both national and international contexts. Consider the chain of trust involved in treating a child's fever with antibiotics: from the doctor's certification to the drug's approval by government agencies to enforcement through malpractice litigation. This trust ensures the safety and efficacy of the treatment.

In international trade, the chain of trust is also fragile. Historically, trade has involved one-sided trust e.g., China exported blue jeans and imported US aircraft. Now, with AI-enabled, data-generating products, trust must be mutual, not one-sided.

To address this, we must build an international chain of trust. The WTO is well-positioned to contribute to this project. The links of the chain separate into two broad areas, technical standards and social values. Social values include views on things like privacy and what constitutes harmful content. No single international regulatory body can rebuild the many technical and social dimensions of the chain of trust. Multiple approaches are needed.

The WTO is uniquely suited to managing technical disputes. Specifically, the TBT and SPS committees provide a highly effective forum for technical disputes. Since 1995, around 56,000 regulatory measures have been notified to the TBT Committee, with only around 830 STCs raised and only 11 disputes resulting in a panel report. This track record of soft-law mediation highlights the WTO's effectiveness in technical dispute resolution.

What makes WTO committees such as TBT and SPS committees even more unique is that they bring technical experts together with government officials who understand the social dimensions of disputes. Thus, technical and social issues are explored simultaneously. In contrast, other standards-setters, such as the 3rd Generation Partnership Project (3GPP) collaborative project of telecommunications associations, which sets 5G and 6G standards, are poorly suited to discussing social values disputes because the discussion can be dominated by certain firms or governments. This does not happen in the TBT and SPS committees.

Policymakers are closely focused on global value chains. They must now become equally attentive to the problem of deteriorating global chains of trust. The WTO has a unique role to play in this.

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economies when adopting trade measures. These provisions also grant developing economies flexibilities and longer implementation periods with respect to their WTO obligations and commitments, or are concerned with the provision of technical assistance to developing economies. Some WTO S&D provisions apply exclusively to LDCs. Technical assistance and S&D have been stressed in various WTO "soft law" instruments, such as the TBT Conformity Assessment Procedures Guidelines (WTO, 2024b), the two TBT-related March 2024 Ministerial Declarations[80] and the TBT Committee's Six Principles,[81] in particular Principle 6 on "Development Dimension". These WTO instruments play an important part in promoting regulatory alignment and stress the importance of technical assistance to help developing economies overcome their constraints, including in the area of national quality infrastructure (see Chapter 4(b)(iii)). As seen in Chapter 2, investment in AI is unequal across the globe, and policy action is largely dominated by developed economies. Given the unprecedented opportunities that AI offers to improve productivity and stimulate growth, a lack of investment in and policy action with regard to AI is likely to exacerbate further the already significant digital divide. Additional international financial and technical support is needed to build the capacity of developing economies in AI and enable them to benefit from this technology.

Technical assistance and capacity-building are key pillars of the WTO's work and play a fundamental role in furthering understanding of the WTO rules and agreements and of other trade-related topics. Training on AI and trade are being integrated into some WTO technical assistance activities; for example, the WTO has incorporated the topic of AI and IP into its technical cooperation activities, including two flagship technical assistance events (the WIPO-WTO annual colloquium for IP researchers and teachers and the WIPO-WTO annual advanced course on topical IP policy issues for government officials). However, the WTO alone cannot address all of the challenges related to trade, including digital trade and new technologies such as AI. Capacity-building, more broadly, is also frequently provided through various multi agency and multi stakeholder programmes.

Multi-stakeholder programmes like Aid for Trade and the Enhanced Integrated Framework could be further leveraged to help developing economies seize the benefits of AI for trade. Enhancing international cooperation is critical for making digital trade more inclusive (IMF-OECD-UN-WBG-WTO, 2023). The Aid for Trade initiative is a WTO-led multi-stakeholder programme launched in 2005 to help developing economies, and in particular LDCs, to build the trade capacity and infrastructure they need to benefit from trade opening. The initiative can play an important role, for instance, in supporting the governments of developing economies in their efforts to enhance connectivity and leverage technologies like AI for trade by adapting their policies to provide an enabling environment for investment, competition and innovation. Some recent Aid for Trade projects have focused on sectors such as transport, soft and hard infrastructure, and agriculture, which already integrate an AI dimension; such projects aim to help beneficiary economies use AI to optimize transportation or manufacturing processes, or to promote sustainable agriculture. Beyond direct support for using AI, Aid for Trade contributes to bolster digital connectivity by fostering physical and digital infrastructure, both of which are essential to foster AI deployment. Aid for Trade commitments to the ICT sector stood at around US$ 2 billion in 2022. Launched in 2008, the Enhanced Integrated Framework's institutional and productive capacity building projects also help participating LDCs to develop digital strategies and skills. In addition to these initiatives, the WTO Secretariat and the World Bank are working together on the "Digital Trade for Africa" project. The aim of this project is to support efforts by African economies to develop the hard and soft infrastructure necessary to harness the opportunities of digital trade. Capacity-building and the digital divide have also been addressed under the Work Programme on E-commerce (see section 4(a)(ii)). Members have shared their own experience with regard to the challenges that they face in building their digital capacity, but also examples of projects and programmes designed to create a conducive e-commerce environment.

(f) Scholars' views on the possible implications of AI for international trade rules

The WTO provides a framework that can help address the trade-related aspects of AI governance but the rise of AI could also have implications for international trade rules. To explore these implications, academics working at the intersection of AI and trade were asked to respond to a survey (see Annex 4).[82] This section presents their views based on their responses to the survey and related literature. Relaying questions raised by academics and experts is important to help better understand the dynamically evolving context in which the WTO agreements operate. However, the views expressed do not reflect the positions or opinions of WTO members or the Secretariat and are without prejudice to members' rights and obligations under the WTO agreements. The academics' opinions expressed herein are the sole responsibility of the respective authors.

AI gives renewed emphasis to some well-known issues raised by the increasing digitalization of our economies. These include issues related to cross-border data flows, data localization, source code, and the blurring of the lines between goods and services (see also Box 4.4).[83]

AI has prompted some academics to wonder about the implications of the technology for international trade rules. The unique characteristics of AI, and in particular the technology's capacity to learn, evolve and generate outputs autonomously (see Chapter 1), and the greater interactivity that this implies, could, these academics argue, pose new challenges for regulators, with ramifications for trade. For example, some academics wonder whether automated legal advice tools, which are increasingly used for a range of tasks by a number of law firms, may comply with qualification requirements and how this may relate to the General Agreement on Trade in Services (GATS).[84] Other authors also wonder whether generative AI's ability to produce output autonomously might not make the classification or the determination of the origin of certain services more complex.[85]

Some scholars have stressed the benefits of basing services measures on international standards and notifying regulations and standards on such services. As already noted, experts have pointed to the fact that widely differing domestic regulatory approaches may lead to fragmentation and hamper the opportunities and benefits associated with AI. International standards play an important role in promoting regulatory coherence. The GATS, however, contains limited provisions on standards. In addition, the lack of TBT-like disciplines related to technical regulations, standards and conformity assessment procedures in the GATS may lead members not to notify measures that only apply to AI-enabled services.[86]

Scholars also note that recent AI developments may lead members to take a fresh look at the WTO reference paper on telecommunications. An expert has stressed the importance of assessing how the digital transition has impacted competition, for example by making some markets harder to define, and market dominance more difficult to identify. This expert has suggested that disciplines on anti-competitive behaviour in telecommunications, such as those covered by the reference paper,[87] should take account of AI developments, in particular the shift to programmable software defined networks and network function virtualization – both of which are increasingly AI-enabled – which allow traffic on telecommunications networks to be automatically optimized, and thereby affect the nature of competition.[88]

Academics have also suggested that, given the pervasive nature of AI and the complexities and sensitivities of the issues it raises, regulators and businesses could benefit from notifications of draft measures addressing AI, similar to what is done in the TBT Committee. Regulations related to services are particularly relevant for AI. According to one expert, one option could be to introduce a mechanism allowing WTO members to notify draft measures related to AI in the context of the GATS Council. Such a mechanism could enhance transparency and help to address concerns related to AI-enabled services.[89]

On the goods side, some academics are of the view that customs valuation issues and expanding the scope of the Information Technology Agreement (ITA) could warrant attention. As noted in Box 4.4, while the Customs Valuation Agreement and the 1995 Decision on Valuation of Carrier Media Bearing Software for Data Processing Equipment can be useful vehicles to capture the value of AI-enabled features of imported goods, the evolutionary nature of AI raises new issues. For example, some experts indicate that the software embedded in automated vehicles or other AI-enabled devices does not fit squarely with the 1995 Decision. If such software were to fall outside the scope of the Decision, then the question would be how an electric vehicle embedded with free AI software that provides for basic self-driving features should be valued, if it integrated the possibility to upgrade the software for a significant price later on to achieve a much higher degree of autonomy. Given the rapid pace of innovation and the potential for upgrading hardware that supports AI, as well as for AI's extensive application in new ICT products, an expert suggested that consideration could also be given to expanding the scope of the ITA to further support AI development and deployment.[90]

A key question raised by academics concerns the role of private parties and non-governmental bodies in the development of AI-related standards, which are key to trustworthy AI. The TBT Agreement contains various provisions concerning standards. Some provisions require WTO members, when appropriate and when possible, to base their TBT measures on existing international standards adopted by international bodies. The TBT Agreement's Annex 3 ("Code of Good Practice for the Preparation, Adoption and Application of Standards") also contains disciplines on domestic standards, which include not only those adopted by members' governmental bodies, but also those adopted by non-governmental bodies located within a member's territory. There is an ongoing discussion in the TBT Committee on whether "non governmental" standards relate more broadly to "private standards", as this is a term not used in the TBT Agreement (WTO, 2021). Given that purely "private" standards (e.g., standards created by industry consortia) may play an important role in AI governance and regulation, an expert suggested that consideration could be given to clarifying the meaning of "non-governmental" standards under the TBT Agreement, including whether or not, and to what extent, this term may encompass more broadly the concept of "private" standards. This expert suggested that it could be useful to discuss how the mechanisms and tools that already exist in the TBT Agreement (i.e., Annex 3: Code of Good Practice for the Preparation, Adoption and Application of Standards) can be best utilized to ensure that AI standards adopted by non-governmental bodies do not result in unnecessary trade restrictions.[91] Other experts have suggested that dialogue with private parties, in particular non-governmental standard-setting bodies that develop AI standards and guidelines, could be strengthened.[92]

According to some experts, current WTO exceptions may not be sufficient to address the challenges raised by AI. These academics note that a fresh look at the current language used in current WTO exceptions, which is based on a pre-digital age, may be needed to take AI developments into account.[93]

AI also challenges current approaches to IP rights. As noted in Chapter 3(a)(iv), AI poses challenges to the human-centric approach to IP rights. In addition, algorithmic secrecy can prove problematic where there is a need to ensure AI's trustworthiness by investigating how it has arrived at results (see Section 3(b)(iii)).[94] An expert has noted that balanced IP rights policies need to be put in place worldwide in order to preserve the scope for "freedom to operate" for new entrants. Governments and companies trying to join the global knowledge-based economy in a world driven by increasingly faster innovation cycles powered by a technology and AI, need access to large datasets. This access could be rendered more difficult where large stocks of data are protected by IP rights. This expert has suggested that certain choices made decades ago, when members joined the TRIPS Agreement, may no longer be up to date and could be reviewed against the backdrop of new technologies.[95] Meanwhile, some academics have suggested that consideration could be given to fostering dialogue in the TRIPS Council to address IP issues raised by AI. Issues that merit particular attention, in their view, are those related to the use of copyrighted material to train AI systems, the legal status of AI systems as creators or inventors, whether AI-generated works are eligible for copyright protection, the transparency of algorithms, and the balance between IP protection and competition, with adequate IP protection terms.[96]

Another issue raised in survey responses relates to economic rent and competition issues arising from AI's scalability and network effects. As seen in Chapter 2, AI generates significant economic rents due its scalability and network effects, leading to market concentration. An expert has noted that the multilateral rules-based system emerged in a context of low economic rent in a mature, globalized industrial economy.[97] According to some survey respondents, reviving discussions on competition and technology transfer to address the issues raised by an AI-driven rent-rich world would be worth considering.[98]

Some academics have suggested that AI's expected disruptive impact on employment may call for new trade approaches to mitigating disruptions to labour markets. An expert has noted that the WTO Safeguards Agreement, which aims to remedy serious injury, caused by a surge of imports of a specific product, to the domestic industry producing "like products", may not capture AI's potentially significant impact on tasks performed by humans across all economic sectors and industries. This expert argues for the development of a conceptually appropriate approach to manage the trade-related impacts of AI adoption that threaten harm to "tasks across industries, without the pre-condition that there be a competing 'industry' in the importing country".[99]

Some respondents argue that the current rush to regulate AI is creating a risk of regulatory fragmentation, and it is therefore urgent to find a common ground. In their view, however, AI may not yet be "treaty-ready" although it may be "discussions-ready".[100] The emerging fragmented regulatory landscape is raising significant concerns, leading to calls for greater international coherence and multilateral commitments.[101] One expert noted that it seemed more likely that a more harmonized multilateral approach could be achieved if economies take a balanced and progressive view of regulation, covering potential regulatory gaps and adopting high-level governance mechanisms rather than overly prescriptive models.[102] Given AI's fast-evolving and cross cutting nature and the significant challenges it is raising, some experts have suggested the need for a "WTO AI and Trade" task force or working group, or even a dedicated committee.[103] Such an approach, they reason, would help to overcome "the siloed nature of WTO rules that does not permit addressing AI-related issues adequately", not least because of the goods-service classification issues,[104] and this would, in their view, make it possible to discuss trade-related issues in one single place in a coordinated manner;[105] (ii) facilitate cooperation and coordination; and (iii) enable more stakeholders to be informed, get involved and share best practices.[106] A recent report by the World Economic Forum (WEF, 2024) outlines various possible areas of work for the WTO, including hosting educational sessions, conducting a comprehensive assessment of how the current trading system applies to AI and identifying gaps in current rules, encouraging members to present and notify their AI legislation and regulations, reviewing the implications of AI for IP rules, developing rules or best practices around transparency and disclosure with reference to AI use, developing guidance on how to facilitate the transparency and verification of AI systems across borders, and discussing the development of AI technical standards.

The above-mentioned views suggest that more research is necessary. Reflections on the implications of AI for trade rules are still in their early stages. Despite a growing body of literature, more work is needed to fully explore the possible implications of AI for regulatory frameworks and trade rules. Given the speed of AI developments, it is too early to fully grasp these issues in a definitive manner. It is important to underline that discussions on the implications of AI for trade rules do not detract from the rights of WTO members to regulate AI in line with the existing WTO rules. For example, under the GATS, members have the capacity to set non-discriminatory qualification requirements for the supply of services. Rather, this report is an invitation to explore the potential implications of AI for international trade, including its rules, with a view to ensuring that we are prepared for the challenges to come.

Box 4.4: Classification of some digital products: a long-debated issue in the WTO

Debates about the impact of digitalization on how certain products might be treated under WTO rules are not new. Members have long discussed the classification of certain digital products in the context of the WTO Work Programme on Electronic Commerce, adopted in 1998.[107] Classification discussions have, over the years, focused on electronically delivered software. At issue is whether, or under what circumstances, certain products transmitted via electronic means should be covered under GATS rules (as services) or GATT rules (as goods).[108] This question, which remains open in the WTO context, may be pertinent in the case of AI, on the basis that AI systems and models are software algorithms, although this has not been discussed in that specific context in the WTO.[109]

As AI becomes more and more ubiquitous and permeates all economic sectors in different and complex ways, classification issues may resurface. As already discussed, AI also raises issues of IP rights, which are covered by the WTO TRIPS Agreement. All of this may thus present challenges in terms of which or how WTO rules apply in different contexts.[110]

Endnotes

1 Thematic Session on regulatory cooperation on "intangible digital products" organized in the context of the WTO Technical Barriers to Trade (TBT) Committee See WTO official document number G/TBT/GEN/356 (20 July 2023), available at https://docs.wto.org/.

2 See https://www.gov.uk/government/publications/ai-safety-summit-2023-the-bletchley-declaration/the-bletchley-declaration-by-countries-attending-the-ai-safety-summit-1-2-november-2023.

3 The fundamental role of regulatory transparency was recently recognised by the panel in EU and certain Member States – Palm Oil (Malaysia), Panel Report, para. 7.719.

4 Composed of all WTO members, the WTO Technical Barriers to Trade (TBT) Committee is the body responsible for the implementation of the TBT Agreement. For more details on the functions and work of the Committee, see World Trade Organization (2004).

5 European Union. See WTO official document number G/TBT/N/EU/850, available at https://docs.wto.org/.

6 https://www.epingalert.org/en/TradeConcerns/Details?imsId=736&domainId=TBT European Union. See WTO official document number G/TBT/N/EU/850, available at https://docs.wto.org/.

7 Kenya. See WTO official document number G/TBT/N/KEN/1604, available at https://docs.wto.org/.

8 See Lim (2021).

9 See https://www.epingalert.org/.

10 See Annex 3 of the TPRM (https://www.wto.org/english/tratop_e/tpr_e/annex3_e.htm).

11 See, e.g., China TPR (2024), Report by the Secretariat (WT/TPR/S/458), paragraphs 21, 34, 3.92, 3.119 and 3.140; Canada TPR (2024), Report by the Secretariat (WT/TPR/S/455), paragraphs 3.154, 3.227; 3.272, 3.294, and 3.329 3.330; Japan TPR (2023), Report by the Secretariat (WT/TPR/S/438/Rev.1), paragraphs 2.40; 3.134, 3.168; 3.173 and 3.227; and European Union TPR (2023), Report by the Secretariat (WT/TPR/S/442), paragraphs 2.51, 3.168 and 3.282.

12 WTO official document number IP/C/W/698. Some members expressed their willingness and interest to engage (WTO official document number IP/C/M/108/Add.1).

13 For more information see WTO (2022; 2023b; 2023a; 2023d; 2023c).

14 See WTO official document numbers G/TBT/W/788 (16 February 2024); G/TBT/W/780/Rev.1 (1 March 2024) and G/TBT/W/789/Rev.1 (23 May 2024).

15 See WT/MIN(22)/32, available at https://docs.wto.org/dol2fe/Pages/SS/directdoc.aspx?filename=q:/WT/MIN22/32.pdf&Open=True.

16 For more information see: https://www.wto.org/english/tratop_e/sps_e/sps_2506202410_e/sps_2506202410_e.htm.

17 See WTO official document number G/SPS/W/361 (22 April 2024), Proposal from Australia under the 6th Review of the SPS Agreement. Australia observes that digital enabled solutions are "increasingly used within the regulatory frameworks that govern agri food trade". With respect to AI, specifically, Australia notes that "AI platforms also have the potential for assessing compliance and conformance and implementing real time follow up and checking of goods and accompanying documentation." Australia thus proposed that the SPS Committee put "a strong focus on the application of digital technologies [...] as well as the potential application of artificial intelligence" so as to "ensure that the benefits and challenges of these technologies can be considered by all Members".

18 For more information on these issues, see for example National Board of Trade Sweden (2023), Kerry (2024) and Meltzer (2023).

19 See WTO official document G/TBT/M/93 for the minutes of the meeting of 6-7 June 2024, paras. 7.1-7.2.

20 See WTO official document G/TBT/GEN/385 for the UNECE documents and a brief explanation on the draft guidance being discussed.

21 See https://www.wto.org/english/tratop_e/sps_e/sps_2506202410_e/sps_2506202410_e.htm.

22 TBT Agreement, Articles 2.4, 2.5 (second sentence), 5.4 and Annex 3.F. On the presumption under Article 2.5 (second sentence) see Panel Report, Australia – Tobacco Plain Packaging, paragraphs 7.254 7.417. The TBT Agreement states that when an international standard is not an "effective" or "appropriate" means for the fulfilment of the legitimate objectives pursued by a given regulation, a member is not required to use it as a basis. In addition, the TBT Agreement recognizes that developing-economy members should not be expected to use international standards when these standards are not appropriate in light of their development, financial and trade needs (Article 12.4).

23 See Articles 2.6 and 5.5 and Annex 3.G of the TBT Agreement.

24 See Article 11.2 of the TBT Agreement. See also the 2024 WTO Ministerial Declaration on "Strengthening Regulatory Cooperation to Reduce Technical Barriers to Trade" (WT/MIN(24)/35), paragraph 5(h) and the 2024 Ministerial Declaration on the "precise, effective and operational implementation of special and differential treatment provisions of the Agreement on the Application of Sanitary and Phytosanitary Measures and the Agreement on Technical Barriers to Trade" (WT/MIN(24)/36) (available at https://www.wto.org/english/thewto_e/minist_e/mc13_e/documents_e.htm). See also Principle 6 ("development dimension"), of the TBT Committee's "Six Principles" (https://www.wto.org/english/tratop_e/tbt_e/principles_standards_tbt_e.htm).

25 See also section 3(c) for a discussion on socio-technical risks.

26 See references to ISO/IEC foundational AI standards in Annex 3.II.A. As described by Callegari et al. (2022)."Standards have the potential to clarify ambiguities and build common understanding around AI risk concepts and terminologies … foundational standards … are important building blocks in the trustworthy AI domain as they lay the groundwork for future assurance mechanisms like conformity assessments and certification … Given the multistakeholder nature of AI committees, SDOs were seen to be particularly well placed to achieve consensus around key concepts such as bias or human oversight. … Nevertheless, some interviewees urged caution around the role of standards in AI ethics. A government official stressed that 'quite a lot of things that people are worried about in AI risk is a genuine question of ethics or values, where people could completely disagree about the right answer' and that SDOs are not the right institutions to set these values … Instead, standards should enable implementation of agreed-upon values proposed by governments or multilateral organisations …. Consequently, for AI risk areas where fundamental ethical dilemmas persist, standardisation work may face additional complexities and delays."

27 See ISO/IEC Technical Report 24368 (2022): AI – Overview of Ethical and Societal Concerns. See also NIST "A Plan for Global Engagement on AI Standards" (available at: https://nvlpubs.nist.gov/nistpubs/ai/NIST.AI.100-5.pdf). However, others, while considering that AI standards can address "fundamental rights", caution that – in this area at least – this role should be strictly limited to non normative issues, e.g., disseminating information and encouraging best practices in processes and measurement techniques; standards however "can never attempt to decide on a trade off or on a level of acceptability of a given fundamental right risk" (Gornet and Maxwell, 2024).

28 The EU AIA, for instance, refers to the relevance of mutual recognition agreements, that are in line with the WTO TBT Agreement, for facilitating certification procedures of AI systems covered by that regulation. AIA, Preamble, Recital (127).

29 Decision of the Committee on Principles for the Development of International Standards, Guides and recommendations with Relation to Articles 2, 5 and Annex 3 of the Agreement, WTO official document number G/TBT/9, 13 November 2000, para. 20 and Annex 4.

30 See TBT Handbook, pp. 32-33; OECD and WTO (2019, p. 41-43, 61, 80 & 95-96); and McDaniels et al. (2018, p. 819-821).

31 For instance, the G7 Trade Ministers' Digital Trade Principles make specific reference to the Six Principles as the basis for developing international standards for information and communication technology (ICT). See also https://www.gov.uk/government/news/g7-trade-ministers-digital-trade-principles.

32 See, for example, references in UNESCO (2021) to conformity assessment measures and related instruments.

33 See WTO official document G/TBT/54, Section 2.5 ("Acceptance of results").

34 See WTO official document G/TBT/792 (26 February 2024). More broadly on mutual recognition agreements, see WTO Secretariat Note G/TBT/W/42 (28 April 1997).

35 Provisions related to data flows, data localization and source code are not included in the stabilized text that was issued on 26 July 2024 (WTO official document INF/ECOM/87).

36 "Services Sectoral Classification List", WTO official document MTN.GNS/W/120. The list includes the sector of "computer and related services", which refers to category 84 under the Central Production Classification (Provisional).

37 For the four modes of supply distinguished under the GATS, see https://www.wto.org/english/tratop_e/serv_e/gatsqa_e.htm#4.

38 The 1999 Progress Report on E-commerce adopted by the Council for Trade in Services characterized the electronic delivery of services as generally considered to fall within the scope of the GATS. Dispute settlement cases involving services have, to date, echoed this line of reasoning. See the Progress Report to the General Council, adopted by the Council for Trade in Services on 19 July 1999 (WTO official document number S/L/74, 27 July 1999).

39 In the Services Sectoral Classification List (see https://www.wto.org/english/tratop_e/serv_e/serv_sectors_e.htm), "computer and related services" are composed of five subsectors covering different elements of the CPC 84 category: consultancy services related to the installation of computer hardware (CPC 841); software implementation services (CPC 842); data processing services (CPC 843); data base services (CPC 844); other (CPC 845+849).

40 This does not take into account horizontal limitations that may affect all sectors within the schedule. GATS mode 4 (movement of natural persons) commitments tend to refer to horizontal commitments, which are typically "unbound" except for specified categories of natural persons.

41 In the GATS classification system, the telecommunication services sector is composed of 15 subsectors.

42 See the Decision on the Valuation of Carrier Media Bearing Software in WTO document G/VAL/5, paragraphs B.2(i) and (ii).

43 See WTO document WT/MIN(24)/38.

44 Proponents note that the standstill on customs duties has supported a stable and predictable environment for digital trade, allowing it to thrive. Because it signals that WTO members aim to keep current customs duties practices on electronic transmissions unchanged, businesses gain the necessary confidence to invest and create jobs. However, some WTO members have expressed concerns about the lack of clarity in the scope of the moratorium and in the definition of electronic transmissions, and the potential lost customs revenue. These members have expressed the desire to maintain policy space in light of the uncertainty associated with rapid technological change (IMF-OECD-UN-WBG-WTO, 2023).

45 As noted above, AI trustworthiness depends on its ability to meet stakeholders' expectations in a "verifiable way", for example via certification against technical specifications in a regulation or standard.

46 "As AI technologies increasingly underpin the digital services we use every day, the importance of the National Quality Infrastructure in assuring those AI technologies will be brought into even sharper focus" (TIC, 2024). As WTO Deputy-Director General Jean Marie Paugam said in his opening remarks at the 5th China Quality Conference, "it is clear that digitalisation and decarbonation have a potential to revolutionize trading patterns and have implications for Quality Infrastructure. Artificial intelligence and other digital products have an immense potential to facilitate trade while pushing the frontiers of regulatory cooperation on cybersecurity and intangible digital products." (1 September 2023, https://www.wto.org/english/news_e/news23_e/ddgjp_01sep23a_e.pdf). See https://www.tic-council.org/news-and-events/news/press-release-accredited-tic-sector-key-providing-confidence-ethical-ai-development.

47 See TRIPS Agreement, Article 29.1 (https://www.wto.org/english/docs_e/legal_e/27-trips_01_e.htm).

48 Under Article 13.3 of the TRIPS Agreement, the three-step test stipulates that exceptions to copyright protection must only cover special cases, must not conflict with a normal exploitation of the work, and must not be unreasonably prejudicial to the legitimate interests of the copyright-holder. Similar tests are found in Article 17 for exceptions to trademark rights, and in Article 30 for exceptions to patent rights.

49 See TRIPS Agreement, Article 1.1 (https://www.wto.org/english/docs_e/legal_e/27-trips_01_e.htm).

50 TRIPS Agreement, Article 66.2 (https://www.wto.org/english/docs_e/legal_e/27-trips_01_e.htm).

51 TBT Agreement, Preamble, 8th recital.

52 See https://www.wto.org/english/tratop_e/devel_e/dev_wkgp_trade_transfer_technology_e.htm.

53 WTO official documents IP/C/R/TTI/CAN/2, 3 and 4; IP/C/R/TTI/EU/2 and 4; IP/C/R/TTI/CHE/2, 3, and 4. IP/C/R/TTI/USA/2, 3, and 4, available via https://docs.wto.org/.

54 WTO official document WT/GC/W/443, which requests that a Working Group on Trade and Technology Transfer be established, notes that "the lack of full and faithful implementation of these provisions by developed countries have not allowed developing countries to fully benefit from the growth in international trade", and in document WT/WGTTT/3, members note that "in most cases, however, such provisions contain only 'best endeavours' commitments, and are not mandatory rules. The question that arises is to what extent developing countries benefit from these instruments". More recently, the African Group noted that, "A core concern of LDCs has been that while some Members have made efforts, [...] some of the policies and programmes reported by developed countries either barely target or do not at all target LDCs" (document JOB/TN/CTD/8, JOB/TNC/121). Noting that "Article 66.2 of the TRIPS Agreement places a positive obligation on developed countries to provide incentives to enterprises and institutions in their territories for the purpose of promoting and encouraging technology transfer to least developed country

Members in order to enable them to create a sound and viable technological base", LDCs have also "expressed reservations about the extent to this obligation has been fulfilled" (documents WT/GC/W/868, G/C/W/825, WT/COMTD/W/270, IP/C/W/695 and WT/WGTTT/W/33).

55 See also WTO official document WT/WGTTT/3.

56 Under the most-favoured-nation (MFN) principle, WTO members cannot discriminate between their trading partners. This principle is enshrined in several provisions of the WTO Agreements, such as Article I of the GATT, Article II of the GATS, Articles 2.1 and 5.1.1 of the TBT Agreement and Article 4 of the TRIPS Agreement. Meanwhile, the national treatment principle provides that imported and locally produced goods shall be treated equally, at least after the foreign goods have entered the market (e.g., Article III of the GATT and Articles 2.1 and 5.1.1 of the TBT Agreement). The same principle applies to foreign and domestic services (Article XVII of the GATS), and to foreign and local trademarks, copyrights and patents (Article 3 of TRIPS).

57 See WTO official number G/TBT/GEN/356.

58 See Article 2.3 of the TBT Agreement.

59 Panel Report, EC – Sardines, paras. 7.79-7.82. See also EU and certain Member States – Palm Oil (Malaysia), paragraphs 7.189 (and its footnote 374); 7.567 (and its footnote 875); and 7.676 (and its footnote 997). See also WTO (2020a).

60 Article 5.2.7 of the TBT Agreement states that when product specifications in the technical regulations change, the procedures for assessing conformity with them may also need to change accordingly.

61 See also WTO official document G/TBT/GEN/356.

62 WTO official document G/IT/25. For a more detailed overview of all elements of the ITA Committee's NTM Work Programme, see WTO (2017).

63 See WTO official document G/IT/W/17 and its subsequent revisions, "Draft List of the Types of Conformity Assessment Procedures for EMC/EMI used by ITA Participants".

64 For example, general-purposes AI models are general by nature. AI systems, on the other hand, are usually meant to apply to specific domains and applications.

65 See https://www.epingalert.org/en/TradeConcerns/Details?imsId=736&domainId=TBT

66 The WTO agreements covered by the Dispute Settlement Understanding (DSU) are those set out in Appendix 1 to the DSU.

67 For more information, see https://www.wto.org/english/tratop_e/dispu_e/dispu_e.htm.

68 While a total of 54 disputes lodged since 1995 have included claims of violation of the TBT Agreement, only 11 of these proceeded into actual adjudication by panellists and resulted in panel and/or Appellate Body reports. The vast majority of these disputes never proceeded beyond consultations, with some ending by virtue of mutually agreed solutions reached by the parties involved. See WTO (2024a).

69 There are 35 notifications if the addenda are considered. See, e.g., WTO official documents G/TBT/N/USA/1597, G/TBT/N/TPKM/399, G/TBT/N/TPKM/400, G/TBT/N/JPN/610, G/TBT/N/KOR/776, G/TBT/N/EU/567, G/TBT/N/GBR/36, G/TBT/N/TPKM/265, G/TBT/N/USA/2041 and G/TBT/N/GBR/62.

70 There are 30 notifications if the addenda are considered. See, e.g., WTO official documents G/TBT/N/KOR/827, G/TBT/N/USA/1283, G/TBT/N/JPN/752 and G/TBT/N/ARE/550.

71 There are 18 notifications if the addenda are considered. See, e.g., WTO official documents G/TBT/N/KOR/1164, G/TBT/N/FRA/219, G/TBT/N/DNK/108, G/TBT/N/FRA/203, G/TBT/N/USA/1497, G/TBT/N/TPKM/378 and G/TBT/N/JPN/527. There were no STCs raised on robotics at the time period.

72 See, e.g., WTO official documents G/TBT/N/CHN/1742 and G/TBT/N/CHN/880. The legitimate public policy objectives pursued by these measures (as indicated in their notification forms) included the prevention of deceptive practices, consumer protection and information, quality requirements, harmonization, protection of human health or safety, and protection of the environment. The specific problems or challenges they purport to address included interoperability, cybersecurity, privacy and data regulation, and consumer protection.

73 These are: (i) requirements needed for the type approval of the Automated Driving System of fully automated vehicle (STC ID 766); (ii) "On the safety of wheeled vehicles", including as it concerns various advanced autonomous functions (STC ID 687); (iii) the repairability index of various electronic products, including robot electric lawnmowers (STC ID 657); (iv) criteria and test procedures for the approval of motor vehicles with respect to their emergency lane keeping system, including with respect to automated and fully automated vehicles (STC ID 700); and (v) Internet of Vehicles Cybersecurity Protection Guideline Rules (STC ID 537).

74 See Lim (2021) and WTO (2020).

75 EC – Computer Equipment https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds62_e.htm and EC – IT Products https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds375_e.htm, respectively.

76 US – Gambling https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds285_e.htm.

77 China – Publications and Audiovisual Products https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds363_e.htm.

78 Brazil – Taxation: https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds472_e.htm, paragraph 7.583.

79 Brazil – Taxation: https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds472_e.htm, paragraph 7.622.

80 i.e., the Ministerial Declaration on "Strengthening regulatory cooperation to reduce technical barriers to trade" (WT/MIN(24)/35), paragraph 5(h), and the Ministerial Declaration on the "precise, effective and operational implementation of special and differential treatment provisions of the Agreement on the Application of Sanitary and Phytosanitary Measures and the Agreement on Technical Barriers to Trade" (WT/MIN(24)/36).

81 See https://www.wto.org/english/tratop_e/tbt_e/principles_standards_tbt_e.htm.

82 Responses were received from Susan Aaronson (George Washington University), Dan Ciuriak (Centre for International Governance Innovation), Johannes Fritz (Digital Policy Alert), Olia Kanevskaia (Utrecht University), Kholofelo Kugler (University of Lucerne), Heidi Lund (National Board of Trade Sweden), Petros Mavroidis (Columbia Law School), Hildegunn Kyvik Nordås (Council on Economic Policies (CEP), Örebro University), Eduardo Paranhos (Associação Brasileira das Empresas de Software) and Shin-Yi Peng (National Tsing Hua University).

83 Survey responses by Dan Ciuriak, Johannes Fritz, Kholofelo Kugler, and Shin-Yi Peng. One expert suggested looking into the classification issue in terms of "durable" products, e.g., music downloadables, versus "non-durable" products, e.g., streamed music (survey response by Dan Ciuriak; see also Ciuriak, 2022).

84 See Liu and Lin (2020).

85 See WEF (2024) and survey responses by Hildegunn Kyvik Nordås, Kholofelo Kugler and Petros Mavroidis.

86 Survey response by Kholofelo Kugler.

87 See https://www.wto.org/english/tratop_e/serv_e/telecom_e/tel23_e.htm.

88 Survey response by Hildegunn Kyvik Nordås.

89 Survey response by Kholofelo Kugler.

90 Survey response by Johannes Fritz.

91 Survey response by Olia Kanevskaia.

92 Survey response by Dan Ciuriak and Shin-Yi Peng.

93 Survey response by Dan Ciuriak and Shin-Yi Peng.

94 See also survey response by Dan Ciuriak.

95 Survey response by Dan Ciuriak.

96 Survey response by Dan Ciuriak, Johannes Fritz.

97 Survey response by Dan Ciuriak.

98 Survey response by Susan Aaronson and Dan Ciuriak. See also Ciuriak (2024).

99 Survey response by Dan Ciuriak.

100 Survey response by Dan Ciuriak.

101 Survey response by Susan Aaronson, Olia Kanevskaia, Heidi Lund and Eduardo Paranhos.

102 Survey response by Eduardo Paranhos.

103 Survey responses by Kholofelo Kugler. See also Liu and Lin (2020).

104 Survey response by Kholofelo Kugler. Johannes Fritz also notes that "Many AI applications cut across multiple sectors, and core issues like data governance and cybersecurity are horizontal in nature. Relying solely on GATS schedules could lead to fragmentation rather than coherence".

105 Survey response by Kholofelo Kugler.

106 See Liu and Lin (2020).

107 Services that are clearly identified as such – e.g., legal services or accounting services – and are traded digitally do not pose classification issues.

108 Classification matters because rules for goods (according to the GATT, or other specialized WTO agreements addressing trade in goods) and services (according to the GATS) differ.

109 Outside of the WTO, the ISO International Classification System of standards, which applies to goods, has an entry for software, and the WIPO Nice Agreement, which provides a classification system for goods and services for the registration of trademarks, distinguishes between software that can be downloaded – which is classified as a good under class 9 – and software that remains on a company's computer server – which is classified as a service under class 42 (software as a service). In the UN Provisional Central Product Classification (CPC), from 1991, which is commonly used by WTO members to define the scope of commitments under the GATS, computer services comprise various software and computer systems services. The more recent version of the CPC (version 2.1) provides more detail on computer (or information technology services), and classifies "software originals" as a distinct sub-category of IT services. The draft CPC version 3, from 2023, clarifies that AI is covered under relevant existing categories, such as subclasses 83152 "application software provision" and 84392 "on-line software" (https://unstats.un.org/unsd/classifications/CPC/Documents/4-Accompanying-note-Overview-of-the-proposed-main-changes-introduced-in-the-revised-CPC.pdf).

110 For example, in June 2023, members of the WTO TBT Committee, on the basis of a proposal by Canada (WTO official document G/TBT/W/745), held a thematic session on regulatory cooperation on "intangible digital products" (including as they relate to AI) under the TBT Agreement which, like the GATT, is an agreement on trade in goods. See https://www.wto.org/english/tratop_e/tbt_e/tbt_2006202310_e/tbt_2006202310_e.htm.

5 Conclusion

Conclusion

This report highlights the widespread and transformative impact that artificial intelligence (AI) is currently having in many areas, including on international trade, and discusses the possible future impact of AI in this area. AI has the potential to reduce trade costs and enhance productivity, particularly in services sectors that rely on manual processes. However, AI also raises important trade-related policy questions, in addition to the well-known ethical, societal and security risks it generates.

One key challenge lies in addressing the so-called “AI divide”, the existing and widening inequality between economies with advanced technological infrastructures and those which are less advanced in terms of AI adoption, and between big companies and small businesses. Bridging this gap is essential to ensure that the benefits of AI are equitably distributed across all economies. Another challenge concerns the need to access large, accurate and bias-free datasets to train AI models adequately, which must be carefully weighed against the importance of protecting personal data, security and intellectual property (IP).

These questions should be addressed in a coherent way across economies, and ways must be found to balance the need to foster global consensus and coherence in AI governance, while respecting diverse cultural and societal values.

An additional concern is the issue of regulating AI to ensure that it is trustworthy and safe, but without stifling trade. This presents a significant challenge for policymakers, given the opacity and autonomous “behaviour” of AI. In addition, while governments across the globe are increasingly taking steps to promote and regulate AI through domestic, regional and international initiatives, the diversity of these initiatives risks creating a fragmented policy landscape. Given the pervasiveness of AI, a coordinated global approach involving all stakeholders and international organizations with a role to play in AI governance is essential to promote policy convergence, as well as to harness the benefits of AI and mitigate its risks effectively. It is important to ensure that differing AI policy approaches do not lead to fragmentation, as this could create obstacles to trade and thereby limit the potential of trade to foster the deployment of trustworthy and safe AI technologies and the benefits of AI.

As the only rules-based global body dealing with trade policy, the WTO can play a crucial role in limiting regulatory fragmentation and promoting regulatory coherence. This, in turn, can contribute to the development of AI and increase access to it. WTO rules can help to ensure that AI technologies are beneficial to all economies and accessible to all by promoting trade-opening in AI-related goods and services. By reducing trade barriers, and thereby fostering a level playing field across economies in terms of trade, the WTO can encourage the dissemination of AI technologies globally, enabling economies at different stages of development to access AI innovations. WTO rules can also help to ensure that regulatory interventions are not more trade-restrictive than necessary and to address and prevent trade tensions and obstacles. However, AI may prompt questions about the application of current international trade rules.

The WTO also provides a global framework for cooperation and dialogue, within which WTO members can exchange experiences and develop ways to promote trade in AI-enabled products and balance AI risks and opportunities. AI governance requires open and inclusive dialogue involving all stakeholders, as well as close cooperation among international organizations. By offering a multilateral framework combining predictable and enforceable trade rules with the facilitation of dialogue, the WTO can meaningfully contribute to the development of a robust AI governance framework and help to create a more coherent, supportive and inclusive environment for trustworthy and safe AI.

As AI evolves, governments should continue to discuss the intersection of AI and trade and its possible implications for international trade rules. This report is a first attempt to flesh out some of the key implications of AI for trade and trade rules. It is an invitation to explore these issues with the aim of ensuring that we fully understand the opportunities and challenges ahead, and are well-prepared to address them.

Annexes

Annex 1 Key AI-related terms

This report makes reference to several key concepts in AI. To facilitate comprehension of these terms, definitions are provided hereafter.

General versus narrow AI

- **General AI** or artificial general intelligence (AGI) represents a type of AI system that possesses a broad range of capabilities that matches or outmatches humans (Morris et al., 2024). True AGI systems do not yet exist. The concept of AGI remains a visionary goal, but the rapid pace of development of AI hints at the possibilities and potential directions AGI might take.

- **Narrow AI:** Narrow AI refers to a type of AI system that is designed to address specific tasks or solve particular problems. Unlike AGI, which aims for broad capabilities, narrow AI focuses on defined tasks and exhibits expertise within a limited domain. Narrow AI systems are tailored to excel in specific applications or problem domains.

AI technologies

- **Machine learning** is a subset of artificial intelligence (AI) that focuses on the development of algorithms and statistical models that enable computers to perform tasks without being explicitly programmed to do so. In other words, machine-learning algorithms learn from data, identify patterns and make decisions or predictions based on those data.

- **A neural network** is a computational model inspired by the structure and function of the human brain, composed of interconnected nodes, or artificial neurons, organized in layers. Through a process called training, neural networks learn from examples by adjusting the weights of connections to minimize the difference between predicted and actual outputs, thereby enabling them to recognize patterns, make predictions and perform complex tasks across a wide range of domains.

- **Deep learning** is a subset of machine learning that involves training artificial neural networks with many layers of processing units, or neurons, to learn representations of data. The term "deep" refers to the depth of the neural networks, which typically consist of multiple hidden layers between the input and output layers.

- **Large language** models (LLM) are advanced AI systems that are trained on massive amounts of text data to understand and generate human-like language. These models are characterized by their vast size, often containing hundreds of millions to billions of parameters, which enables them to capture intricate patterns and nuances in language.

Supervised versus unsupervised learning

- **Supervised learning** is a machine-learning approach defined by its use of labelled datasets. These datasets are designed to train or "supervise" algorithms into classifying data or predicting outcomes accurately. Using labelled inputs and outputs, the model can measure its accuracy and learn over time.

- **Unsupervised learning** uses machine-learning algorithms to analyse and cluster unlabelled data sets. These algorithms discover hidden patterns in data without the need for human intervention.

In certain AI models, the distinction between supervised and unsupervised learning is more nuanced than in others. For instance, in reinforcement learning, the machine is given only a numerical performance score as guidance, and in weak or semi-supervision models, a small portion of the data are tagged.

Other terms

- **Foundation models** are large-scale, pre-trained models that serve as the basis or foundation for developing more specialized AI applications or models. These foundation models are typically trained on vast amounts of data using techniques such as unsupervised learning. Developers can fine-tune these pre-trained foundation models on specific datasets or tasks to create more specialized AI models tailored to particular applications or domains.

- **Source code** refers to the human-readable instructions written by programmers to define the behaviour, algorithms and models used in AI systems.

- **Artificial Intelligence** of Things (AIoT) refers to the integration of artificial intelligence (AI) technologies with Internet of Things (IoT) devices and systems. AIoT combines the capabilities of AI algorithms with the vast amounts of data generated by IoT devices to create intelligent and autonomous systems.

- **Intelligent automation** combines AI technologies, such as machine learning, computer vision, natural language processing and robotics process automation, to automate and optimize processes, tasks and workflows in various domains and industries.

Annex 2 Technical Appendix on the simulation scenarios

Productivity shocks

The changes projected as a result of AI in labour productivity differ according to skills and sectors,[1] distinguishing between high-skilled, medium-skilled and low-skilled labour.

The size of the productivity shock, or changes to productivity, in the optimistic scenarios is based on a study conducted by Goldman Sachs (2023). The study projects that AI will increase total factor productivity in the United States by 1.5 percentage points annually for 10 years, starting in 2027, 10 years after AI started to transform the technology industry. Since the productivity shock will be phased in over 14 years (2027-40) in the simulation conducted for this report, this implies an approximate shock of 1.06 percentage points per year.

The size of the productivity shock in the cautious scenarios is partially based on Acemoglu (2024), who projects that total factor productivity will go up by 0.66 percentage points in 10 years as a result of AI. However, Acemoglu (2024) follows Svanberg et al. (2024) in assuming that only 23 per cent of AI projects can be profitably implemented. Since a long-term perspective has been employed here, this profitability scaling-down is not applied, which thus leads to a productivity shock of 0.2 percentage points per year.

In the global synergy scenarios, the productivity shocks are applied uniformly across economies. In the divergence scenarios, the productivity shocks are applied taking into account variation in the International Monetary Fund (IMF)'s AI Preparedness Index[2] across economies. The IMF's AI Preparedness Index contains indicators of digital connectivity, skills, innovation capacity and regulations. A replicated AI preparedness index was used for this report, based on IMF methodology (Cazzaniga et al., 2024). This implies that low-income economies would benefit less from productivity increases, because they score lower on this index. To scale the productivity increase according to economies' AI preparedness, the productivity shocks calculated for the United States are multiplied by the AI Preparedness Index of each region relative to the United States.

In both the global synergy and tech divergence scenarios, productivity shocks vary by skill level and across economies. The variation by skill level is based on literature identifying which tasks can be automated through AI in the O*NET catalogue[3] of tasks for each occupation. O*NET describes each occupation in terms of various domains, such as work activities or tasks that need to be completed. Both the global synergy and tech divergence scenarios are based on the AI exposure indicator by Eloundou et al. (2023), who use the tasks attributed to occupations by O*NET. They calculate whether the time spent on completing a task can be reduced by 50 per cent or more through the application of ChatGPT or additional AI software, based both on AI and human judgement. Summing over all tasks for each occupation, an AI exposure indicator at the occupation level can be calculated. The AI exposure indicator is then aggregated to the sectoral level using employment data, differentiating by skill level (high, medium and low).[4]

To distinguish the global synergy scenario from the tech divergence one, it is assumed that the pattern of productivity increases is on aggregate (economy-wise) reverse between middle-skilled and high-skilled labour.[5] In the global synergy scenarios, productivity increase is higher for middle-skilled workers than high-skilled worker, whereas in the tech divergence scenario, higher-skilled workers see a higher increase in productivity. However, the sectoral distribution of AI exposure is kept, as well as the relative gap between high-skilled and middle-skilled workers across sectors. Hence, sectors with larger AI exposure of middle-skilled relative to high-skilled workers will maintain a larger gap compared to sectors where the gap is smaller.

The projections for the level and variation in productivity shocks have been developed for the United States and applied for other economies. However, since productivity shocks vary according to skill and sector, and other regions do not have the same industrial and skill structures as the United States, productivity gains will differ across economies. Regions with more middle-skilled and high-skilled workers, and with a larger sectoral presence in sectors with the highest projected productivity shocks, will incur higher average productivity growth. Also, the degree of convergence between middle and high-skilled workers may differ.

Trade cost shocks

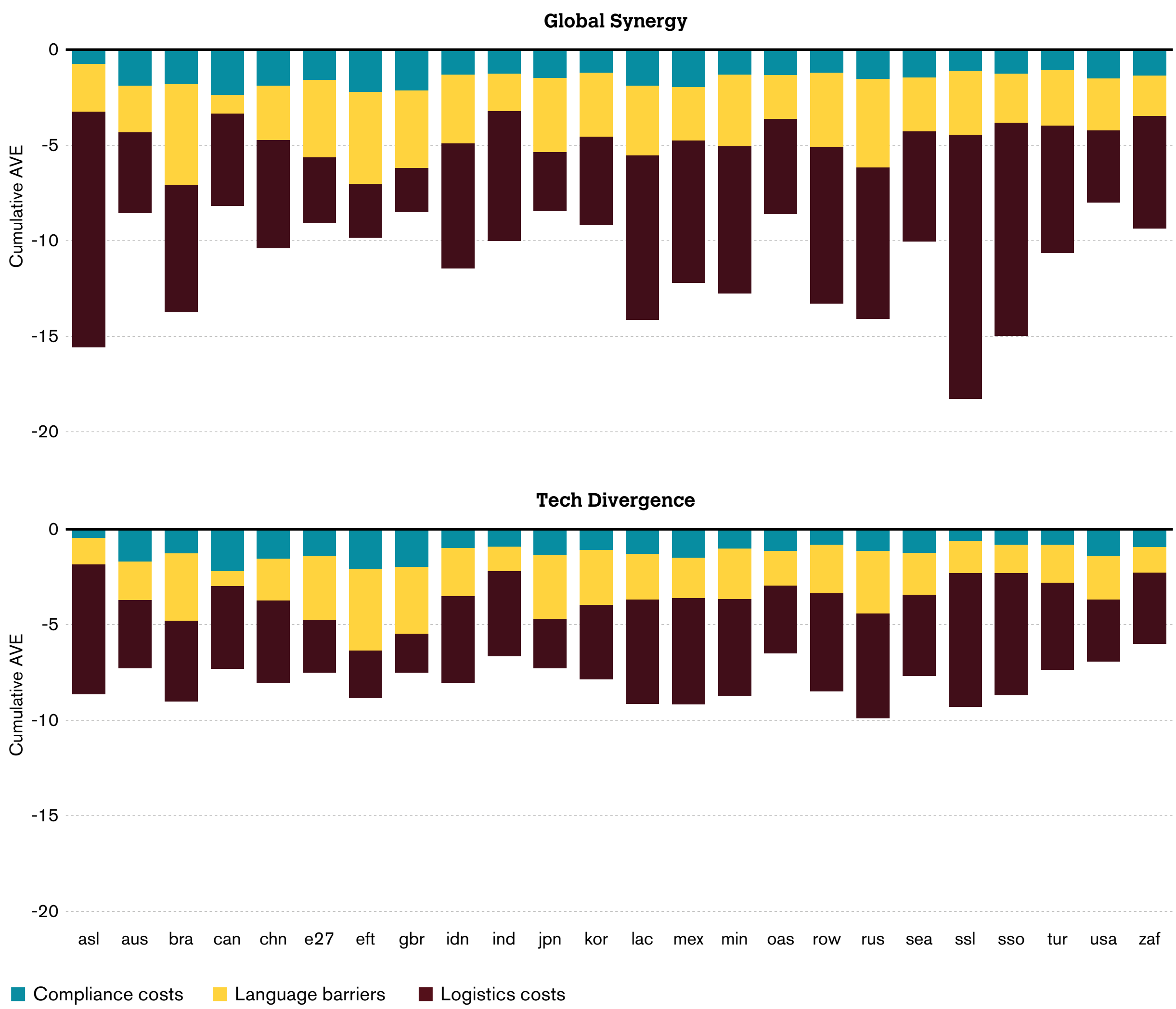
As per Chapter 2, AI is projected to impact trade costs along three channels: diminished compliance costs, reduced language barriers and improved logistics. To gauge the size of the impact, insights from the literature concerning the impact of AI have been considered. As per this estimation, reductions in trade costs can occur per the three channels:

- A reduction in the **costs of compliance with regulations**. To determine the associated trade cost reduction, a measure for compliance costs has been included in a regression of inferred trade costs (employing the Head and Ries (2001) formula) on trade cost proxies. The compliance cost measure employed is the World Bank Group's "Doing Business" indicator, *Documentary compliance to export*, defined as the hours needed to comply with all documentary requirements to export. This generates the ad valorem equivalent trade costs of the documentary compliance. In the counterfactual scenarios, it is assumed that these trade costs fall by 70 per cent. This value is based on a case study of DHL's experience: when using AI-based intelligent document processing to prepare the necessary documentation for international shipments, DHL observed an efficiency gain of 70 per cent.[6] Since costs of documentary compliance are proportional to the time needed to comply, this implies that trade costs can also fall by 70 per cent.

- A reduction in the costs associated with **language barriers** in international trade, since AI will facilitate translation of written and spoken communication. To determine the impact on trade costs, the ad valorem equivalent trade cost associated with a dummy for common official language, as introduced by Melitz and Toubal (2014), was employed. In the regression, spoken common language was controlled for, as this captures the influence of common language on trade and trade costs through, for example, ease in informal communication and building trust in networks. Therefore, it is assumed that trade costs associated with a different official language completely disappear, implying a global a verage ad valorem equivalent trade cost reduction of 2.12 per cent. This is close to the projected trade cost reduction of AI through improved machine translation on eBay in a study by Brynjolfsson et al. (2019), in which ad valorem equivalent implied by the projected trade effect was 2.2 per cent.

- A reduction in **logistics** costs, since AI is expected to reduce the costs associated with logistical planning. To determine the size of the effect, we use the "timeliness" component of the World Bank's Logistics Performance Index (LPI).[7] The LPI reflects the frequency with which shipments are delivered within scheduled or expected delivery times (World Bank, 2023). To capture the potential impact of AI on logistics costs, the difference between the maximum possible value for this indicator (five) and the actual indicator was calculated and included in the regression of inferred trade costs on trade cost proxies. In the counterfactual scenarios, the associated trade cost reduction is 50 per cent, i.e. it is assumed that AI will improve the timeliness of shipments by decreasing delays by half. As developing economies and LDCs tend to have a higher frequency of delays, such an improvement will contribute to convergence effect by reducing the gap in the frequency of delays between these economies and developed economies.

Figure A.1: Cumulative trade cost ad valorem equivalents (%) averaged by importers (2017-40)



Note: Figure A.1 demonstrates projected cumulative ad valorem equivalents of trade cost reductions in the global synergy and tech divergence scenarios by means of compliance, language and logistics. The values are not additive.

Source: Simulations using the WTO Global Trade Model

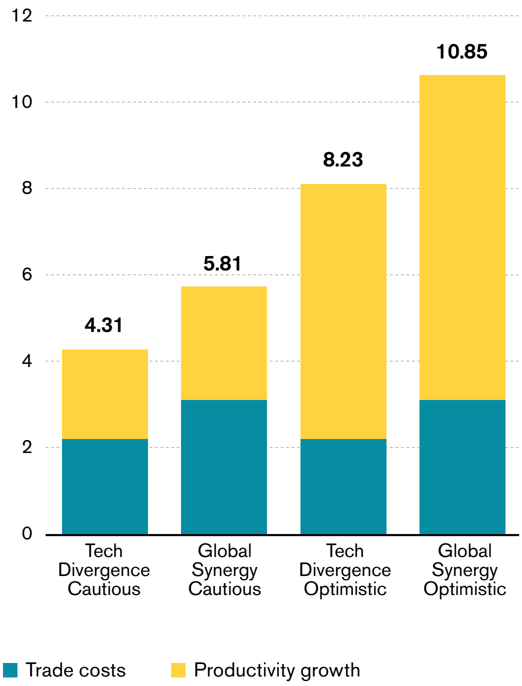
These trade cost shocks are not assumed to vary between the optimistic and cautious scenarios. However, they vary according to whether the global synergy scenario or the tech divergence scenario is considered. In the global synergy scenario, it is assumed that all regions have the same means to implement AI, and that trade cost shocks are therefore identical. In the divergence scenario, the FMI's AI Preparedness Index has been bilateralized and used to scale the trade cost shocks to account for differences in regions' capacity to use AI technologies. It is assumed that trade costs decrease between 2018 and 2040 because some the trends described have already started, such as the reduced costs associated with language barriers referred to in the study of Brynjolfsson et al. (2019).

Figure A.1 displays the projected cumulative trade cost reduction under the global synergy scenario (without considering AI preparedness of economies) and the tech divergence scenario (considering AI preparedness) over the period from 2017 to 2040.[8] The figure clearly shows that the largest projected trade cost reductions will be in LDCs and developing economies. This is because these regions have the greatest potential to leverage AI to lower compliance costs, logistics costs and costs related to language barriers. The largest projected trade cost reduction is expected to come from decreased logistics costs for LDCs and developing economies, while diminishing language barriers play a major role for some developed regions, such as the European Union and the European Free Trade Association (EFTA).

Figure A.2 shows the projected changes in real GDP between 2023 and 2040. In the optimistic global synergy scenario, global real GDP is expected to grow by 11 percentage points compared to the baseline over the period, highlighting the impact of AI in boosting the global economy. The results mirror those for trade, though labour productivity plays a more significant role in driving GDP growth.

Figure A.2: Cumulative global GDP growth rate (2023-40)

(Difference to baseline, percentage points)



Note: This figure demonstrates the impact of AI on projected cumulative global GDP growth (as percentages) between 2023 and 2040 in four scenarios. The values represent the deviation from the baseline scenario.

Source: Simulations using the WTO Global Trade Model

Table A.1: Abbreviations

Regions		Sectors	
AUS	Australia	**AGR**	Agriculture
OAS	Other Asian countries	**OIL**	Oil
CIN	China	**ONR**	Other natural resources
JPN	Japan	**PRF**	Processed food
KOR	Republic of Korea	**TWL**	Textiles, wearing apparel and leather
SEA	ASEAN	**P_C**	Petroleum, coal products
ASL	Asian LDCs	**CHE**	Chemicals and petrochemicals
IND	India	**PRP**	Pharmaceuticals, rubber and plastic products
IDN	Indonesia	**OTG**	Other goods
CAN	Canada	**MET**	Metals
USA	USA	**EEQ**	Electronic equipment
MEX	Mexico	**ELE**	Computer, electronic and optical products
BRA	Brazil	**OMF**	Other machinery
LAC	Latin America	**MVT**	Motor vehicles
E27	EU-27	**OTN**	Transport equipment not elsewhere classified (n.e.c.)
GBR	United Kingdom	**UTC**	Utilities and construction
EFT	EFTA countries	**TRD**	Trade
ROW	Rest of World	**TRP**	Transport
RUS	Russian Federation	**WIS**	Accommodation, food and services activities
MIN	Middle East and North Africa	**WHS**	Warehousing and support activities
TUR	Türkiye	**CMN**	Communication
SSA	Sub-Saharan Africa	**OBS**	Business Services
SSL	Sub-Saharan LDCs	**INS**	Insurance
ZAF	South Africa	**FIN**	Financial Services
		OTS	Other Services
		EDH	Education and human health
		ROS	Recreational and other services

Endnotes

1 In the Global Trade Analysis Project (GTAP) Data Base (https://www.gtap.agecon.purdue.edu/databases/), "off_pros" are mapped to "high-skilled", "tech_aspros", "clerk" and "service_shop" are mapped to "medium-skilled", and "ag_othlowsk" are mapped to "low-skilled".

2 See https://www.imf.org/external/datamapper/datasets/AIPI.

3 A survey-based database of information on jobs and occupations (https://www.onetonline.org/).

4 The skill level of each occupation is based on the International Standard Classification of Occupations (ISCO-08) major groups score per occupation (in which 1-3 are high-skill; 4-8 are medium-skill and 9 are low-skill), employing a mapping to US Standard Occupational Classification (SOC2018) occupations.

5 It is worth noticing that such an approach does not mean that all sectors will have a larger productivity shock in middle-skill occupations than in high-skill occupations.

6 See https://www.abbyy.com/customer-stories/deutsche-post-dhl-group-increases-efficiency-by-70-with-rpa-and-abbyy-idp/.

7 See https://lpi.worldbank.org/.

8 We assume that trade cost reductions begin earlier, in 2017, compared to the increase in productivity starting in 2023, as empirical evidence suggests that AI has already contributed to lowering logistical and translation costs.

Annex 3 Key Policy and Standard-Related International Initiatives in the Area of AI

I. Policy-related initiatives in the area of AI

A. Organisation for Economic Co-operation and Development (OECD)

In May 2019, the OECD Council adopted the OECD AI Principles (OECD, 2019a), considered to be the first intergovernmental policy instrument in this area (Ebers and Navas Navarro, 2020; Morley et al., 2020). The document includes the following five high level values based principles for responsible AI stewardship:

1) “inclusive growth, sustainable development and well-being”;
2) “human-centred values and fairness”;
3) “transparency and explainability”;
4) “robustness, security and safety”; and
5) “accountability”.

The document also provides five policy recommendations intended to guide both national government policies and international cooperation, to be undertaken in a manner consistent with the five AI principles, namely:

1) investing in AI research and development;
2) fostering a digital ecosystem for AI;
3) shaping an enabling policy environment for AI;
4) building human capacity and preparing for labour market transformation; and
5) international cooperation for trustworthy AI.

The OECD AI Principles have been recognized by economies beyond the 38 OECD members. Notably, the G20 AI principles (see below) – which are mostly based on the OECD principles – were adopted by various non-OECD economies, including Brazil, China and India.

The policy recommendations of the OECD Principles suggest elements that, directly or indirectly, may relate to trade and WTO issues. For instance, they refer to the fact that national policies and international cooperation need to include the preparation and use of regulatory instruments, such as technical standards, conformity assessment (certification and verification) and international standards for interoperable and trustworthy AI.

The OECD Principles also propose a common understanding of certain key AI terms. Global agreement over key AI terminology and definitions may be a particularly important element for ensuring coherence and interoperability across economies' regulatory interventions in this area (Meltzer, 2023). The OECD Principles contain various AI definitions, of which two – “AI system”[1] and “AI system lifecycle”[2] – are key for the implementation of any national AI strategy, policy or regulation. As explained in this report, regulatory fragmentation itself can represent an important trade barrier, in particular for developing economies and MSMEs.

In February 2020, the OECD launched the AI Policy Observatory, an inclusive hub for public policy on AI. The AI Policy Observatory aims to help economies encourage and monitor the responsible development of trustworthy AI systems. It is intended to facilitate dialogue and provide multidisciplinary, evidence-based policy analysis and data on areas impacted by AI. For governments, it is also intended to serve as a centre for policy evidence collection and debate, with support from strong partnerships with a wide spectrum of external actors.[3]

B. G20

In June 2019, G20 economies committed to a human-centred AI, and, to this end, adopted non-binding AI Principles.[4] The G20 AI Principles were drawn from the OECD AI Principles described above, which include five high-level principles for responsible stewardship of trustworthy AI and five recommendations for national policies and international cooperation in the area of AI.[5]

Since 2019, the G20 has been implementing aspects of the AI Principles.[6] For instance, to foster knowledge on existing approaches and practices, the G20 launched the “Examples of National Policies to Advance the G20 AI Principles”,[7] and the “Policy Examples on How to Enhance the Adoption of AI by MSMEs and Start-ups”.[8] AI policy issues were a key issue at the G20 Summit in Rio de Janeiro in November 2024, which focused on the use of AI for sustainable development.

C. Council of Europe

In 2021, the Council of Europe's Committee on AI was tasked to prepare a legally-binding international instrument on the development, design and application of AI, based on the Council's standards on human rights, democracy and the rule of law.[9] These negotiations concluded in 17 May 2024 with the adoption of a “Framework Convention on Artificial Intelligence, Human Rights, Democracy and the Rule of Law”, the first binding international instrument on AI policy. The Framework Convention aims to ensure that activities within the lifecycle of AI systems are fully consistent with human rights, democracy and the rule of law, while being conducive to technological progress and innovation (Council of Europe, 2024). It sets out several fundamental principles related to activities within the AI systems lifecycle, such as human dignity and individual autonomy, equality and non-discrimination, transparency and oversight, respect for privacy and personal data protection, accountability and responsibility, reliability, and safe innovation.

The Framework Convention also sets requirements to ensure the availability of remedies, procedural rights and safeguards, as well as requirements for risk and impact management. It states that its membership is open not only to the members states of the Council of Europe, but also to non-members, under certain conditions.

D. United Nations Educational, Scientific and Cultural Organization (UNESCO)

In November 2021, UNESCO's 193 members adopted the first-ever global policy instrument on AI ethics – a non-binding "Recommendation on the Ethics of Artificial Intelligence" (UNESCO, 2021). The Recommendation is designed to guide the responsible development and application of AI technologies, ensuring that they are aligned with human rights and ethical standards.[10] It provides a set of ten core principles, to be followed by all actors in the AI system lifecycle, that encapsulate a human rights approach to AI, emphasizing the importance of safety, security, privacy, transparency, responsibility, accountability and non-discrimination. It also lays out the following values: "respect, protection and promotion of human rights and fundamental freedoms and human dignity"; "environment and ecosystem flourishing"; "ensuring diversity and inclusiveness"; and "living in peaceful, just and interconnected societies".

The Recommendation also sets out eleven key areas for policy actions which call for the development of international standards to ensure the safety and security of AI systems, achieving accountability and responsibility for the content and outcomes of AI systems, and fostering research at the intersection between AI and intellectual property (IP).

To assist its members in implementing the Recommendation, UNESCO has developed the "Readiness Assessment Methodology" (UNESCO, 2023a), a tool aimed at evaluating preparedness for the ethical deployment of AI.

Like the other AI initiatives described in this section, the Recommendation contains various elements that relate to WTO agreements and issues. For instance, it stresses the need to develop international standards (see Chapter 4(a)(iii) on TBT) as tools to support AI policies, regulations and standards adopted in furtherance of the principles and policy actions proposed by the Recommendation. It also refers to the importance of discussing the intersection between AI and IP (see Chapter 4(b)(iv) on trade-related aspects of intellectual property rights (TRIPS).

E. G7

In May 2023, G7 leaders established the "Hiroshima Process on Generative AI" with the aim of promoting safe, secure and trustworthy AI.[11] In this context, in December 2023, the G7 Digital and Tech Ministers agreed on the Hiroshima AI Process "Comprehensive Policy Framework", which includes "International Guiding Principles for Organizations Developing Advanced AI Systems"[12] and the "International Code of Conduct for Organizations Developing Advanced AI Systems".[13] These documents, which are based on the OECD AI Principles and take into account recent developments in advanced AI systems, aim to promote the safety and trustworthiness of AI systems by providing guidance, in the form of principles and actions, for organizations developing and using the most advanced AI systems.

Several principles of the "International Guiding Principles for Organizations Developing Advanced AI Systems"[14] are particularly relevant for trade. They include: taking appropriate measures to identify, evaluate, and mitigate risks across the AI lifecycle; investing in and implementing robust security controls, including physical security, cybersecurity and insider threat safeguards across the AI lifecycle; advancing the development of and, where appropriate, the adoption of international technical standards; and implementing appropriate data input measures and protections for personal data and IP.

The actions proposed in the "International Code of Conduct for Organizations Developing Advanced AI Systems"[15] include: measures to identify, evaluate and mitigate risks across the AI lifecycle (such as employing diverse internal and independent external testing measures and implementing appropriate mitigation to address identified risks and vulnerabilities); implementing robust security controls, including cybersecurity policies across the AI lifecycle; advancing the development of and, where appropriate, adoption of international technical standards; and implementing appropriate data input measures and protections for personal data and IP. In July 2024, the OECD announced a pilot phase to monitor the application of the G7 Hiroshima Process International Code of Conduct for Organisations Developing Advanced AI Systems.[16] At their October 2024 meeting, Digital and Tech Ministers announced that they would continue to work to develop the Reporting Framework with the aim to advance it by the end of the year, in collaboration with the OECD and the participating organizations.[17]

In the G7 Verona and Trento Ministerial Declaration, adopted in March 2024, beyond advancing these actions under Hiroshima AI Process, G7 economies also expressed their desire to participate in the discussions initiated by the Brazilian G20 Presidency on the specific issue of "AI for sustainable development".

Relatedly, the G7 has played an important role in developing and operationalizing the notion of "Data Free Flow with Trust" (DFFT) (Meltzer, 2023).[18] For example, the G7 Digital Trade Principles provide that "data should be able to flow freely across borders with trust", and call for unjustified obstacles to cross-border data flows to be addressed, on the one hand, and for privacy, data protection, the protection of IP rights, and security, on the other.[19] In April 2023, the G7 agreed to establish the "Institutional Arrangement for Partnership" to operationalize the DFFT concept through principles-based, solutions-oriented, evidence-based, multi-stakeholder and cross-sectoral cooperation (see also Chapter 3(b)(i)) for a discussion of cross-border data flows).[20]

The G7 also recognizes the importance of interoperability between tools for trustworthy AI (such as regulatory and non-regulatory frameworks and technical standards).[21] In this context, the G7 has developed an "Action Plan for Promoting Global Interoperability between Tools for Trustworthy AI" in which G7 economies have pledged to raise awareness of international AI technical standards development efforts, build capacity among stakeholders on ways to actively participate in such processes, and encourage adoption of international AI standards as tools for advancing trustworthy AI.[22]

F. United Nations (UN) AI Advisory Body

In October 2023, the UN Secretary-General formed a high-level AI Advisory Body, composed of experts from government, industry, academia and civil society, to develop a set of recommendations on the international governance of AI.[23] The Final Report of the UN AIAB was published in September 2024 (UN, 2024).

Rather than proposing any single model for AI governance, the UN AI Report outlines five guiding principles for the creation of new AI governance institutions.

The five guiding principles concern:

(i) inclusivity (AI "should be governed inclusively, by and for the benefit of all");
(ii) public interest (AI must be governed in the public interest");
(iii) "data governance" ("AI governance should be built in step with data governance and the promotion of data commons");
(iv) universality ("AI governance must be universal, networked and rooted in adaptative multi stakeholder collaboration"); and
(v) "international law" ("AI governance should be anchored in the UN Charter, International Human Rights Law, and other agreed international commitments such as the Sustainable Development Goals").

The UN AI Report identifies three main governance gaps - representation gaps, coordination gaps, and implementation gaps – and formulates recommendations to "advance a holistic vision for a globally networked, agile and flexible approach to governing AI for humanity, encompassing common understanding, common ground and common benefits to enhance representation, enable coordination and strengthen implementation". Specific recommendations include:

- the creation of an independent international scientific panel on AI, made up of diverse multidisciplinary experts in the field serving in their personal capacity on a voluntary basis.
- the launch of a twice-yearly intergovernmental and multi-stakeholder policy dialogue on AI governance on the margins of existing meetings at the United Nations.
- the creation of an AI standards exchange, bringing together representatives from national and international standard-development organizations, technology companies, civil society and representatives from the international scientific panel.
- the creation of an AI capacity development network to link up a set of collaborating, United Nations-affiliated capacity development centres making available expertise, compute and AI training data to key actors.
- the creation of a global fund for AI managed by an independent governance structure.
- the creation of a global AI data framework that would outline data-related definitions and principles for global governance of AI training data, establish common standards around AI training data provenance and use, and institute market-shaping data stewardship and exchange mechanisms for enabling flourishing local AI ecosystems globally.
- the creation of an AI office within the Secretariat, reporting to the Secretary-General.

G. Bletchley process

In November 2023, the United Kingdom hosted the AI Safety Summit, at which 28 economies and the European Union agreed on the "Bletchley Declaration" on AI Safety. The Summit brought together various governmental and non-governmental stakeholders to discuss how to mitigate the risks posed by AI through internationally coordinated action (UK Government, 2023). The Bletchley Declaration recognizes the urgent need to understand and collectively manage potential risks through a new joint global effort to ensure AI is developed and deployed in a safe, responsible way for the benefit of the global community. It agrees to focus cooperation on identifying common AI safety risks and building a shared scientific and evidence based understanding of these risks, and building respective risk-based policies across countries to ensure safety in light of such risks, collaborating as appropriate while recognising that approaches may differ based on national circumstances and applicable legal frameworks. Indeed, international cooperation is a key tenet stressed throughout the text of the Bletchley Declaration.

As part of the commitment to international cooperation and building a shared scientific and evidence-based understanding of certain AI risks under the Bletchley Declaration, the attending economies also agreed to support the development of an independent and inclusive "State of the Science" Report on "frontier AI".[24] The interim version of this report was published in May 2024.[25] The final version of the Report is expected to be published ahead of the next AI summit, scheduled for February 2025 (UK Government, 2023b).

H. UN General Assembly

In March 2024, the UN General Assembly unanimously adopted a non-binding resolution on seizing the opportunities of safe, secure and trustworthy AI systems for sustainable development (UN AI Resolution).[26] Although certain UN specialized agencies (including UNESCO, as noted above) have adopted AI related instruments, this resolution is the first adopted on a UN-wide basis.

The UN AI Resolution establishes a vision that AI systems[27] should be human-centric, reliable, explainable, ethical and inclusive, as well as oriented toward sustainable development. It recognizes the "rapid acceleration" of the design, development, deployment and use of AI systems and their potential to contribute to "accelerating the achievement" of the UN Sustainable Development Goals (SDGs). Consequently, it stresses the "urgency of achieving global consensus" on safe, secure and trustworthy AI systems such as by promoting the following actions:

(i) developing regulatory and governance approaches frameworks;
(ii) promoting internationally interoperable identification, classification, evaluation, testing, prevention and mitigation of risks of AI systems;
(iii) developing mechanisms of risk monitoring and management and for securing data across the lifecycle of AI systems;
(iv) developing internationally interoperable technical tools, standards or practices;
(v) respecting IP rights, including copyright protected content;
(vi) safeguarding privacy and the protection of personal data when testing and evaluating systems;
(vii) promoting transparency, predictability, reliability, understandability and human oversight of AI systems; and
(viii) sharing best practices on, and promoting international cooperation in, "data governance" for greater consistency and interoperability, where feasible, of approaches for advancing trusted "cross border data flows" for safe, secure and trustworthy AI systems.

More broadly, the resolution recognizes that the AI governance is still an "evolving area". As such, it stresses the need for "continued discussions" on possible governance approaches that are "appropriate, based on international law, interoperable, agile, adaptable, inclusive, responsive to the different needs and capacities of developed and developing countries alike and for the benefit of all". In this respect, the resolution calls for AI "regulatory and governance approaches" to be developed based on inputs from many stakeholders, i.e., the private sector, international and regional organizations, civil society, the media, academia and research institutions, technical communities and individuals.

I. World Intellectual Property Organization (WIPO)

From 2019 to 2020, WIPO, as the UN specialized organization dedicated to IP issues globally, held a series of "Conversations" on the impact of AI on IP policy.[28] As discussed in Box 3.2 (Chapter 3) of this report, AI technologies can raise important questions concerning the creation and protection of IP rights. In the WIPO "Conversations", governments and other stakeholders debated and submitted inputs about the most pressing questions likely to face IP policymakers as AI increases in importance. The key points generated from these debates were compiled in a WIPO Secretariat "Issues Paper on Intellectual Property Policy and Artificial Intelligence" (WIPO, 2020). The issues identified in the paper included patents, copyright and related rights, data, designs, trademarks, trade secrets, the technology gap and capacity-building, and accountability for IP administrative decisions.

WIPO has also developed an "AI and IP Clearing House" and an "IP policy toolkit". WIPO's AI and IP Clearing House is a searchable database that "continuously collates and publishes the main government instruments of relevance to AI and IP with the aid of the Member States".[29] The "IP policy toolkit" (WIPO, 2024) is intended to allow policymakers to engage on "how to best shape their AI innovation ecosystem and to structure their future work with a firm understanding of the current state of knowledge".

J. International Telecommunication Union (ITU) (AI for Good platform)

The ITU, in partnership with 40 UN bodies, has convened the "AI for Good" platform, the goal of which is to identify practical applications of AI to advance the UN SDGs. "AI for Good" consists of a year-round online programme and an annual "AI for Good" Global Summit.[30] The ITU has also launched a global AI Repository to identify AI-related projects, research and other initiatives that can accelerate progress towards the SDGs.

II. Standardization in the area of AI

There are significant efforts underway on developing international standards on AI. Such activities are taking place inter alia in the Joint Technical Committee of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), the ITU and the Institute of Electrical and Electronics Engineers (IEEE) (Meltzer, 2023).

A. ISO/IEC

In 2018, the ISO/IEC Joint Technical Committee (JTC) 1[31] established a subcommittee to work exclusively on AI standardization. As the focal point of standardization on AI within the ISO and IEC, the committee looks at the entire AI ecosystem and provides guidance to ISO and IEC committees developing AI applications. Its work programme comprises standardization in the areas of foundational AI standards, data standards related to AI, big data and analytics, AI trustworthiness, governance implications of AI, testing of AI systems, and ethical and societal concerns (ISO/IEC, 2024).

The ISO/IEC Joint Technical Committee and subcommittee have already published 25 standards on AI[32] and are currently working on developing another 31 AI standards.[33] Among the standards already published are standards on concepts and terminology, risk management and safety of AI systems. The ISO/IEC Joint Technical Committee and subcommittee also published a technical report in 2022, containing an extensive overview on the issue of "ethical and societal concerns" related to AI governance.[34] Standards still under development cover a wide range of new topics such as: "requirements for bodies providing audit and certification of artificial intelligence management systems", "guidance on addressing societal concerns and ethical considerations", "environmental sustainability aspects of AI systems" and "objectives and approaches for explainability and interpretability of ML models and AI systems".

B. ITU

The ITU's Telecommunications Standardisation Sector (ITU-T) has developed various technical standards on AI in the form of frameworks for evaluating intelligence levels of future networks and for data handling, as well as architectural frameworks for machine learning and AI-based networks.[35] The ITU-T is one of the ITU branches that develops international standards in the area of information and communication technologies.[36]

C. Institute of Electrical and Electronics Engineers (IEEE)

The IEEE has developed various standards dealing with socio-technical issues related to AI systems. Among other functions, the IEEE develops international standards on telecommunications, information technology and power-generation products and services.[37] Standards related to AI developed by the IEEE include standards for addressing ethical concerns during system design, for transparency of autonomous systems, and for algorithmic bias considerations.

D. United Nations Economic Commission for Europe (UNECE)

In February 2023, UNECE launched a new project aiming at developing new guidance on digital product regulation focused on regulatory compliance of "products with embedded AI or other digital technologies". The UNECE has historically developed and adopted standards under the "Working Party on Regulatory Cooperation and Standardization Policies" (WP.6) (UNECE, 2024). In the context of the new project, UNECE issued in November 2023 a document prop osing various recommendations and approaches on the regulation of AI-embedded products that related to international trade in general, and WTO disciplines in particular, including that:

Governments should ensure that regulatory measures applied to products with embedded digital technologies are consistent with the World Trade Organization (WTO) Technical Barriers to Trade (TBT) Agreement. This includes, but is not limited to, the TBT Agreement's obligations pertaining to notification, publication, non-discrimination, avoidance of unnecessary barriers to trade, achievement of legitimate objectives and use of international standards (UNECE, 2023).

This project is still ongoing, and no outcome has yet been adopted with respect to the proposals in the UNECE November 2023 document.

Endnotes

1 See Chapter 2(a) for the OECD's definition of "AI system".

2 According to OECD AI Principles (2019a), section 1.I, an "AI system lifecycle" involves: "i) 'design, data and models'; which is a context dependent sequence encompassing planning and design, data collection and processing, as well as model building; ii) 'verification and validation'; iii) 'deployment'; and iv) 'operation and monitoring'. These phases often take place in an iterative manner and are not necessarily sequential. The decision to retire an AI system from operation may occur at any point during the operation and monitoring phase".

3 See https://oecd.ai/en/dashboards/overview/policy.

4 See https://www.mofa.go.jp/policy/economy/g20_summit/osaka19/pdf/documents/en/annex_08.pdf.

5 It is important to note, however, that G20 economies did not adhere to the definitional part of the OECD AI Principles (2019), including the definitions of "AI system" and "AI system lifecycle", although they did not expressly reject this part either.

6 See http://www.g20.utoronto.ca/2020/2020-g20-leaders-declaration-1121.html#:~:text=We%2C%20the%20G20%20Leaders%2C%20meeting,century%20for%20all%20by%20empowering; https://www.governo.it/sites/governo.it/files/G20ROMELEADERSDECLARATION_0.pdf, and https://www.mea.gov.in/Images/CPV/G20-New-Delhi-Leaders-Declaration.pdf.

7 See http://www.g20.utoronto.ca/2020/2020-g20-leaders-declaration-1121.html#:~:text=We%2C%20the%20G20%20Leaders%2C%20meeting,century%20for%20all%20by%20empowering.

8 See http://www.g20italy.org/wp-content/uploads/2021/11/Annex1_DECLARATION-OF-G20-DIGITAL-MINISTERS-2021_FINAL.pdf.

9 See https://www.coe.int/en/web/artificial-intelligence/cai.

10 Unlike OECD (2021), the Recommendation does not define "AI". It states that it "does not have the ambition to provide one single definition of AI, since such a definition would need to change over time, in accordance with technological developments. Rather, its ambition is to address those features of AI systems that are of central ethical relevance". Nevertheless, it does provide a broad understanding of what "AI systems" mean, i.e. "systems which have the capacity to process data and information in a way that resembles intelligent behaviour, and typically includes aspects of reasoning, learning, perception, prediction, planning or control".

11 See https://www.soumu.go.jp/hiroshimaaiprocess/en/index.html and https://www.soumu.go.jp/hiroshimaaiprocess/pdf/document01_en.pdf.

12 See https://www.soumu.go.jp/hiroshimaaiprocess/en/index.html.

13 See https://www.mofa.go.jp/files/100573473.pdf.

14 See https://www.soumu.go.jp/hiroshimaaiprocess/en/index.html.

15 See https://www.mofa.go.jp/files/100573473.pdf.

16 See https://www.oecd.org/en/about/news/press-releases/2024/07/oecd-launches-pilot-to-monitor-application-of-g7-code-of-conduct-on-advanced-ai-development.html.

17 See https://assets.innovazione.gov.it/1728987577-final-g7-digital-joint-ministerial-statement-15_10_24.pdf.

18 See https://www.digital.go.jp/assets/contents/node/basic_page/field_ref_resources/390de76d-d4f5-4f45-a7b4-f6879c30c389/0fbffe8a/20231201_en_news_g7_result_00.pdf, https://bmdv.bund.de/SharedDocs/DE/Anlage/K/g7-praesidentschaft-final-declaration-annex-, https://www.mofa.go.jp/policy/economy/g20_summit/osaka19/en/documents/final_g20_osaka_leaders_declaration.html and https://www.priv.gc.ca/en/opc-news/speeches/2022/communique-g7-220908/.

19 See https://www.gov.uk/government/news/g7-trade-ministers-digital-trade-principles.

20 See https://www.bundeskartellamt.de/SharedDocs/Publikation/EN/Others/G7_2023_Communique.pdf?__blob=publicationFile&v=2 and https://www.digital.go.jp/assets/contents/node/basic_page/field_ref_resources/390de76d-d4f5-4f45-a7b4-f6879c30c389/0fbffe8a/20231201_en_news_g7_result_00.pdf.

21 See http://www.g7.utoronto.ca/ict/2023-annex5.html and https://www.soumu.go.jp/hiroshimaaiprocess/pdf/document02_en.pdf.

22 See https://www.digital.go.jp/assets/contents/node/basic_page/field_ref_resources/390de76d-d4f5-4f45-a7b4-f6879c30c389/0fbffe8a/20231201_en_news_g7_result_00.pdf.

23 See https://www.un.org/techenvoy/ai-advisory-body.

24 "For the AI Safety Summit at Bletchley Park, frontier AIs were defined as models that can perform a wide variety of tasks and match or exceed the capabilities present in today's most advanced models" – Glossary, Interim Report (page 88).

25 See https://assets.publishing.service.gov.uk/media/66f5311f080bdf716392e922/international_scientific_report_on_the_safety_of_advanced_ai_interim_report.pdf.

26 UN General Assembly (UNGA) Resolution "Seizing the Opportunities of Safe, Secure and Trustworthy Artificial Intelligence Systems for Sustainable Development" (A/78/L.49), adopted on 11 March 2024 (available at https://documents.un.org/doc/undoc/ltd/n24/065/92/pdf/n2406592.pdf).

27 The UN AI Resolution clarifies that its content is limited to AI systems in the "non military domain". It also clarifies that, for its purpose, the AI "lifecycle" comprises the following stages: "pre-design, design, development, evaluation, testing, deployment, use, sale, procurement, operation and decommissioning" (https://documents.un.org/doc/undoc/ltd/n24/065/92/pdf/n2406592.pdf).

28 See https://www.wipo.int/about-ip/en/artificial_intelligence/conversation.html.

29 See https://www.wipo.int/about-ip/en/frontier_technologies/ai_and_ip.htm.

30 See https://aiforgood.itu.int/

31 ISO and IEC established a joint committee (JTC 1) to coordinate development of digital technology standards in 1987. See JTC 1 (2024).

32 See https://www.iso.org/committee/6794475/x/catalogue/p/1/u/0/w/0/d/0.

33 See https://www.iso.org/committee/6794475/x/catalogue/p/0/u/1/w/0/d/0.

34 See https://www.iso.org/obp/ui/en/#iso:std:iso-iec:tr:24368:ed-1:v1:en.

35 See ITU-T Y.3172 "Architectural framework for machine learning in future networks including IMT -2020" (IMT stands for "International Mobile Telecommunications") (ITU, 2020b); ITU-T Y.3173 "Framework for evaluating intelligence levels of future networks including IMT-2020" (ITU, 2020d); ITU-T Y.3174 "Framework for data handling to enable machine learning in future networks including IMT-2020" (ITU, 2020c); ITU-T Y.3177 "Architectural framework for artificial intelligence-based network automation for resource and fault management in future networks including IMT-2020" (ITU, 2020a).

36 See https://www.itu.int/en/ITU-T/about/Pages/default.aspx -.

37 See https://www.ieee.org/about/at-a-glance.html?utm_source=linkslist_text&utm_medium=lp-about&utm_campaign=at-a-glance

Annex 4 Survey of Academics

Following a literature review, scholars working at the intersection of trade and AI were identified and invited to respond to the following two questions.

1. What are the main challenges that AI poses to the WTO's current rules, principles and practices?
2. How could WTO members ensure such rules, principles and practices remain fit-for purpose in light of challenges? In your view, may specific rules, principles and practices need to be adjusted, and if so how?

Responses were received from Susan Aaronson (George Washington University; Centre for International Governance Innovation), Dan Ciuriak (Centre for International Governance Innovation), Johannes Fritz (Digital Policy Alert), Olia Kanevskaia (Utrecht University, Department of International and European Law, and Utrecht Centre for Regulation and Enforcement in Europe), Kholofelo Kugler (University of Lucerne; Counsel, Advisory Centre on WTO Law (ACWL)), Heidi Lund (National Board of Trade Sweden), Petros Mavroidis (Columbia Law School), Hildegunn Kyvik Nordås (Council on Economic Policies (CEP), Örebro University), Eduardo Paranhos (Head of AI Work Group at Associação Brasileira das Empresas de Software (ABES)) and Shin-Yi Peng (National Tsing Hua University). Chapter 4(f) reflects these responses.

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Artificial intelligence (AI) is transforming the way we live, work, produce and trade. As it further develops, AI is expected to unlock unprecedented economic and societal opportunities. However, it is also a source of significant risks and challenges.

This report examines the intersection of AI and international trade. It discusses how AI may shape the future of international trade by reducing trade costs, improving productivity and expanding economies' comparative advantages. The report reviews some key trade policy considerations, in particular the urgent need to address the growing AI divide between economies and between large and small firms, as well as data governance and intellectual property issues. It examines how to guarantee the trustworthiness of AI without hindering trade. The report also provides an overview of domestic, regional and international government initiatives to promote and regulate AI, and highlights the resulting risk of regulatory fragmentation.

Finally, the report discusses the critical role of the WTO in facilitating AI-related trade, ensuring trustworthy AI and addressing emerging trade tensions, noting that the rapid evolution of AI is prompting questions about the implications of AI for international trade rules.

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