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).

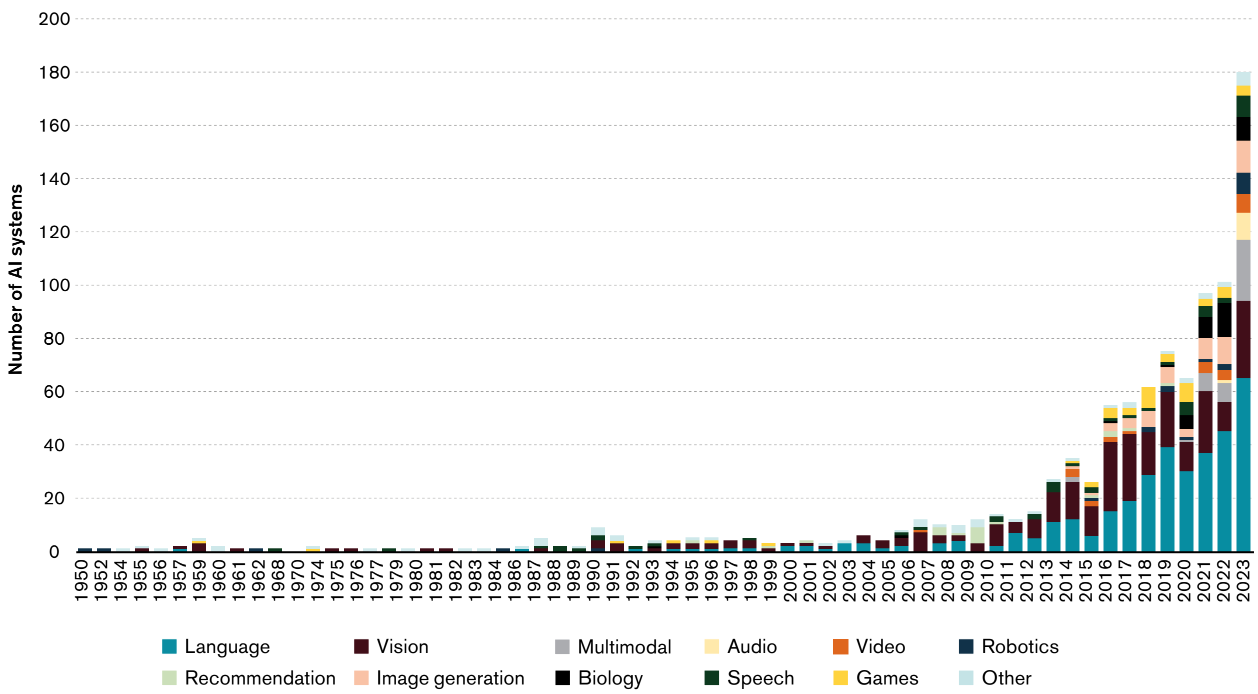
Contemporary advances in generative AI render AI distinct from other technologies in several key ways. First, AI serves as a general-purpose technology, capable of adapting to various domains and tasks with unprecedented flexibility and efficiency. Second, it feeds on large datasets to improve its performance 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 ChatGPT2, an earlier version of OpenAI's language model released in February 2019, was estimated to produce 300 metric tons of CO2 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 datasets and 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 rapid advancement 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.

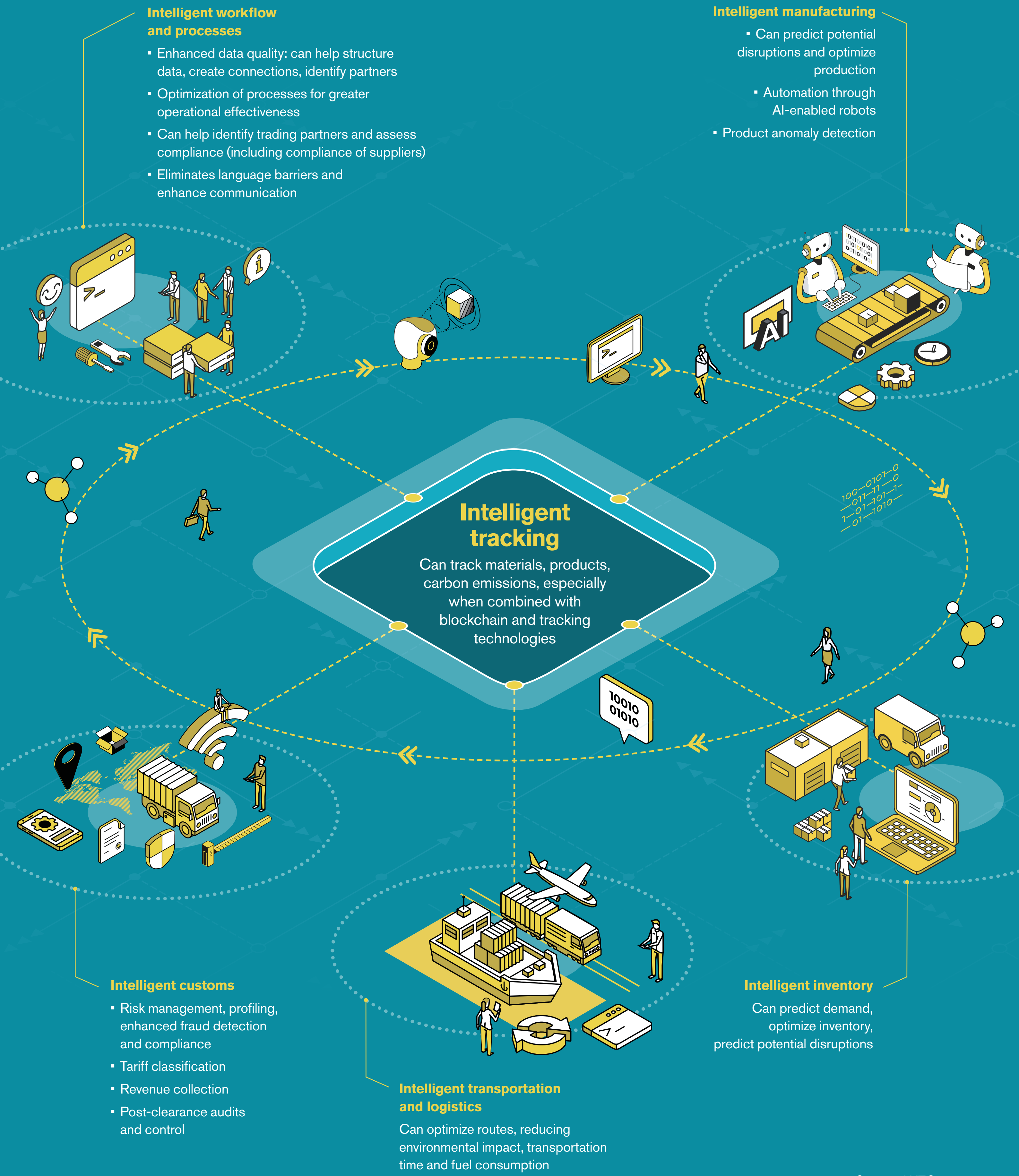
AI serves a multitude of purposes in customs and border controls

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 Al 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 MSMEs, including automated processing with classification algorithms, error and fraud detection through anomaly detection, and capacity planning using regression and forecasting (UNECE, 2021).

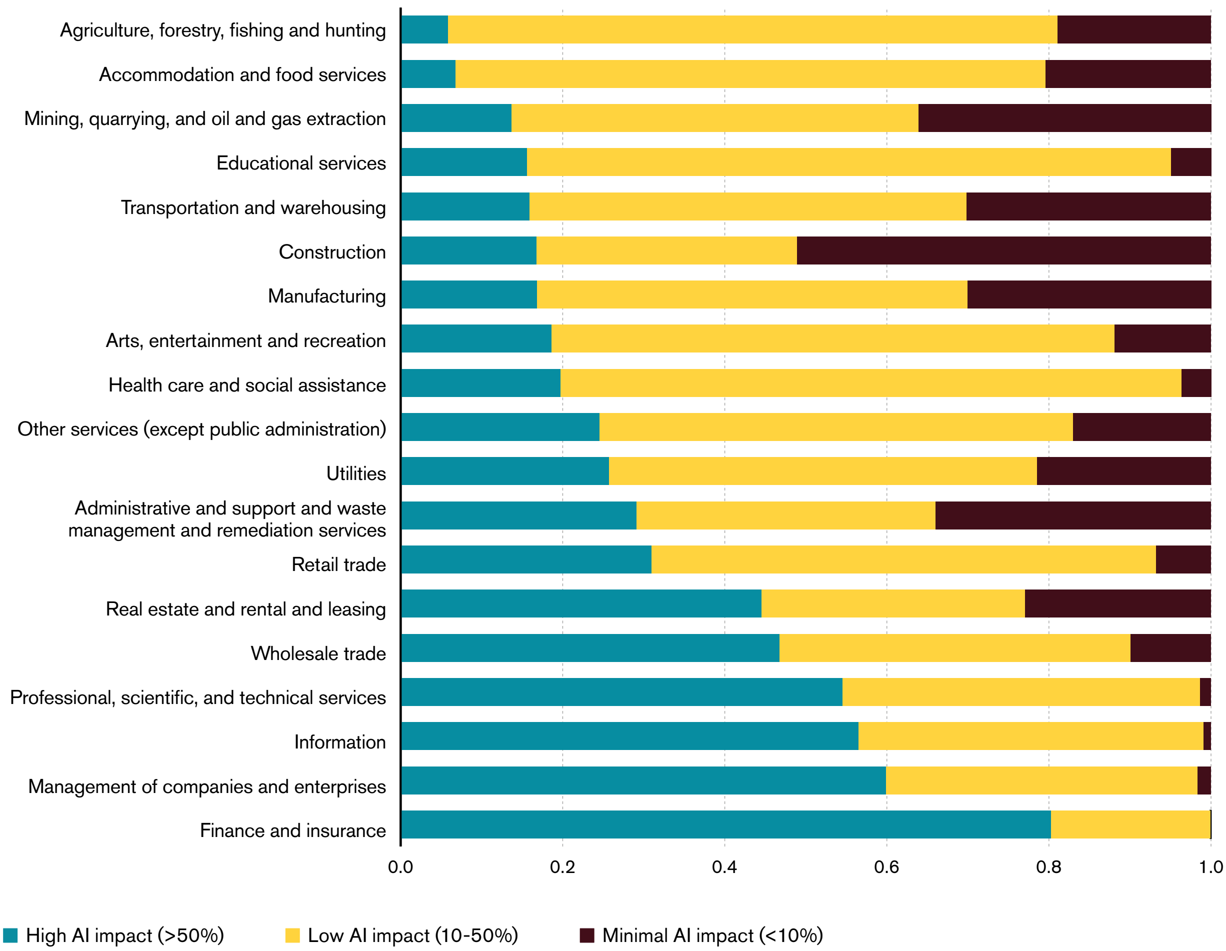
(ii) The most significant trade impact of AI will be on trade in services

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

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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).

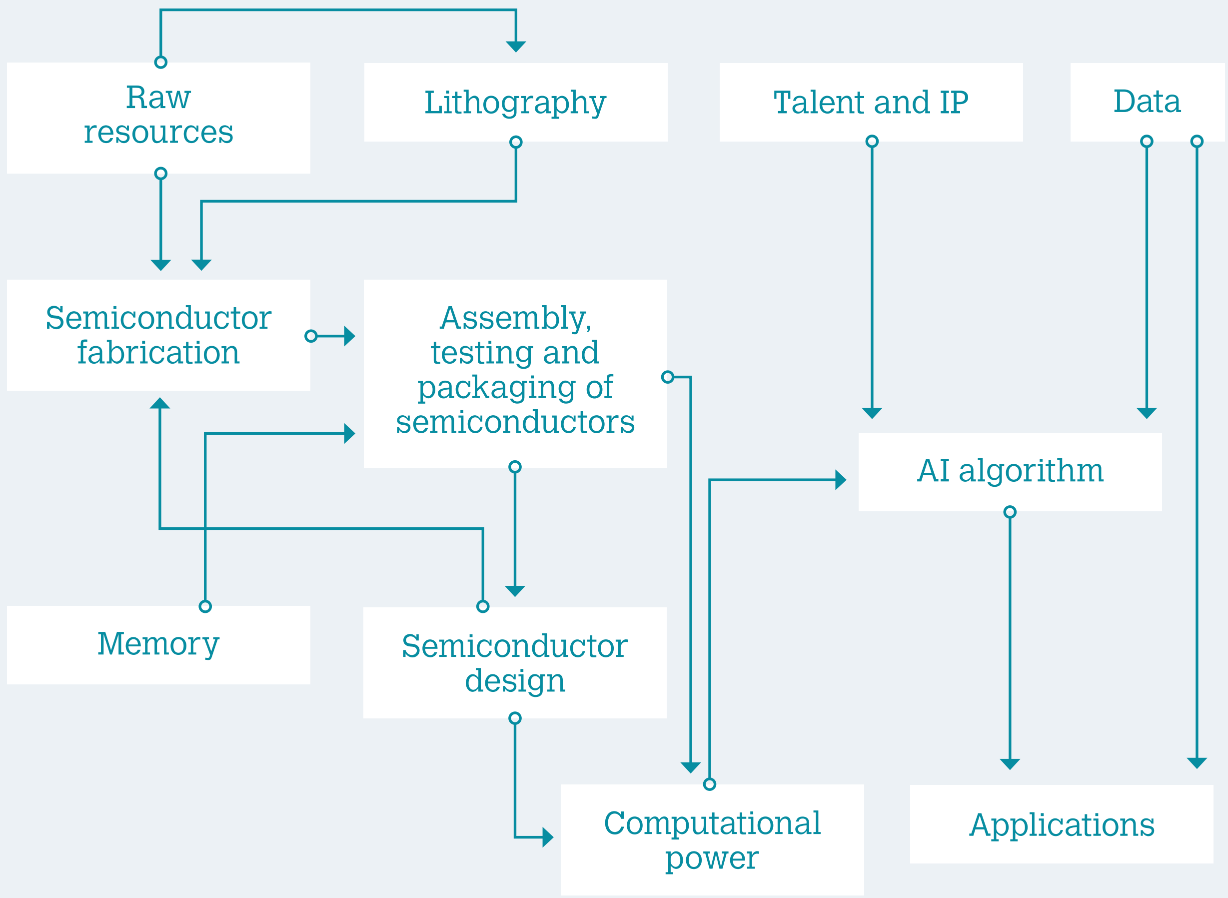
The impact of AI on jobs in advanced economies could exacerbate existing inequalities and make it necessary to develop substantial adaptation strategies. AI has the potential to reshape income distribution by decreasing the labour share and increasing the returns on capital. As AI and automation become 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).

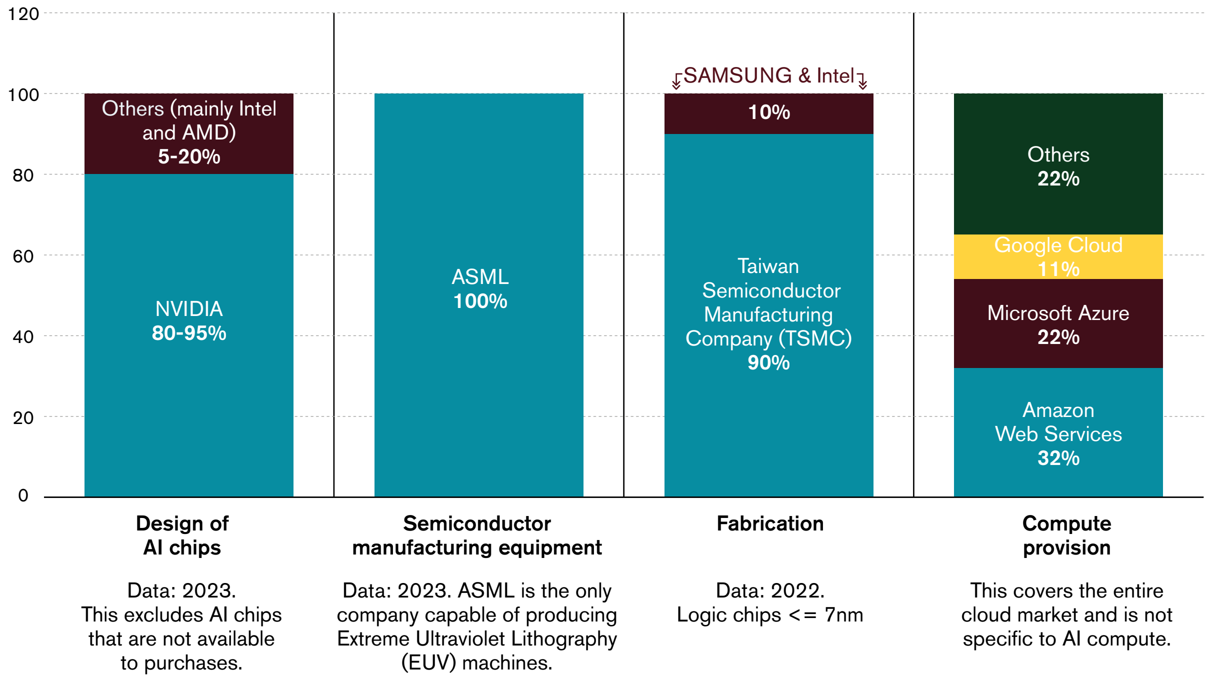
Many of these goods and services are often supplied by a small number of economies. International trade therefore serves as an important channel to foster AI development worldwide. The production of AI technologies is heavily concentrated within a globally integrated supply chain. As indicated in Figure 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

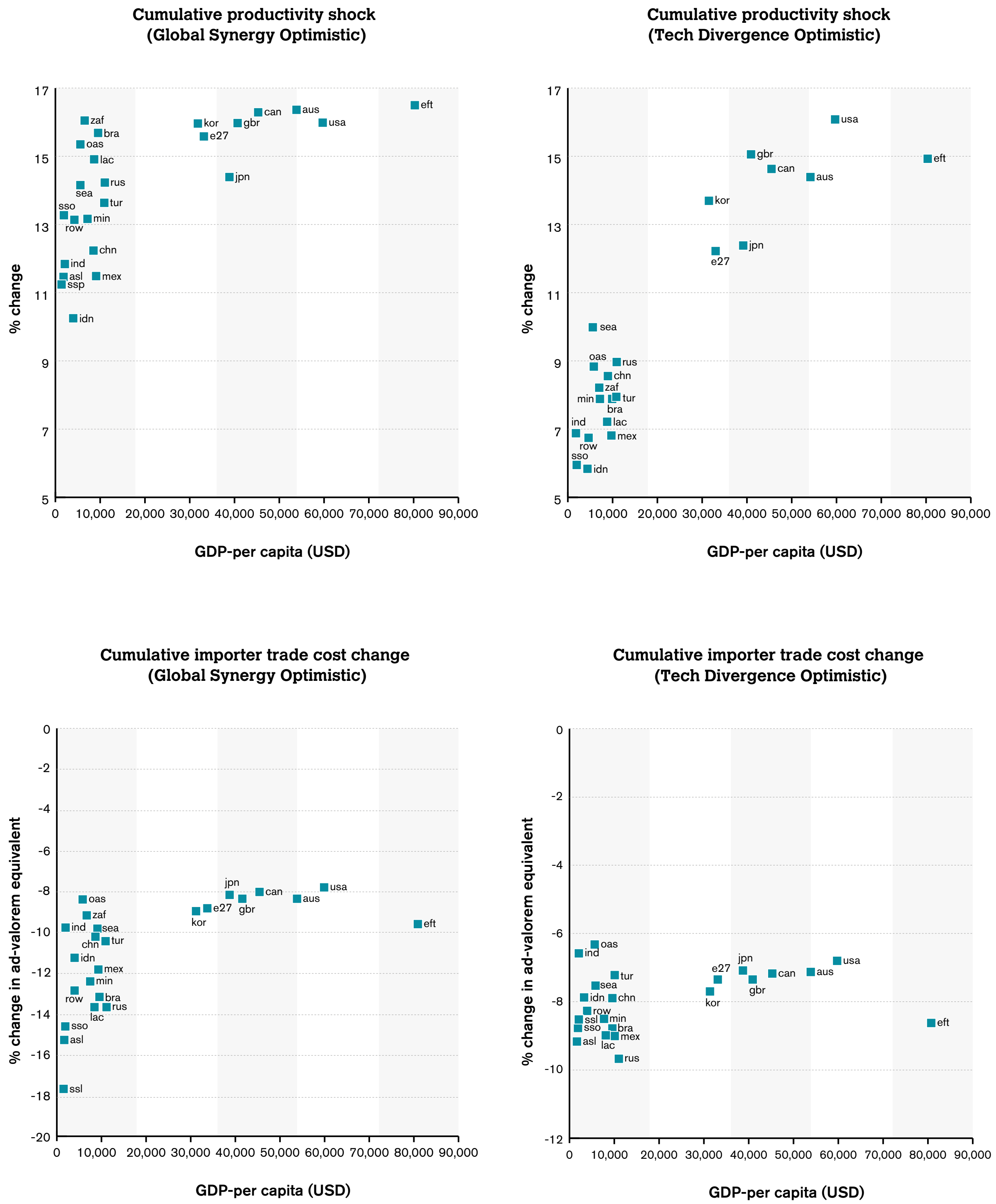
While high-income economies are expected to see the largest productivity gains, trade cost reductions can favour low-income economies. As shown in the upper panel of Figure 2.7, productivity increases are particularly significant in higher-income economies, due to their greater AI preparedness and specialization 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 percentage points 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



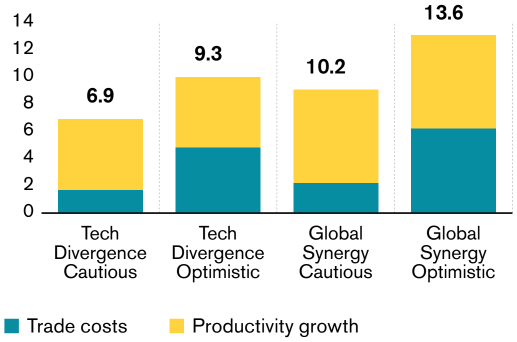
Source: Simulation results based on the WTO Global Trade Model.

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. See Table A.1 in Annex 2 for a list of abbreviations of regions.

The expected impact of AI on real trade growth differs within sectors. As shown in Figure 2.11, in the optimistic global synergy cenario, 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)

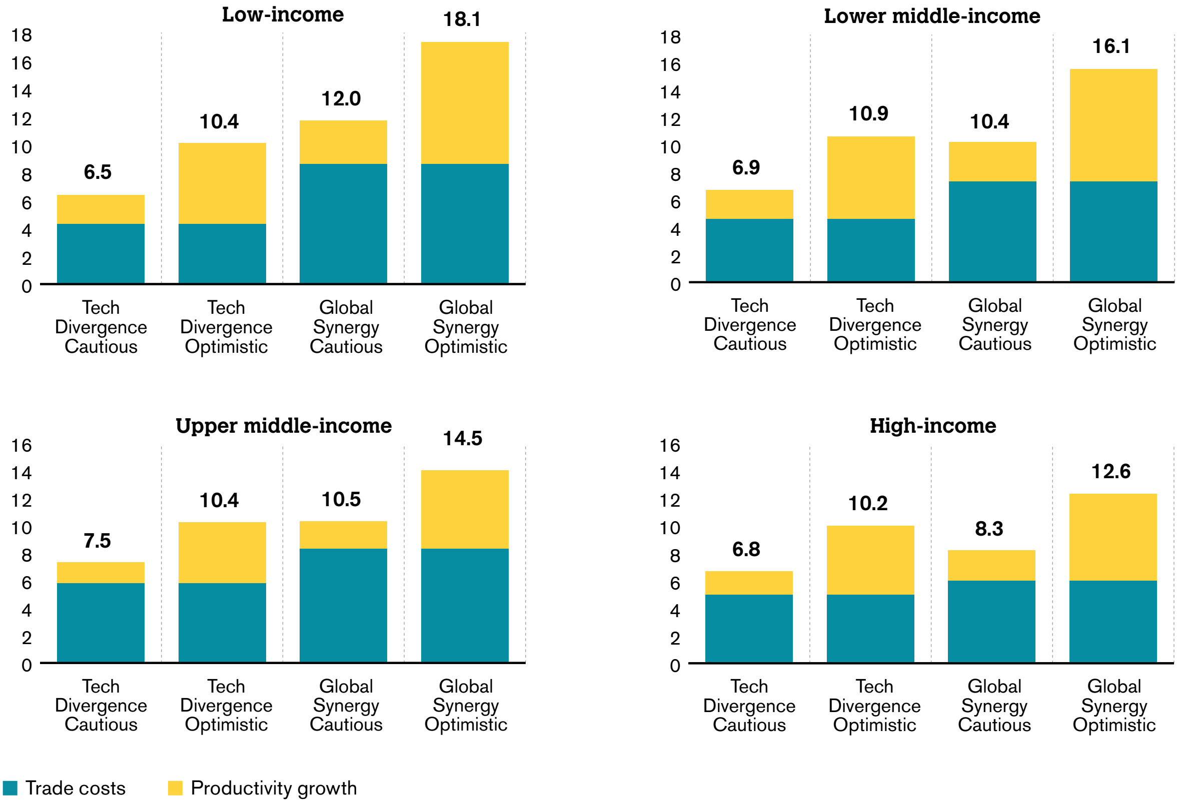


Source: Simulation results based on the WTO Global Trade Model.

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 values above the bars indicate the total effect.

Figure 2.9: Cumulative regional real export growth rate (2023-40)

(Difference to baseline, percentage points)

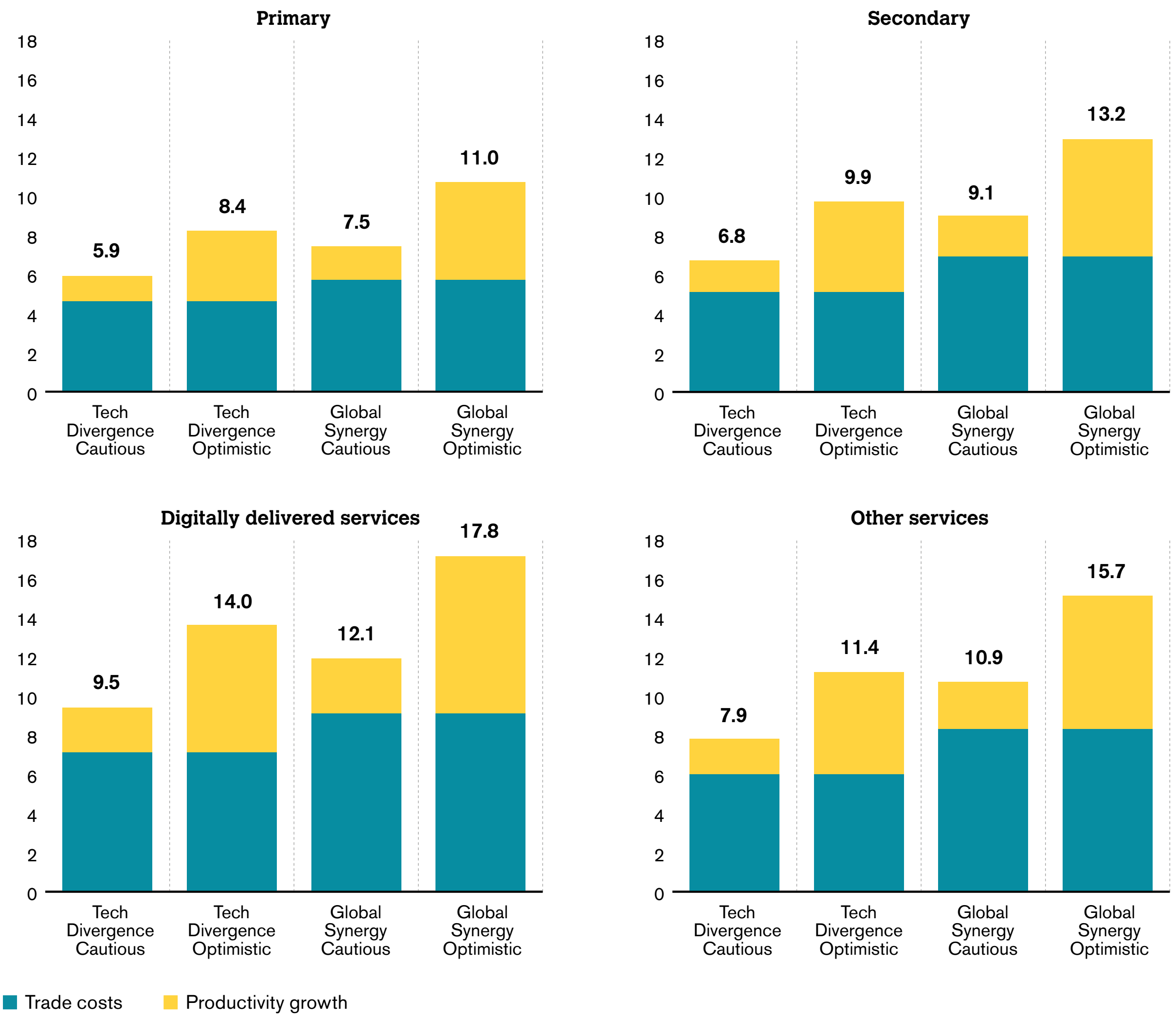


Source: Simulation results based on the WTO Global Trade Model.

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 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.

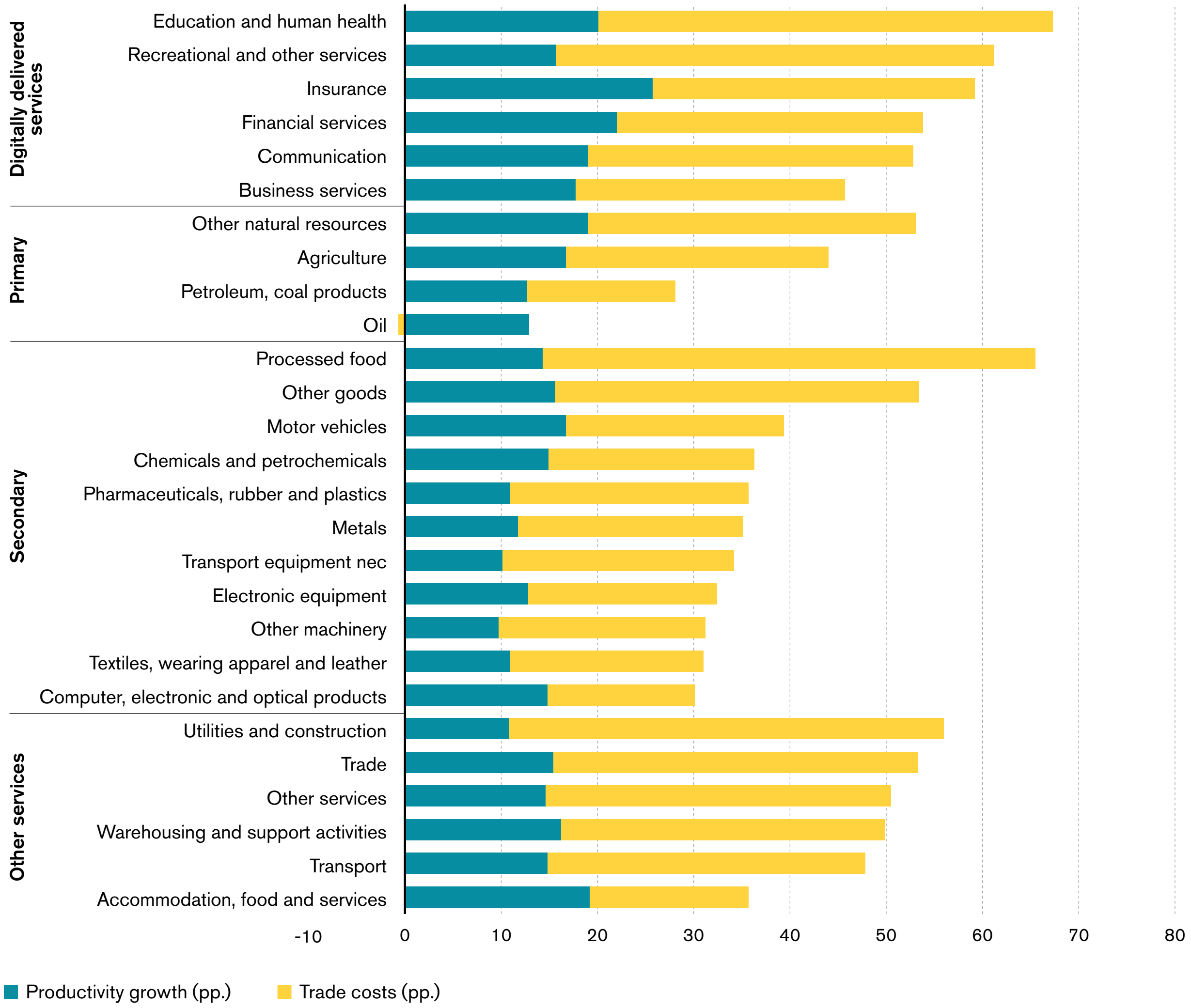
Note: This figure demonstrates the impact of AI on projected cumulative sectoral real exports growth (in percentage points) over 2023-40 in four policy scenarios. The yellow and blue bars represent the effects of trade cost reduction and productivity growth respectively, and the values above the bars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