

Impacts of AI on Thailand's Economy and Society: A Scenario Modelling Assessment



The Institute of Public Policy and Development
Phraya Suriyanuwat Foundation

Written by



About This Report

This report builds on a research programme undertaken by The Economist Intelligence Unit (The EIU) between September and December 2019 and commissioned by the Institute of Public Policy and Development (IPPD). The views and opinions expressed in this publication are those of The Economist Intelligence Unit and do not necessarily reflect the official position of the IPPD. The foreword was written by the IPPD. The report contains the methodology and key-findings of a scenario modelling exercise that explores the potential impacts that the development of artificial intelligence could have on Thailand's economy and society. Findings from the scenario modelling exercise were supplemented with secondary research and in-depth interviews with experts in the field. We would like to thank the following experts for their time and insights:

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The Institute of Public Policy and Development (IPPD) is a policy laboratory and impact-oriented platform whose mission is to translate ideas, intelligence, evidence, and public opinion into solutions for long-term sustainable development.

The Institute consists of four labs: Foresight and Futures Lab, Data and Intelligence Lab, Design and Testing Lab and Public Opinion and Dialogue Lab. Together, they pursue innovative approaches and methods for better understanding of and solutions for key challenges and opportunities.

The IPPD is a non-profit organisation under the Phraya Suriyanuwat Foundation affiliated with the Office of the National Economic and Social Development Council (NESDC). More information on the IPPD can be found at <http://www.ippd.or.th>.

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Foreword

The Institute of Public Policy and Development partnered with the Economist Intelligence Unit to create a scenario analysis of Thailand's economic future with respect to Artificial Intelligence. AI is one of the key families of technologies driving the Automation megatrend, which sees unprecedented disruption due to the increasing number of mechanical and cognitive tasks that can be performed by machine.

Existing work has highlighted the potential of AI technology to replace workers in the ASEAN region and explored the impact on economic growth and employment in Thailand. This exercise further extends the analysis to the impact of AI on the agricultural, industrial, and services sectors, with interview-supported commentary on two services-sector industries: tourism and healthcare.

This report constructs three scenarios, based on different combinations of policy outcomes and external factors, which serve to highlight the importance of different policy areas and provide context for policy implications.

This scenario exercise is not designed to prove any particular outcome or to make as accurate a forecast as possible, but to explore potential futures to enable planning for different outcomes – which would not be possible if one considered only the most probable outcome.

Our approach seeks to find a balance: the use of quantitative evidence aims to be more convincing than would a purely hypothetical/exploratory scenario process, while the use of storytelling, qualitative evidence, and interviews paints a more accessible and relatable picture of the potential futures would a purely analytical exercise.

This report is designed to be a starting point for further discussion: it lays a structure from which we can adjust scenarios to respond to new information, get an intuitive sense of how different policy measures fit together in the issue, or identify areas where we can increase our understanding and flesh out the scenario stories.

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Executive Summary

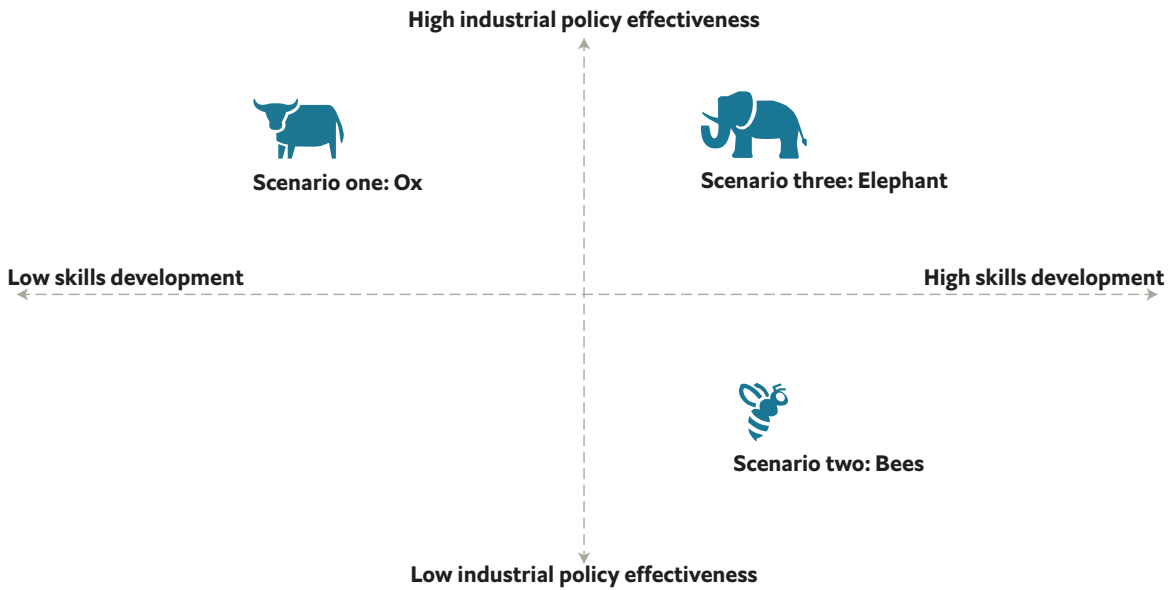
Artificial intelligence (AI) is reshaping labour markets in both developed and emerging economies, prompting fears of unprecedented job losses across manual and knowledge-driven work. As AI tools are commoditised and commercialised, their real-world applications indicate that they will be broadly adopted across sectors and industries, from law and medicine to accounting, digital manufacturing and tourism.

Certain industries are particularly vulnerable to automation, such as manufacturing and business process outsourcing (BPO). In emerging economies that have built up sizeable workforces in these areas, there is a growing call for proactive interventions to minimise job losses and seize job-creating opportunities enabled by technology. By introducing the right interventions, governments and policy stakeholders can harness AI and its associated automation tools to strengthen international competitiveness, improve public services and unleash new types of business.

Policymakers in Thailand are working to develop effective interventions that will enable them to seize the opportunities associated with AI and automation, and to minimise the risks. To support them in this work, this report presents three different scenarios that illustrate how AI could affect key social and economic metrics in Thailand. These scenarios are not forecasts. Rather, they illustrate how different policy choices can shape the impact of AI and automation on Thailand's economy and its workforce, drawing on both quantitative analysis (macroeconomic modelling) and qualitative insights drawn from expert interviews and historical policy and technology analysis. The scenarios are intended to help Thai stakeholders consider and prepare for the different possible futures that they outline.

Across all three scenarios, we have assumed that AI technology will substantially increase the use of computers and raise productivity. This has allowed us to focus the scenarios on the importance of industrial policy and skills development in an AI-augmented economy. Figure 1 presents the three scenarios in a scenario matrix, with industrial policies and skills development as the two key variables.

Figure 1: Scenario matrix



Source: The Economist Intelligence Unit

Our model focuses on four social and economic metrics: GDP growth, employment, productivity and the relative importance of different sectors in the economy (industry, services and agriculture).¹ We used qualitative analysis to build out our scenarios, considering the implications of AI and AI-assisted automation for specific sub-sectors of the economy, as well as wages, inequality and social/political impacts. Figure 2 summarises the key consequences of each scenario.

Figure 2: Scenarios overview

	Baseline	Scenario one: Ox	Scenario two: Bees	Scenario three: Elephant
In a nutshell	Incremental improvement	Industrial policy success without skills	Upskilling without industrial progress	Effective skills development and industrial policy
Inputs	Industrial policy			
	Skills development			
GDP US\$bn				
Outcomes	Employment (vs. baseline) As a % of the total working-age population	-5%	+18%	+18%
	Main sectors benefiting		Aviation Automotive Electronics Robotics Logistics Consumer health Construction	Digital economy Tourism Care economy Agriculture

Source: The Economist Intelligence Unit

1 For the avoidance of confusion between industry and manufacturing, ‘industry’ relates to mining, quarrying, construction and utilities, in addition to manufacturing.

Baseline Forecast: Business as Usual

Based on The EIU's core forecast, we project an “incremental improvement” for Thailand in 2035, based on current policies.

We expect Thailand to experience moderate growth (averaging 2.6%) in the period to 2035. The automotive, manufacturing and tourism industries will become more important to the Thai economy, but automation and an ageing population will lead to declines in employment. This forecast is included in this report to offer a reference benchmark of relative performance for each alternative scenario.

Scenario One: Ox

Industrial policy succeeds, but there is limited focus on skills development.

This scenario is labelled “Ox” to represent powerful industrial output and GDP growth, but with workers who are replaced by automation lacking the agility needed to transition to new jobs due to a failure on re-skilling. In this scenario, strong industrial policy focuses on manufacturing in regional development zones. This supports Thailand's competitiveness in industries such as aviation, electronics and medical technology. However, underinvestment in education results in substantial job losses.

Thailand successfully pursues a strong industrial policy, initially focused on its Eastern Economic Corridor but later fanning out to other regional zones. This helps to increase its share of regional and global value chains in established industries like aviation, computing electronics and medical technology. Overall growth accelerates to 3.2%, which is 0.6% higher than in the baseline. This brings some benefits for the agricultural sector as well, which provides agro-commodities needed by industry. The services sector also benefits as demand from industry increases for finance, logistics and trade services. Fiscal incentives are made available to attract global manufacturers, who bring with them sizeable automation capabilities. However, this leads to limited job growth and delivers muted fiscal benefits for the government. Regional inequality worsens, and potentially competitive domestic industrial firms are drained of talent by multinationals. Failure to invest in fundamental skills through primary and secondary education means that Thailand lacks the necessary human capital to seize opportunities beyond manufacturing that new technologies can offer. Failure to ensure that workers are retrained also means that many people who are displaced from their roles by AI-assisted automation struggle to find new jobs. Employment falls by 5%, relative to our baseline.

Scenario Two: Bees

Failures in industrial policy undermine Thailand's competitiveness, but there is a strong focus on skills development.

This scenario is labelled "Bees" to emphasise the policy focus on workers' skills and industriousness and that many workers are employed, but overall output (GDP) is low. In this scenario, Thailand's digital services economy powers ahead, and agriculture benefits from precision tools linked to AI. Manufacturing loses steam.

Industrial policies fail to drive manufacturing, prompting leading international companies to choose hubs other than Thailand for their South-east Asian base. GDP reaches just US\$726bn by 2035, compared to US\$772bn in the baseline. The services sector records a more positive trendline, growing at an average rate of 2.3% per year to 2035. This growth is driven by government interventions in the digital economy, including a well-managed spectrum licence for 5G (and later 6G) wireless, which is tied to a smart-city strategy initially focused on Bangkok and Phuket. Technology transfers from Chinese tech giants stoke progress in smart cities, benefiting tourism and fostering a fledgling urban-tech ecosystem. The services sector employs 50% of the labour force, accounting for 18m full-time equivalent jobs, with strong growth in areas that are relatively immune to AI and automation, such as the care economy.

The government pursues a successful talent strategy, leveraging AI to build labour market matching tools that offer digital job support to individuals, including training in growth areas that are relevant to their experience, expertise or location. The government also focuses more deliberately on primary and secondary education, increasing education spending relative to GDP and investing in teacher training and curriculum reform to develop students' 21st-century skills, raising the creativity, adaptive intelligence and entrepreneurialism of the next generation. Private-sector-provided education is fully deployed, powered by digital platforms. Full-time equivalent employment reaches 85%, compared to a baseline figure of 67%.

Scenario Three: Elephant

A strong focus on both industrial policy and skills development leads Thailand to reach its full potential.

This scenario is labelled “Elephant” (Thailand’s national animal) to represent superior and more equitably shared industrial and GDP growth, compared to the other scenarios. Balanced and sustained sectoral growth is enabled by broad adoption of AI and AI-linked automation across the aerospace, automotive and electronics industries, as well as smart investment that supports labour-market adaptability.

The government supports export-focused manufacturing, but it also nurtures the digital economy and services, including strengthening the intellectual property (IP) system and skills base. In addition to the aerospace, automotive and electronics industries, Thailand’s industrial sector branches into emerging manufacturing opportunities in the health and wearable tech industry, building on its comparative advantage in this area. Industrial value added expands at 4.4% per year to 2035, compared to just 3.1% per year in the baseline.

Thai entrepreneurs create diverse businesses as the start-up and services ecosystem flourishes, supported by enabling infrastructure such as 5G and cloud computing; skills investment in primary, secondary and tertiary education; and a focus on digital skills, in collaboration with global tech companies. Productivity increases in the agricultural sector, driven by the logistics improvements brought about by AI and precision agriculture. GDP growth accelerates to 4.5% by 2035. Policy interventions that help to distribute the benefits of AI across sectors also lead to a reduction in inequality. Full-time equivalent employment reaches 85%, compared to a baseline figure of 67%. GDP reaches US\$1trn, compared to US\$772bn in the baseline.

Policy Insights

AI will have unpredictable impacts on Thailand's labour market. Nonetheless, policymakers must embrace this global technology to avoid Thailand falling behind its peers. Thailand can use a range of policy instruments to take advantage of AI's opportunities and manage its risks, enabling it to achieve the best outcomes across these three scenarios. This report outlines policy instruments in three key areas that can position Thailand to prosper in the AI age.

Industrial Policy

- Focus on promoting individuals' employment prospects, rather than protecting specific jobs.
- Continue to pursue "old economy" industrial policies to boost Thailand's competitiveness (e.g. through tax and regulatory reform and infrastructure investment).
- Broaden "digital backbone" investment so that companies and individuals across the country can access the Internet and benefit from the latest digital technology.

Skills Development

- Use carefully designed employment subsidies or company tax relief to encourage worker training and hiring in high-potential growth industries, such as tourism and healthcare.
- Pursue balanced investment in primary, secondary and tertiary education to support the entrepreneurial capacity of the next-generation labour force. This includes adapting curricula to align with 21st-century skills.

A Digital Public Sector

- Make use of AI in government and public services, including using AI-based systems to perform rote administrative work. This can free up public servants to focus on more complex policy issues.
- Pursue AI-powered labour market support to help workers cope with expected changes to their jobs, and to transition to new jobs in growing industries.

Introduction

Artificial intelligence (AI) has moved from the margins to the mainstream over the last five years, reflecting remarkable improvements in performance, range and speed. These improvements have been enabled by a number of interlocking trends, including the development of more powerful chip technology, the emergence of large data sets, and refinements in techniques such as neural networks and deep learning.

AI is one of the markers of the Fourth Industrial Revolution, along with robotics, digital manufacturing, and the integration of cyber and physical systems. Although technology has been automating work for centuries, there are concerns that this era could bring dramatic social dislocations as software becomes capable of performing a growing number of tasks. Estimates of job losses were first produced for Western economies, before broadening out to developing countries, particularly in Asia, which has built up a large, job-intensive presence in industries such as electronics, business process outsourcing (BPO) and manufacturing, which are considered vulnerable to automation.

Technology-driven worker displacement brings major risks. Will displaced workers find new occupations? What will happen to aggregate demand if incomes fall as a result of declining employment? Will increasing shares of the economic pie accrue to AI engineers and patent holders in global tech centres, worsening inequality? How will local talent in less advanced economies take advantage of the new opportunities that technology brings? Despite these risks, however, any attempts to halt or delay the arrival and development of AI and automation would be counterproductive, as countries that do not adopt best-in-class technology will lose their competitiveness. It is also important to recognise that AI and automation can bring considerable benefits, including improved efficiency in public services, opportunities to optimise critical areas like medical diagnosis and helping local firms to compete globally as they leverage technological tools such as chatbots and automated back-office processes.

Taking into consideration both the risks and the benefits, policymakers need to think carefully about how AI and AI-assisted automation will affect their country's economy and labour market. Previous research conducted by The Economist Intelligence Unit (The EIU) has demonstrated that the

impacts of AI are largely shaped by a government's policy choices and by a country's economic structure.^I

To support decision-makers in the Thai context, the Institute of Public Policy and Development (IPPD) commissioned The EIU to study the impacts of increased AI adoption on the Thai economy. This report explores the findings from a scenario-modelling exercise that simulated the potential economic impacts of AI adoption on the country, drawing on expert interviews and a literature review to provide additional depth and context to the quantitative analysis and to consider social and political impacts.

Defining AI

For the purposes of this report, we define AI as computer-based applications that carry out functions typically associated with humans, such as visual perception, decision-making, pattern-spotting and speech recognition. While AI has been in development for over half a century, it has enjoyed a sudden leap in performance over the past decade. Methodological advances such as machine learning and neural networks now allow tools to refine decision-making, learn from experience and integrate evolving data sets. This contrasts with conventional computing systems, which apply rules to data (albeit at speeds and quantities beyond the capacity of humans).

In addition to looking at the direct impact of AI, this report considers the impact of AI-assisted automation. This covers technologies included under the rubric of the Fourth Industrial Revolution—a paradigm that fuses together cyber, physical and biological capabilities. We use the definition of computer-assisted automation adopted by the International Labour Organization (ILO) in its 2016 report on the impact of this automation on the Association of Southeast Asian Nations (ASEAN). As AI advances, it will be used to enhance a growing range of computer-based applications, and the vast majority of computer-based automation will be AI-assisted.^{II}

This study did not model the impacts of artificial general intelligence (AGI; technology that can perform a broad range of uncorrelated tasks to the same standard as a human being, or to a higher standard) because this technology does not yet exist and it remains unclear whether it can be achieved. The economic impact of AGI would also be radically different to the economic impact of existing AI, which means that a single model would not function accurately or coherently if it attempted to cover both.

Thailand in 2035: Three Scenarios

To understand AI's potential economic impacts on Thailand through to 2035, we used a scenario-modelling approach that combined the latest data on the Thai economy, EIU forecasts and an analysis of relevant policy trends and behaviours, as well as expert insights from a panel of interviewees. This approach (supported by a model that simulated interactions between key variables) allowed us to identify credible, internally consistent and varied pathways for Thailand in the coming decades.

The methodology of scenario analysis was first trialled in the 1950s in the context of national security and policy design. It is important to note that scenarios are not forecasts; rather, they illustrate possible futures to help decision-makers understand how different choices can lead to different end points. The purpose of scenario analysis is to understand what decision-makers can do today to prepare for both the opportunities and the challenges of tomorrow.

This report bases its scenarios on informed assumptions about how core factors such as AI deployment and relevant government policies might develop in Thailand. After creating a shortlist of factors that are likely to influence Thailand in the period to 2035, we narrowed this list down to two factors that are particularly relevant to how Thailand's economy will fare in a world where AI is dominant:

- The success of Thailand's industrial policy in boosting competitiveness.
- The success of its skills development efforts.

The resulting analysis explored how the adoption of AI technology could impact labour markets, productivity, economic growth and society at large, based on the success or failure of industrial policy and skills development efforts. The final section of the report uses findings from the three scenarios to develop policy insights designed to help Thailand reap the benefits of next-generation technology.

Baseline: Business as Usual

Unlike the three scenarios, the baseline is a forecast of the most likely outcomes for Thailand to 2035, driven by The EIU's core forecasting model.

Macroeconomic Outlook

In our baseline forecast, we expect the Thai economy's growth to have slowed to 2.2% by 2035 (following growth averaging 2.6% over the period 2019-35). Living standards have risen, and GDP per capita is around 50% higher than in 2019. The business environment improves during the 2020s and 2030s following policy reforms by the government. In particular, Thailand liberalises key industries such as power and communications, improving business efficiency and boosting demand for the country's output in both foreign and domestic markets. In addition, the government has some success with its "Thailand 4.0" industrial policy, which helps industry to move into higher value-added segments. The policy focuses on smart electronics, high-income and medical tourism, agriculture and biotechnology (biotech), food and beverages, the automotive industry, robotics, aerospace, digital services, bioenergy and biochemicals, and healthcare. Using investment incentives, it focuses on encouraging the introduction of new technology—for example, by offering import-duty exemption on capital goods for listed industries. However, insufficient amounts of skilled labour prevent the policy from reaching its full potential, and the target of reaching 5-6% growth by 2021 is missed. This lack of skilled labour is due to ineffective leveraging of migration policy to mitigate the challenges of an ageing population, as well as insufficient progress in improving workers' skill levels. Employment falls by 18 percentage points, compared to 2019.²

Thailand increases economic integration, particularly with China and members of the ASEAN Economic Community (AEC). Economic and trade links with China are strengthened by the development of overland transport routes during the 2020s, and integrated markets within ASEAN provide opportunities for businesses to regionalise, encouraging technical innovation and a dynamic private sector. Between 2019 and 2030 regional supply chains relocate in response to changing tariff regimes and increased trade tensions between the United States and China. Thailand benefits from these shifts, although competition from other countries in the region (especially Vietnam) limits the boost to Thailand's growth.

² This is measured in full-time equivalent employment—i.e. the total number of hours worked across the economy divided by the hours for a typical full-time job. A full-time job is assumed to be 40 hours per week, for 48 weeks per year.

Sectoral Development

The industrial sector expands from 35% of GDP in 2019 to 38% in 2035. Some manufacturing workers are reskilled, enabling them to perform more sophisticated tasks as Thailand moves into higher value-added industrial production. The automotive industry becomes one of Thailand's leading industries. Services output also grows, but not to the same extent as industry. As a result, its share of GDP shrinks from 57% in 2019 to 55% in 2035. Increased productivity drives development in this sector, particularly in the retail and hospitality industries. Tourism is a key economic engine, and it benefits from the government's push to make Thailand a high-end tourist destination.

The agricultural sector's share of GDP declines from 8% in 2019 to 6% in 2035, although this is still high for a country at Thailand's level of development. The continued importance of agriculture is driven by the country's pursuit of agro-allied industrialisation (industrial development that uses inputs from the agricultural sector) as part of the Thailand 4.0 policy, as well as strong political support for the sector. Emerging technologies are increasingly used in agriculture (e.g. AI-based weather forecasting and insights from AI-supported agrosience), leading to productivity gains. However, as the economy modernises, individuals enjoy higher incomes and spend a smaller share of their income on food, leading to a fall in agriculture's share of GDP. At the same time, improved productivity among workers means that fewer people are required to produce the same level of output, leading to job losses.³

³ For a more detailed understanding of how this is arrived at, Appendix 1 provides a detailed explanation of our modelling assumptions.

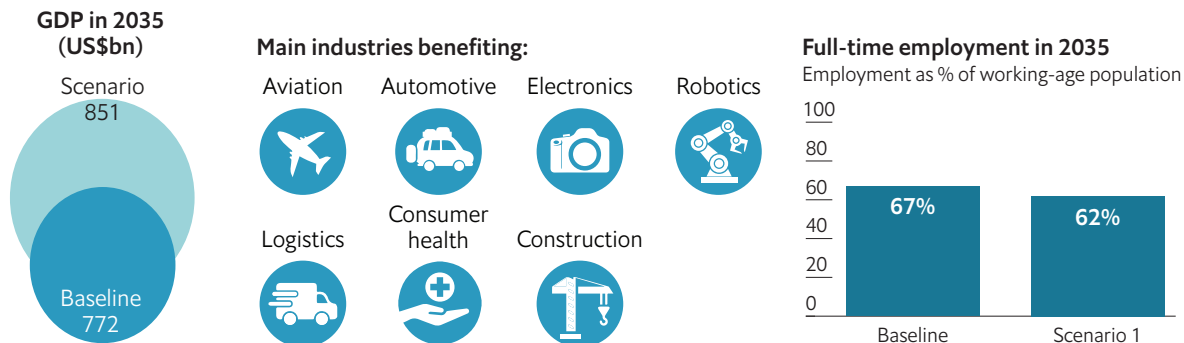
Scenario One: Ox

Thailand 4.0 is partially achieved through the successful development of the Eastern Economic Corridor (a three-province advanced development zone that begins as the scheme’s testbed), followed by initiatives in other special economic zones. This leads to productive export clusters in aviation, computing electronics and medical technology. However, heavy use of AI and AI-assisted automation, coupled with a failure to reskill workers, means that growth is “jobless”. The fiscal incentives used to attract multinational corporations deliver limited tax benefits for governments to reinvest in crucial areas such as primary, secondary and tertiary education. This scenario is therefore labelled “Ox”, to represent powerful industrial output and GDP growth, but with those workers who are replaced by automation lacking the agility needed to transition to new jobs due to the failure on re-skilling.

Figure 3: An overview of “Ox”



Scenario one: Ox



Note: Employment is calculated as full-time equivalent employment, i.e. hours worked divided by full-time working hours per worker which are assumed to be 40 hours per week x 48 weeks per year.

Source: The Economist Intelligence Unit

Macroeconomic Outlook

In this scenario, overall economic growth accelerates to 3.2% per year, which is 0.6 percentage points higher than overall growth in the baseline. The government implements its industrial policy programme, which includes fiscal and regulatory incentives such as exemption from corporate income tax and machinery import duties, straightforward and long-term work visas for foreign

talent, and access to land ownership.^{III} The policy is implemented in the Eastern Economic Corridor, which the Thailand 4.0 policy has designated as the powerhouse for industrial production. Ten “S curve”⁴ industries are targeted, including next-generation automotive, smart electronics, aviation and logistics. Centred in the eastern provinces of Chachoengsao, Chonburi and Rayong, the Eastern Economic Corridor emerges as a productive industrial cluster, with other zones in Tak, Sa Keao, Trat and Chiang Rai.^{IV} The government invests heavily in infrastructure, including high-speed rail linkages. It also upgrades export-focused assets, notably airports and ports.^V

Attracted by the prospect of selling to Asia’s growing consumer and industrial markets in areas such as robotics, the automotive industry and biotech, several global multinationals set down roots or expand their presence, bringing with them best-in-class automation software and robotics technology. Rolls-Royce expands its research collaboration with Thai Airways International, adding its machine learning and Industrial Internet of Things (IoT) platform to the plane fleet.^{VI} BYD, a Chinese company that makes electric cars, builds on its past export ties to set up local production facilities for the Thai market as part of the regionalisation of its supply chain.^{VII}

Beyond the Eastern Economic Corridor, multinational manufacturers in industries like biotech are drawn into clusters like the Thailand Science Park, near Bangkok. This includes medical technology brands such as Amgen and Siemens and consumer health technology companies like Fitbit. The presence of global industrial and electronics titans brings significant automation and AI capabilities to the country, both in terms of software and IP. It also attracts foreign experts, who are drawn to the high quality of life in the country, especially its health system and opportunities for tourism and leisure.

From a technology perspective, machine learning and pattern-recognition software hugely improve industrial productivity, error detection and production efficiency; the Industrial IoT and 3D printing allow agile and data-optimised production, shortening design cycles and reducing material waste; and self-learning AI quickly understands how to assemble new products without needing complex code and programming. Thanks to significant AI and AI-assisted automation, Thailand becomes a regional leader in aviation, the automotive industry (autonomous and electric vehicles) and electronics (including graphics-processing units, IoT appliances, medical technology and biotech).

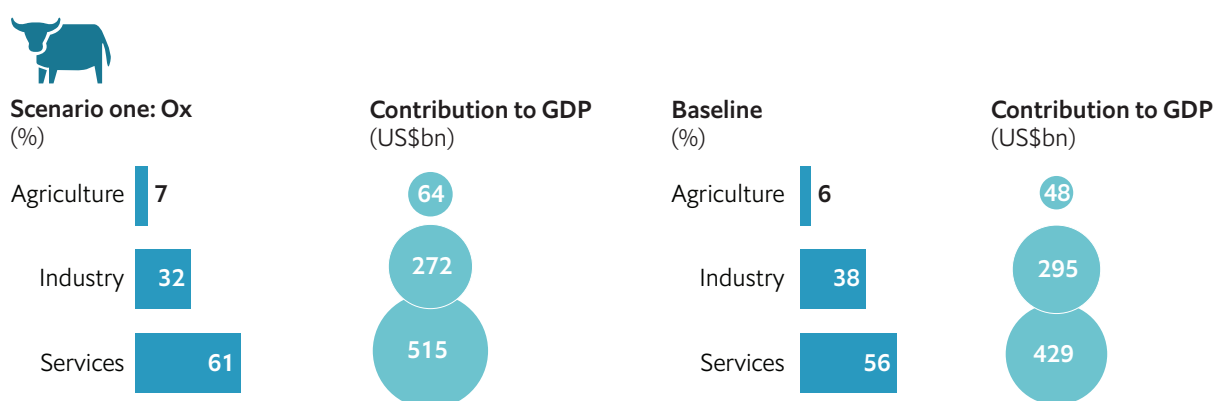
4 “S curve” industries are those in which companies undergo multiple growth inflection points through innovation, rather than a steady state expansion or stable state.

However, this growth engine does not extend to the wider economy, leading to increased regional inequality. The heavy fiscal and regulatory tape-cutting needed to attract the best brands also means that the government’s tax revenue is limited. Local manufacturing companies are too far behind the productivity frontier to compete, and there is a “brain drain” of technical talent. In the absence of worker reskilling efforts, the local labour force is unable to take advantage of new jobs created in software, design and data, which are taken by experts from multinational subsidiaries in the West, or from regional market leaders such as Singapore, Malaysia and China. The easy visa scheme further reduces the need for companies to train local talent.

Worker productivity is improved by tools like virtual reality (VR) and mixed reality, which can allow factory workers to optimise output—for example, by detecting and fixing machine faults quickly and efficiently. Overall, however, many of the jobs that are created are performed by robotic and automated tools. While industrial output greatly increases, foreign multinational corporations capture many of the benefits of this expansion, and there is high spending on imported inputs (both capital goods and management services).⁵

Sectoral Development

Figure 4: Sectoral shares of GDP in “Ox”



Source: The Economist Intelligence Unit

In terms of wider sectoral development, services and agriculture both benefit from the expansion in industrial output that takes place in this scenario. The services sector gains because the boom in industrial output leads to more demand for industry-allied services, such as trade services, transport,

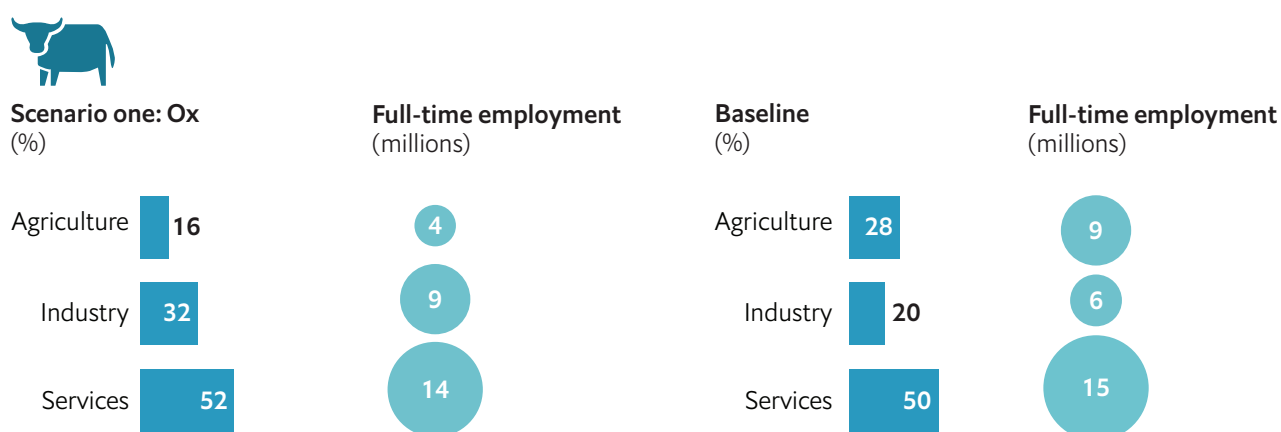
⁵ This high spending on imported inputs means that industrial value-added in Thailand is actually lower than the baseline, expanding value added at an average of 2.4% per year (compared to 3.1% in the baseline).

finance and renting of machinery and equipment.^{VIII} The agriculture sector, meanwhile, gains because the increase in industrial output leads to greater demand for intermediate agricultural goods that are processed in Thailand’s factories, particularly in the biotech industry. Productivity in agriculture also improves, facilitated by the emergence of digital tools and precision agriculture. However, these tools are only adopted by better resourced agricultural producers and farms, leading to sector consolidation, a reduction in agricultural employment and increasing inequality within the sector.

The services sector also sees a smaller number of workers performing higher-value tasks as more and more service workers use computers, and as routine tasks become increasingly automated (e.g. loan applications, reviews of legal documentation, issuing prescriptions for certain medicines). AI is used in the tourism industry to good effect, allowing Thailand to focus on tourists with a higher average spend (including medical tourists). This, combined with increasing domestic demand for services as Thailand’s GDP rises, boosts the share of services in the economy to 61%.⁶

Skills and Employment

Figure 5: Sectoral shares of employment in “Ox”



Source: The Economist Intelligence Unit

Growth is geographically uneven, and poverty persists in rural areas and the country’s northern region. While the government envisaged creating 100,000 jobs a year in manufacturing and services in the EEC alone, automation has not been accompanied by significant worker retraining. This means that fewer new jobs have been created, and that foreign professionals have taken most of those new

⁶ In contrast to industry, in this scenario the services sector does not need to rely on imported inputs to the same extent.

jobs.^{IX} Only half of the workers displaced by industrial automation are able to find new jobs. As a result of these dynamics, public disquiet against inequality and the uneven social and political impact of technology grows, with Thais objecting to the creation of expatriate-dominated industrial enclaves.

The government fails to invest in primary and secondary education. Thailand continues to lag behind in the Organisation for Economic Co-operation and Development's (OECD) global Programme for International Student Assessment (PISA) rankings, and many young Thais are confined to low-productivity jobs in the informal urban service economy. Existing technical talent moves to Malaysia, Singapore and China for tertiary education, with emigrants often choosing to remain overseas after graduation.

Employment declines significantly, driven by increased AI use across all three sectors of the economy and insufficient efforts to retrain workers. The per working-age population employment rate falls by 23 percentage points.⁷ Few jobs are created in manufacturing due to higher levels of automation, but employment increases in construction (which is more difficult to automate) as Thailand implements an ambitious infrastructure- and factory-building programme.

Overall, industrial employment remains stable as a share of the working-age population. The lowest-productivity manufacturing workers are the first to be displaced by automation, increasing worker productivity. The agricultural sector sees the biggest decline in employment, reflecting both the increased use of advanced technology and the fact that many workers in the sector had low levels of productivity. As farmers become increasingly able to produce the same level of output with far fewer workers, the share of workers employed in the sector falls to 16% by 2035 (compared to 28% in the baseline). Increased use of automation and AI in services reduces employment in the sector by about 17 percentage points.⁸

7 This is five percentage points higher than in the baseline. See Appendices 1 and 2 for further details.

8 Overall employment falls faster than services employment, due to rapid declines in agriculture. This means that services' share of employment actually rises.

Scenario Two: Bees

In this scenario, there is limited investment and reform in Thailand’s industrial sector. Despite some export growth, the country loses market share as regional manufacturing rivals Vietnam and Malaysia pull ahead. The services economy fares better, boosted by a vibrant digital ecosystem in several Thai cities. Agricultural productivity and food security improve following the introduction of precision tools. This scenario is therefore labelled “Bees”, to emphasise the policy focus on workers’ skills and industriousness and that many workers are employed, but that overall output (GDP) is low.

Figure 6: An overview of “Bees”



Scenario two: Bees



Note: Employment is calculated as full-time equivalent employment, i.e. hours worked divided by full-time working hours per worker which are assumed to be 40 hours per week x 48 weeks per year.

Source: The Economist Intelligence Unit

Macroeconomic outlook

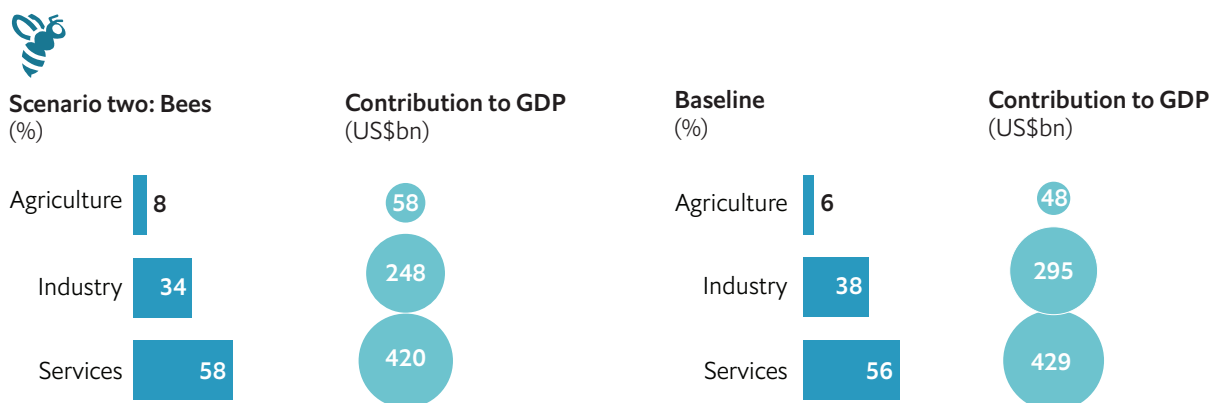
The Thailand 4.0 policy fails to nurture manufacturing success and entice international companies to prefer Thailand to other regional locations. The business environment remains costly and bureaucratic, there are fewer tax concessions and incentives than in other countries, and connectivity infrastructure is weak due to underinvestment and a subsequent failure to implement the Transport Master Plan. Capacity limitations in the country’s IP agency also lead to weak IP protection and slow IP processing. This deters international firms from bringing first-in-class AI and automation to the country, which in turn lowers immigration of foreign talent compared to the “Ox” scenario.

Domestic industrial companies are too far behind the technology curve to compete, with Vietnam and Malaysia, in particular, racing ahead in high-growth industries like autonomous vehicles.^X AI and automation lead to significant worker displacement. However, Thailand does not adopt market-leading AI and automation technologies and is therefore unable to effectively participate in emerging

global value chains in advanced manufacturing. As a result, average growth over the period falls to 1.6% (one percentage point lower than in the baseline).

Sectoral development

Figure 7: Sectoral shares of GDP in “Bees”



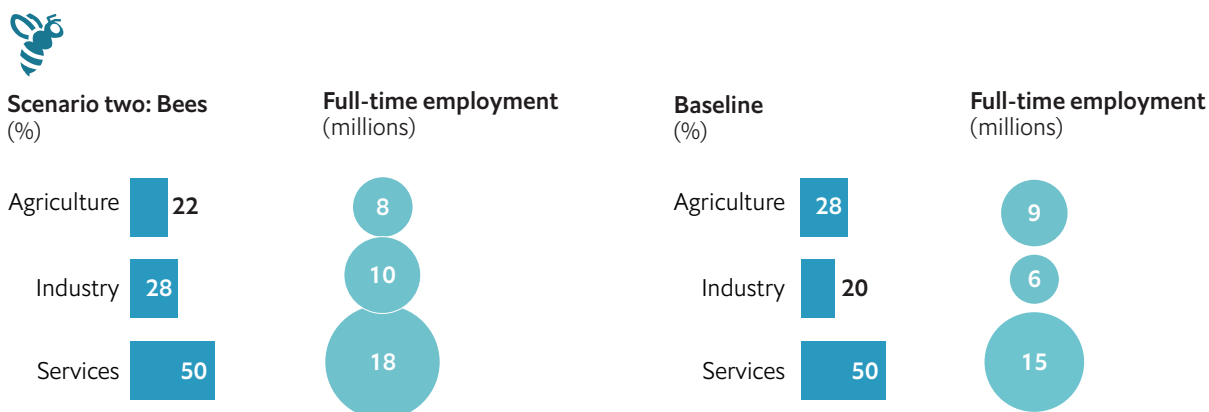
Source: The Economist Intelligence Unit

The services sector enjoys a more positive trendline, growing at an average rate of 2.3% per year to 2035. In part, this is because the government pursues enabling interventions in the digital economy, including a well-managed spectrum licensing process for 5G (and later 6G) connectivity. This process is tied to a smart-city strategy that focuses on Bangkok and Phuket (a tourism magnet), improving safety, reducing congestion and helping to improve the tourist experience. These efforts are helped by technology transfers from Alibaba Cloud’s ET City Brain project in China.^{XI} Smart-city initiatives also stoke job creation and increase productivity in the tourism industry. The creation of open data systems leads to the emergence of Thai urban-tech start-ups, which develop apps and products for the on-demand economy and logistics industry, creating new engines of employment.

Software innovation helps to boost services. For example, the adoption of multilingual chatbot technology enables Thai tourism businesses to attract, and provide services and information to, travellers from further afield including Latin America, Africa, and southern and eastern Europe. The same tools are adopted in the BPO industry, helping Thailand to grow this industry to serve more markets.

Skills and employment

Figure 8: Sectoral shares of employment in “Bees”



Source: The Economist Intelligence Unit

The government uses technology to improve labour market matching, working with recruitment platforms to build algorithms that more efficiently link jobs to candidates. The government engages with international innovators—such as Bayes Impact, a US- and Europe-born AI company—to create personal AI job assistants that compare a candidate’s skills and location with available opportunities, lowering search costs. Taking inspiration from the United Kingdom, Australia and Malaysia, Thailand also begins to publish a critical occupations list. This helps young Thais to make more informed decisions about tertiary education and helps to reduce the inequality that often comes with uneven adoption of new technologies. The government also works with cloud computing leaders (including Microsoft Azure and Amazon Web Services) to substantially leverage AI and machine learning, giving Thai companies a computing productivity boost. The tourism and medical industries both benefit from a combination of local know-how and experience with global, AI-driven technology platforms.

In this scenario, the government invests more in primary, secondary and tertiary education, increasing education spending to 6% of GDP and investing in curriculum and teacher training to place greater emphasis on 21st-century skills such as creativity and flexible thinking. These investments improve Thailand’s performance in the OECD PISA rankings and create a more creative, adaptable and entrepreneurial population that is better able to seize opportunities in the services sector. The Ministry of Digital Economy and Society launches a programme with education ministries⁹ to create technical

⁹ This refers to the Ministries of Education and Higher Education.

and vocational education centres focused on Thailand's strengths, notably tourism, health tourism and the care economy. In addition, government-funded scholarships allow a select group of students to travel to regional technical excellence centres in AI, such as Peking University. Although this leads to an increase in outward migration among students, many Thais eventually return home to apply their skills.

In the services sector, tourism and the care economy benefit from the increased use of automation for administration and back-office processes. However, both industries continue to require a "human touch" and flexible problem-solving, resulting in growth in services employment, which is 24% higher in 2035 than in the baseline. Thailand also produces its first "unicorn" firms (defined as start-ups worth a billion US dollars) in the tourism and travel industries.

As in all scenarios, the agricultural sector enjoys an increase in productivity relative to 2019, having adopted precision agriculture tools that optimise resource allocation (such as real-time fertiliser monitoring and advanced weather modelling). This increases agricultural productivity per worker and improves food security. Tech-savvy agri-businesses increase their share of the sector, resulting in a decline in employment as fewer workers are needed to produce the same level of output. However, a focus on worker upskilling in this scenario means that there is less worker displacement than in the baseline, with more agricultural workers able to retain their jobs.

Overall employment across the economy also declines less than in the baseline, as worker reskilling allows people to take up new roles operating alongside technology. New jobs for displaced workers are primarily located in the services sector, although there are some in agriculture. However, the hit to Thailand's competitiveness means that the value of what each worker produces is less than in the baseline, as the country has to specialise in low-cost value-added segments in order to continue selling to international markets.

The social and political impacts of this scenario are more positive than in the "Ox" scenario. In particular, employment is much higher, reducing the likelihood of discontent among the unemployed. However, in contrast to our "Ox" scenario, regional enclaves that have been designated as major economic production zones lag behind. This limits the emergence of auxiliary industries that support manufacturing, including facilities services and agri-commodities used in industrial processing.

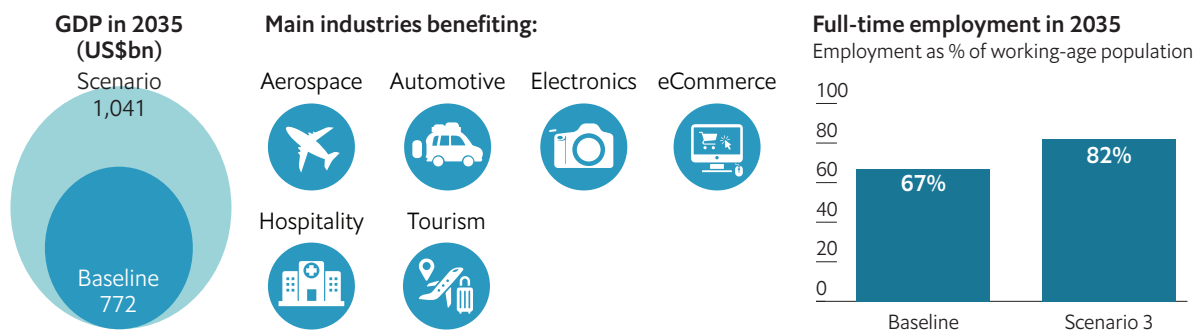
Scenario Three: Elephant

Thailand enjoys balanced sectoral growth. Smart investments and broad adoption of AI and automation help to improve the labour market’s responsiveness to change. The government combines support for export-focused manufacturing (part of the Thailand 4.0 policy) with efforts to nurture the digital economy and services, including strengthening the IP system. Thai entrepreneurs create diverse businesses and the start-up ecosystem flourishes, supported by enabling infrastructure such as 5G and cloud computing, as well as skills investment in primary, secondary and tertiary education. Productivity increases in the agricultural sector, driven by increased demand for agro-commodities in the industrial sector, higher living standards and wages in the wider economy, and logistics improvements brought about by AI. This scenario is therefore labelled “Elephant” (Thailand’s national animal) to represent superior and more equitably shared industrial and GDP growth, compared to the other scenarios.

Figure 9: An overview of “Elephant”



Scenario three: Elephant



Note: Employment is calculated as full-time equivalent employment, i.e. hours worked divided by full-time working hours per worker which are assumed to be 40 hours per week x 48 weeks per year.

Source: The Economist Intelligence Unit

Macroeconomic outlook

In this scenario, Thailand makes the most significant progress towards transitioning through the “middle-income” trap. Structural transformation is achieved by putting in place the necessary enabling conditions and reforms, including greater investment in human capital; robust competition laws and stronger IP protections, increasing commercial dynamism; worker retraining and reskilling

efforts, led by governments, universities and companies; and targeted public funding. The country's growth accelerates to an average rate of 4.5% in the period to 2035, doubling GDP per capita. Policy interventions that seek to distribute the benefits of AI across sectors and geographies lead to a reduction in inequality.

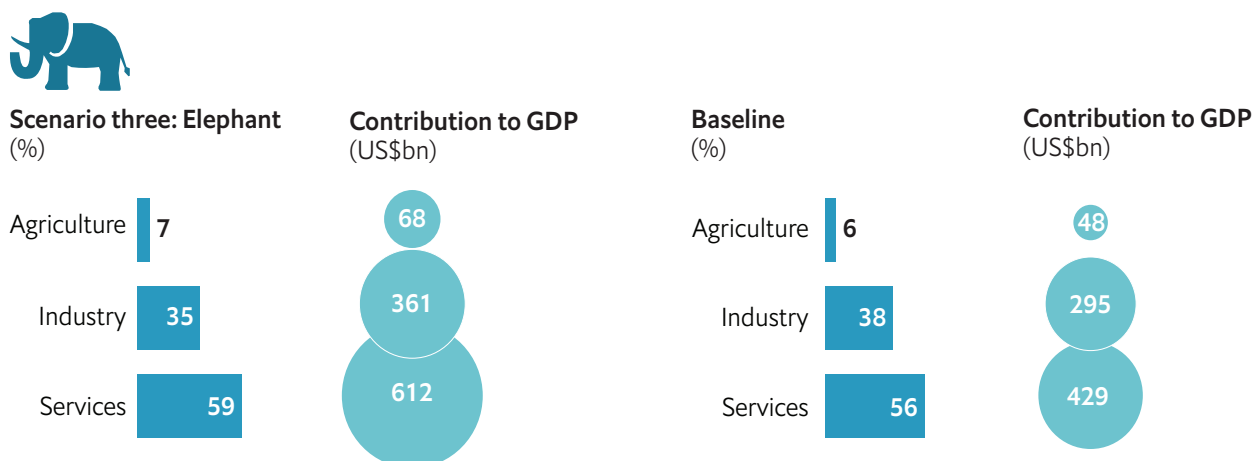
Having implemented effective industrial policy, Thailand achieves major growth in the industrial clusters identified in Thailand 4.0. Progress is particularly notable in the aerospace, automotive and electronics industries, driven by advances in the materials, technology and skills required by these industries. Investment promotion incentives (outlined in our "Ox" scenario) help to attract international firms, which bring with them best-in-class automation, AI and robotics. The government balances fiscal incentives with carefully designed local content provisions to ensure that local talent and the domestic supply chain are integrated into the expanding industrial network.

Strong regional growth in ASEAN also attracts international companies, which view Thailand as an entry point to the South-east Asian market. Unlike in the "Ox" scenario, higher skill levels among Thai workers mean that these companies do not need to rely on management from abroad or imports of capital goods to the same extent, allowing more of the value added to remain in Thailand. As a result, industrial value added expands at 4.4% per year to 2035 (compared to 3.1% per year in the baseline).

In addition to building its presence in the aerospace, automotive and electronics industries, Thailand's industrial sector takes a leadership role in wearable technology, especially health wearables such as health and fitness trackers. In this, Thailand draws on its comparative advantage in medicine and healthcare and takes advantage of the lower technical requirements. Unlike in the "Ox" scenario, this means that more local experts and companies enter the industrial sector and benefit from the jobs and revenues it generates. Thai start-ups and small and medium-sized enterprises (SMEs) in the industrial supply chain are helped by a new Industrial IoT innovation centre—a co-investment between multinational manufacturers and the government. Here, AI, VR and analytics facilities provide space and support for local firms to develop prototypes, collaborate with industry and become innovators. While the "Bees" and "Elephant" scenarios have the same level of investment in worker reskilling, workers are able to perform higher-value jobs in the "Elephant" scenario because broader industrial policy has created the necessary conditions for these industries to flourish.

Sectoral Development

Figure 10: Sectoral shares of GDP in “Elephant”



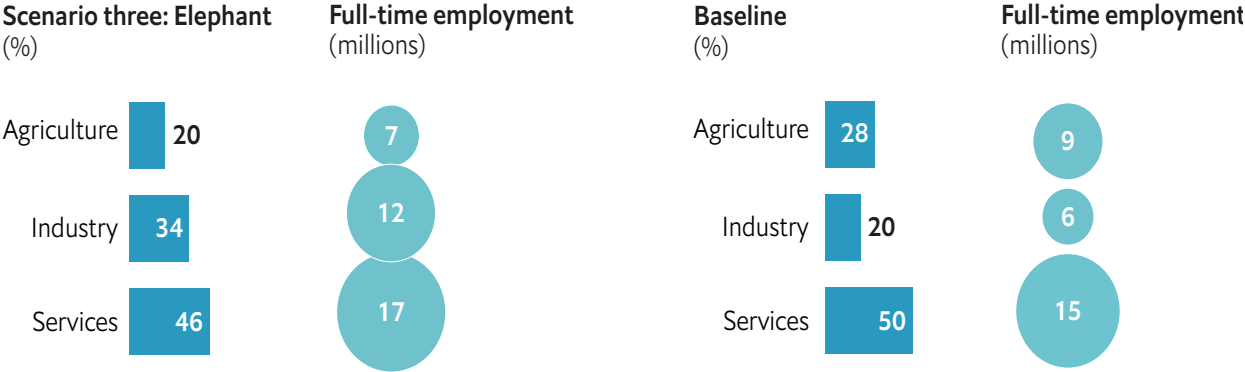
Source: The Economist Intelligence Unit

In terms of wider sectoral development, the services economy flourishes. Thailand’s e-commerce industry becomes the fastest growing in South-east Asia, supported by improved connectivity, growth in the number of smartphone users and rising Internet penetration. The online retail industry grows significantly. On average, the services sector expands at an annual rate of 4.7% between 2019 and 2035— faster than growth in the industrial sector because services tend to play an increasingly important role in an economy as income levels rise. However, employment in the services sector does not increase, as low-productivity service workers are drawn to new and better jobs in the booming industrial sector. This, coupled with technology deployment in the services sector, leads to substantial improvements in services’ productivity.

The government’s use of AI and analytics also helps to strengthen the business environment for both services and industrial firms. Using highly efficient automated software quickens everything from tax filing to compliance paperwork, allowing companies to spend more time on productive activity. The service economy, which is strongly shaped by the knowledge and skills of the wider population, benefits from the government’s strong and balanced investment across primary, secondary and tertiary education.

Skills and Employment

Figure 11: Sectoral shares of employment in “Elephant”



Source: The Economist Intelligence Unit

As in our “Bees” scenario, the government implements wide-ranging curricular reform to emphasise applied learning and creativity. It also supports Thailand’s technical universities and strengthens partnerships and twinning initiatives with top global centres of excellence in health and biotech, such as Johns Hopkins and Cambridge University. Research partnerships evolve in areas such as medical robotics and prosthetic and bionic limbs. There is also an emphasis on developing management and business education in universities, including Master of Business Administration (MBA) programmes—a key skills gap that is often underappreciated in middle-income contexts.

More specific, modular skills and training programmes are a major part of the services and industrial boom. The Digital Economy Promotion Agency (DEPA), launched in 2017, sees a large increase in budget allocation from Bt280m (US\$9m) to Bt400m (US\$13m). It launches successful global skills schemes, including Coding Thailand in collaboration with Microsoft, Cisco and Google.^{XII} The presence of tech giants in the country increases their absorption of Thai talent, identified through their incubators and skills programmes. DEPA also launches structured skills programmes in mechatronics and industrial AI. Thailand adopts and adapts best practices from the region, including Taiwan’s TRIPLE programme, which matches global hardware start-ups with hardware partners and resources in Taiwan; and Cyber-Port, a digital city initiative in Hong Kong. It also passes IP protection laws and strengthens the capacity and mandate of the Department for Intellectual Property, leading

to an improved ranking in the Global Innovation Index. Reforms to the agency shorten the time taken to secure patents from seven years to two years. Thailand’s overall competitiveness is also helped by successful delivery of its Transport Master Plan.

Productivity in the agricultural sector improves following the introduction of precision agriculture tools that optimise resource allocation. This, in turn, improves food security. There is also greater fusion between the digital economy and the agricultural sector, with big domestic companies like Siam, Indorama and Charoen Pokphand leveraging technology and innovation. However, agriculture’s share of GDP drops; this is because agricultural value added still grows, but at a slower pace than in the industry and services sectors, as is to be expected with rising income levels.

While there are some job losses, increased investment in tertiary education allows more Thais to take up new opportunities in engineering, coding, robotics and design, reducing the need for skilled immigration. Workers who have been displaced from more routine-based manual manufacturing tasks are also more actively reincorporated into the sector—for instance, to product-test “carebots” for human users. The expansion of Thailand’s industrial sector also creates jobs in construction, which is building the necessary facilities and transport infrastructure to support this expansion. As in our “Bees” scenario, there is only a small decline in overall employment because the vast majority of workers who have been displaced by AI and automation are able to find new jobs elsewhere.

The net result is that AI has a positive social and political impact on Thailand. The population sees direct and varied benefits as AI tools are used for public services, rather than exclusively by private corporations. Strong privacy legislation also ensures high levels of trust in new technologies.

Case Study: Assistive AI boosts Healthcare Excellence

Healthcare is one of Thailand's fastest growing industries, reaching US\$18.7bn in 2018—an 8% increase since 2014.^{XIII} Globally, the industry has been a lead adopter of AI. Computer vision and machine learning are already improving clinician productivity, surpassing humans in diagnostic accuracy and ramping up pharmaceutical research and development (R&D) through the ability to map, model and analyse huge data sets, especially in genomics. AI can also reduce administrative work.

The tech industry has noted Thailand's energetic adoption of technology. For example, Jake Lucchi, head of Head of AI and Data Value-Government Affairs and Public Policy at Google Asia Pacific says “I am always impressed that Thailand has been so forward-thinking on public health.” Bangkok's Bumrungrad International Hospital, for instance, is employing IBM's Watson platform to help oncologists monitor newly published cancer research. The government is also working with Microsoft AI and Cognitive Services to capture, track and share data on public restrooms through a mobile app,^{XIV} helping to mobilise community participation and set up early warning systems for communicable diseases.

It is likely that healthcare companies will continue to partner with technology companies to incorporate machine learning, improve diagnoses and reach patients in rural areas. Jake Lucchi underscores the great opportunities for healthcare companies to make use of such new technologies. As part of its Thailand 4.0 policy, Thailand plans to leverage its excellence in medical services and strengthen its position as the regional medical hub. To promote medical robotics, the Thailand Board of Investment (BOI) has already offered a range of investment promotion incentives related to three targeted activities: manufacturing automation machinery/equipment with engineering design, assembling robots or automation equipment/parts, and manufacturing high-risk or high-technology medical devices.^{XV}

While automation is frequently portrayed as a job displacer, experts in healthcare see ample opportunity for assistive AI. For instance, Dr Ekkehard Ernst, chief of macroeconomic policies and jobs at the ILO, notes that it could enable pharmacists and nurses to provide diagnostic and treatment services that might otherwise require higher levels of training. Matching algorithms could also optimise health services allocation to regions based on need, improving productivity;

and advanced data and analytics could optimise predictive public health—for example, by exploring the interplay between weather and the transmission of malaria.

Fears that greater economic power will amass to a small community of patent holders and AI engineers may also be overblown. Jake Lucchi emphasises that ‘off-the-shelf’ AI tools and software allow firms of all sizes, as well as developers and researchers to benefit from AI without requiring specific AI expertise. As a result, AI may enable Thailand to create jobs by increasing the country’s exports of health tourism. For example, Dr Ernst argues that innovations that enable remote diagnosis services would complement Thailand’s comparative advantage in health tourism.

Given the expected increase in Thailand’s income across scenarios, as well as its ageing population, we expect demand for healthcare services to grow substantially, both in the baseline and across the “Ox”, “Bees” and “Elephant” scenarios. However, developing and implementing effective policies will be crucial to service this demand, including policies that make effective use of AI. This will require appropriate privacy legislation and regulatory frameworks that balance access to big data sets (to train AI systems) with patient rights. This includes allowing individual patients to opt out, and protecting them against data misuse. In order to fully exploit AI in healthcare, it will also be necessary to retrain health workers to use or work alongside the latest technology.

In our “Ox” scenario, the lack of worker reskilling means that health providers in Thailand would have to improve their output by relying on the latest technology, as they would struggle to find enough workers for key roles. However, technology would only be able to substitute for skilled workers to an extent, limiting Thailand’s ability to service growing demand and/or expand medical tourism. This may prompt wealthier Thais to seek healthcare abroad.

By contrast, efforts to develop workers’ skills in the “Bees” and “Elephant” scenarios would enable the healthcare industry to become an increasingly important employer, and to expand to service demand from both the domestic market and medical tourists. We also expect the digital economy to expand in these two scenarios, which would allow healthcare to benefit from technologies developed by home-grown health-tech start-ups.

Case Study: AI powers Thai tourism

Tourism is a major driver of the Thai economy, generating approximately US\$66bn (around 12.5% of GDP) in revenue from international tourists in 2018.^{XVI} The World Travel and Tourism Council has estimated that one in five new jobs in Thailand were created in this industry in 2018 alone.^{XVII}

Like healthcare, tourism around the world is benefiting from AI and data science, from sharing-economy platforms like Airbnb to increasingly sophisticated ticket comparison sites. The commoditisation of web development software and payments technology, led by the likes of Squarespace and Stripe, has also lowered entry barriers, allowing even the smallest companies and tourism providers to have an online presence.

Thailand has taken advantage of the opportunities in tourism brought about by digital innovation. Hayk Hakobyan, partner at VisionCapital, notes that TripAdvisor (a US-based online travel agency platform) is already working with Thai agencies to use AI to match customers with the best travel options, and that Thailand's tourism industry still has "huge potential" to deploy AI: "It is only a matter of time before travel agents are replaced by AI-driven booking applications in Thailand. That is a low hanging fruit." However, he also notes that this will have employment effects: "A lot of the jobs in this area will get automated and people will lose out. This is an example of where this can happen very fast. Everyone is going into having an AI-powered application." Dr Ernst agrees, highlighting that AI is already making travel agents redundant by facilitating peer-to-peer recommendations and offering match-making platforms connecting tourists and experiences.

However, AI also presents Thailand with an opportunity to upgrade its tourism industry and shift to higher value-added services. Furthermore, it has the potential to grow the industry by facilitating the provision of more customised services and helping to overcome language barriers—for instance, through multilingual chatbots that help tourists interact with local agents and services. Experts also note that digital technology can create new ways for workers to find employment in tourism by supporting digital marketplaces where consumers hire workers directly and on demand, as exemplified in the on-demand and ride-hailing economy (led by the

likes of Grab and Go-Jek in the region). Mr Hakobyan explains: “The stereotype attached to AI is that it is killing jobs and those who lose jobs become perennially jobless, but we forget the creating part.” These tools have also made revolutionary changes to public transport, which benefits tourism by making it easier for visitors to travel and pay for transport.

Nonetheless, the disruption caused by new digital technologies does create policy challenges. For instance, ride-hailing apps have upset taxi drivers across the South-east Asian region, and many governments have struggled to regulate these companies. In order to make the most of digital opportunities, Dr Ernst emphasises that it will be important to provide public support for workers to transition to new jobs created by technology, including connecting jobseekers with employers and facilitating internal migration. Dr Ernst adds that AI can support this process through data analysis to help match individual workers to jobs.

We expect demand for tourism to remain strong in the baseline and across the “Ox”, “Bees” and “Elephant” scenarios, given the positive impacts on global GDP (and possible increases in leisure time) that may come with the deployment of AI worldwide. This demand highlights the importance of maintaining the competitiveness of Thailand’s tourism industry, which will require effective AI deployment and efforts to train workers for new roles, especially those moving out of the agricultural sector (where a large exodus of workers is expected). As with healthcare, digital start-ups should be able to help Thailand’s tourism industry to make the best use of cutting-edge digital technologies.

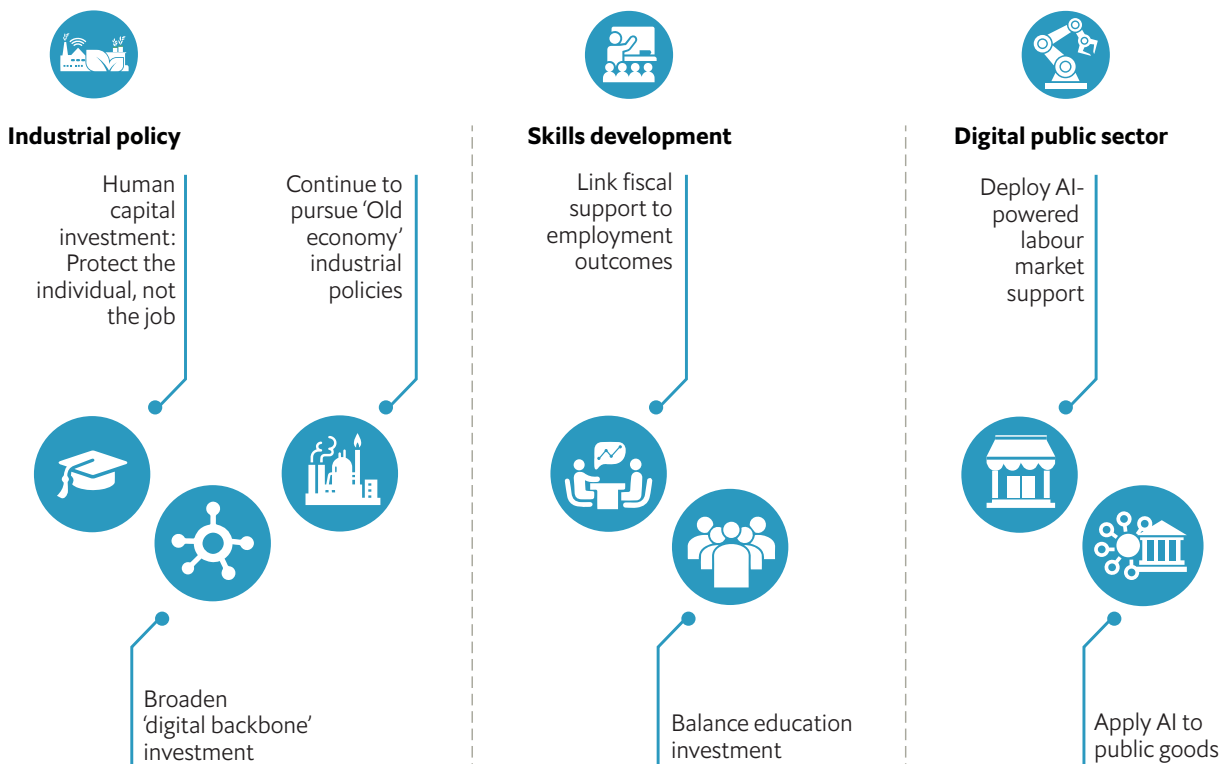
Many jobs in tourism do not require high skill levels, which means that the industry may flourish across all three scenarios. In the “Ox” scenario, low-skilled jobs in tourism may become a refuge for workers who have been displaced by automation,^{XVIII, XIX} although some low-skilled jobs will be automated (e.g. taking guests’ reservations). However, Thailand may only be able to fully achieve its tourism goals in the “Bees” and “Elephant” scenarios. Thailand is currently facing ecological constraints to its tourism development, and a key part of the government’s tourism strategy is to shift its focus to higher-income tourists. This may require tourism workers with strong customer service skills, who would only be available in scenarios that support strong skills development efforts.

Harnessing Automation for Thailand: Policy Insights

Our analysis shows potentially large differences in GDP, employment and productivity across the “Ox”, “Bees” and “Elephant” scenarios. In particular, it shows that failure to develop either workers’ skills (as in the “Ox” scenario) or industrial policy (as in the “Bees” scenario) will have significant negative consequences for Thailand. The scenarios also show important changes in the relevance of agriculture, services and industry to Thailand’s economy. In order to prepare for these scenarios, Thailand’s policymakers will need to tailor their industrial policy and skills development approaches to boost the competitiveness of Thailand’s economy and the skills of Thai workers, focusing their efforts on industries where Thailand is likely to have the greatest opportunities in the future. To support such efforts, we outline several policy implications that are relevant across all scenarios.

Figure 12: Policy implications

Policy implications



Source: The Economist Intelligence Unit

Industrial Policy

All three scenarios demonstrate that it is important for Thailand to develop and implement industrial policies that not only encourage the adoption of AI, but also boost growth and competitiveness more broadly. The following policy implications could support such efforts.

1. Human capital investment: protect the individual, not the job. All three scenarios involve job displacement, highlighting the inevitability of labour market churn and disruption due to technological change. The more globalised an economy, the more it will be affected by technological developments taking place elsewhere. This means that policymakers cannot resist new technologies, nor should they try to shore up specific industries, companies or job types that will not survive the AI age. Instead, they should focus on ensuring that the population is well equipped to seize opportunities and thrive in an increasingly knowledge-intensive global economy.

2. Continue to pursue “old economy” industrial policies (in addition to “new economy” policies). Thailand will need to encourage AI adoption in the coming decades, but this is just one aspect of industrial policy. Policies will also be needed that allow firms to compete with the world’s most successful economies. In particular, infrastructure investments and incentives will be needed to provide boosts to the country’s growth, and clusters will need to be created through the use of specialised industrial zones. Deeper integration with the rest of the region (particularly China and other ASEAN members) will also provide opportunities for exports and industrial development. This can be achieved by deepening trade agreements and removing non-tariff barriers to spur trade within the AEC, and by strengthening transport infrastructure links (e.g. overland routes to China).

In addition, Thailand can seek to simplify and streamline regulations to reduce the cost of compliance for businesses, including using software and AI to improve company–government interactions. Thailand’s scores in the World Bank’s Doing Business index are above the average for middle-income countries, ranking 27th overall out of 190 economies, above the likes of Spain, France and the Netherlands.^{XX, XXI} However, the country does have areas of weakness, particularly trading across borders (for which it ranks 62nd) and paying taxes (for which it ranks 68th). Both of these areas are relevant to international business location decisions, and tax issues in particular can be substantially aided by the use of software and AI. Some countries are already using automation to

improve their business environment. For example, Estonia has used digital systems to improve court and judicial processes. Thailand can also boost the overall efficiency of its economy through well-managed spectrum licensing and by rolling out 5G connectivity.

A stronger innovation ecosystem, enabled by more efficient IP protection, can help to encourage local and global firms to invest more in R&D. While Thailand is a member of both the World Trade Organisation (WTO) and the World Intellectual Property Organisation (WIPO), evidence shows that its implementation of IP protection has declined over time, as indicated by its rankings in the World Economic Forum's Global Competitiveness Index.^{XXII} In this index, Thailand ranks 50th for overall innovation capability, with low scores for innovation-relevant indicators such as patent applications and trademark applications, social capital, and information and communications technology (ICT) adoption and skills. At the same time, however, Thailand's private sector is ranked as innovative on metrics such as companies' willingness to embrace disruptive ideas and attitudes towards entrepreneurial risk.^{XXIII} This apparent disconnect indicates that policy restrictions may be holding the private sector back.

3. Broaden “digital backbone” investment. As outlined in the three scenarios, Thailand needs a flourishing digital economy to maintain its level of employment in the future. To achieve this, Thailand needs to make sure that it invests in infrastructure that will allow its digital economy to compete, such as 5G telecommunications infrastructure. A strong legal framework that encourages private investment in such infrastructure will also be important.

Thailand also needs to bridge its “digital divide” so that more Thais have opportunities to transition to jobs in the digital economy. Internet access is far from universal in Thailand, so a focus on improving access in rural areas and small towns and cities will be necessary.^{XXIV} Jonathan Wong, chief of technology and innovation at the United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP), emphasises that this is crucial to ensure that AI-augmented public services are inclusive, and that small businesses are not left behind. Once this has been achieved, the government can digitise more of its public services to benefit the whole population.

Skills Development

As our scenarios and case studies demonstrate, skills development is critical to help displaced workers find new employment and to support economic growth. The contrast between the “Ox” and the “Elephant” scenarios highlights that developing workers’ skills can have a substantial, positive impact on GDP, in addition to the usual benefits of effective industrial policy. However, if reskilling is to lead to new jobs, workers will need to receive training in relevant skills and industries, which are likely to change as sectoral shifts take place within Thailand’s economy. The following policy insights focus on promoting reskilling for Thailand’s industries of the future—a strategy that will benefit both employment and growth.

1. Link target subsidies and fiscal support to employment outcomes, including hiring and upskilling. Helping companies to upskill their workforces can ensure that the private sector leads employment growth. Amazon, for instance, has published an “Upskilling 2025” programme that includes software engineering schools to teach people how to code; paid study time for warehouse staffers to achieve credentials to work as IT support technicians; and coverage of 95% of tuition costs in occupations outside its core business, including nursing and aircraft mechanics.^{XXV,XXVI} Governments can support companies in such efforts by providing tax credits for SMEs that invest in reskilling workers, workforce development boards that help colleges and schools customise offerings to suit the needs of emerging industries, and grants for mid-career apprenticeships (following the examples of Germany and Switzerland, which are world leaders in leveraging the apprentice model). They could also look to government–union–industry collaboration models. In the United Kingdom, for example, workers are offered retraining that is relevant to the challenges of both automation and the greying economy.^{XXVII}

Our analysis also shows that there will be significant shifts in employment, particularly as workers move out of agriculture. Thailand will need to ensure that retraining efforts target workers who are at high risk of losing their jobs, whether through automation or other economic shifts. Based on the improvements in agricultural and services productivity that are expected in the “Ox” and “Elephant” scenarios, these are likely to include low-wage agricultural and service workers (e.g. low-wage retail and hospitality workers).

2. Balance education investment across primary and secondary spheres to create an adaptable labour force and encourage entrepreneurial mindsets. Thai students perform at the low end of Asia's rankings for the OECD's PISA.^{XXVIII} Analysis by the organisation reveals especially low scores for collaborative problem-solving, and for cumulative expenditure by educational institutions per student aged 6 to 15.^{XXIX} Collaboration is a domain in which humans' interpersonal skills, perceptions and emotional intelligence are far more advanced than AI, which means that educational systems should be emphasising this capability. Thailand should strengthen its curricular focus on 21st-century skills such as creativity, applied learning and problem-solving, representing a shift away from memorisation and towards the development of deeper cognitive skills. "The idea that people all need STEM (science, technology, education and mathematics) skills is overblown," says Dr Ernst. "We need engineers but we don't need to retrain everyone to become a software engineer and mathematics expert."

At the tertiary level, governments can provide financial and policy resources to support universities to develop disciplines such as computer vision, AI, industrial engineering and data analytics. Targeted interventions to support skill upgrades in high-potential industries could also be warranted—for example, business management skills for the tourism and healthcare industries. Governments can provide diplomatic support to help national universities build international partnerships with overseas centres of excellence, as well as offering supports such as fellowships, shared research initiatives and pooled funding. Public education campaigns to encourage more participation in university are also key, as recent data shows that only 230,000 people applied for 300,000 available places at Thai universities. This is partly a consequence of Thailand's ageing population, but it also reflects a broader international trend towards declining university participation as the quality of online learning improves and the cost of institutional tertiary education increases. In this environment, universities need to adapt to stay relevant. This could involve a shift in focus to retraining and reskilling people who are already in the job market, rather than focusing on a dwindling cohort of young people.^{XXX}

A Digital Public Sector

In order to successfully fulfil its role in skills development, the government may need to deploy AI to improve the provision of public services and strengthen policy analysis. For example, the government could invest in smart cities to deliver more efficient public services, and it could work with start-ups in promising areas (such as AI-powered job counselling) to match talent to opportunity. The following policy insights detail possible AI mechanisms for optimising governance and public services.

1. Deploy AI-powered labour market support. Countries that provide job support typically do so through state-funded employment agencies and counsellors. This can be costly and often involves long waiting times. In low- and middle-income countries, employment counselling is usually lacking. This can result in wasted talent and deepening inequality. Taking note of positive practices that have been implemented elsewhere, especially in Europe, governments can improve outcomes by fostering data innovation in job-matching. For example, digitised AI job counsellors could provide tips and suggestions for those who are out of work, including achievable retraining or relocation measures.

2. Apply AI to public goods. Automation and AI can improve the efficiency and effectiveness of public services by performing certain administrative tasks, freeing up government workers to focus on pressing policy issues. Examples of AI- and automation-powered public services include digital and electronic identity schemes at customs checks, blockchain for authenticating trade documentation, AI-based systems for spotting welfare fraud, rapid assessment of trademark and IP applications, and chatbots to garner citizens' views on public services and answer common questions.^{XXXI,XXXII}

As this report has highlighted, AI and AI-assisted automation are likely to have profound impacts on Thailand's economy and society. However, these impacts will be shaped by Thailand's response to these technological developments. This report has outlined the importance of developing and implementing effective industrial policy and taking strong action to develop workers' skills to ensure that Thailand can seize the opportunities AI and automation present. These policies and skills development efforts will need to take into consideration the economic changes that Thailand is undergoing, which will shrink some sectors and allow others to flourish. Policymakers need to prepare for both of these challenges by taking steps today that will enable the Thailand of tomorrow to reach its full potential.

Appendix 1: Modelling Methodology

Our results are based on a model of Thailand's economy, using a Cobb-Douglas production function. The Cobb-Douglas production function is widely used in the academic literature, including for estimating total factor productivity (TFP).¹ We selected the Cobb-Douglas production because it has a number of desirable features that mean it offers a good description of an actual economy-wide production function. In particular, Cobb-Douglas production function factors can be substituted for one another to maintain production; the marginal product of any factor of production decreases as that factor increases relative to GDP, and it increases as more units of other factors employed in the economy increase (holding other factors and parameters constant).² Modified production functions have been used previously to study the macroeconomic impacts of AI and AI-assisted automation.^{XXXIII}

Computer capital is separated out from the rest of capital to allow for assumptions regarding the level of computer capital investment and its productivity.

The equation is as follows:

$$Y = \alpha * K^\beta * H^\rho * M^\gamma$$

Y is output (GDP).

α is total factor productivity.

β , ρ and γ are the output elasticities of non-computer capital, labour and computer capital, respectively.

K is non-computer capital.

H is human labour.

M is computer capital.

1 For example, see: Md. Zobaer Hasan et al. 2012. "A Cobb Douglas Stochastic Frontier Model on Measuring Domestic Bank Efficiency in Malaysia." PLoS ONE 7(8): e42215. [<https://doi.org/10.1371/journal.pone.0042215>]; Devesh Raval. 2015. "Beyond Cobb-Douglas: Estimation of a CES Production Function with Factor Augmenting Technology." World Bank. [<http://siteresources.worldbank.org/INTMACRO/Resources/jmp.pdf>]; Federica Saliola & Murat Seker. 2011. "Total Factor Productivity Across the Developing World." World Bank. [<http://documents.worldbank.org/curated/en/646931468157519398/pdf/682730BRI0ESN00LIC00Productivity023.pdf>].

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We estimated this model using an Ordinary Least Squares (OLS) model with robust standard errors, using historical data for Thailand’s economy to understand the relationships between these variables.³ In order to ensure that the estimated relationships were not out of date, we tested for structural breaks in the model. Where we found these, we used the coefficients obtained following the structural break. In addition, we used analogous equations to estimate changes to sectoral value-added. Using the same econometric approach, we estimated the following equation for employment at the sectoral level:

$$H_i = a_i * Y^{\theta_i} * K^{\tau_i} * M^{\omega_i}$$

Y, K and M are as above, while θ_i , τ_i and ω_i are parameters determining the elasticity of employment with respect to GDP, non-computer capital and computer capital, respectively, in sector i; and a_i is a constant (with different values for each i). We did not estimate employment for the whole economy because this is assumption-driven in the model.

We then combined the various equations into an interlinked model of the economy, as well as the relationships between total employment, GDP, sectoral value added, and employment and factors of production for Thailand.

Our assumptions for the “Ox”, “Bees” and “Elephant” scenarios were then applied to this model to simulate the outcomes.⁴ Those assumptions were as follows:

- For all scenarios: To simulate the effects of the future development of AI technology, we assumed a gradual increase in the productivity of computer capital to 2035, with each baht spent on computer capital adding progressively more to output as time goes on (reflecting how AI is expected to increase

3 Ordinary Least Squares (OLS) is a simple approach to econometric estimation. While alternative approaches are available, we selected the OLS method because we favoured simplicity and transparency for this report. One of the main challenges in using OLS is that it does not adjust for endogeneity in the regression. This may mean that our estimates of γ represent an upper-bound estimate of the true value.

4 The baseline is, however, based on The EIU’s core forecast for Thailand to 2035; the assumptions are outlined in the section on the baseline in the main body of the report. For further details on the EIU’s core forecast, please see information available on eiu.com. For further details on the EIU’s core forecast, please see information available on eiu.com.

the range of tasks that computers can complete, and the standard to which they can complete them). Due to the development of AI technology and AI-assisted automation, 30% of workers are gradually replaced by computers by 2035 and become unemployed (60% of jobs are automated, but half of these workers are placed in new jobs immediately). Among the workers who are laid off each year, 50% are assumed to find new jobs in the same year; the fate of the rest depends on the scenarios (as outlined below). These assumptions are based on projections from the ILO's 2016 report forecasting the extent of worker replacement in ASEAN countries as a result of computer-assisted automation.⁵ We reflect this worker replacement in the model by removing workers from the workforce in accordance with these assumptions, and then adding the number of computers that would be necessary to maintain GDP at the same level as before the workers were removed (having already applied our assumptions about the increase in the productivity of computers).

- For scenario 1: As in the other scenarios, 30% of workers are gradually replaced by computers by 2035, and the marginal productivity of computers rises significantly.⁶ Due to the failure to act on skills development, workers who are not placed in new jobs immediately are not able to subsequently find work. We applied these assumptions on computer productivity and worker replacement to all three scenarios (in addition to other assumptions, detailed below).

Due to the success of Thailand's industrial policy in boosting competitiveness, TFP growth transitions gradually towards China's level of TFP growth when it was at the same level of GDP per capita as Thailand under this scenario.⁷ We made this assumption because China is a

5 The relevant ILO report indicates that 15% of jobs are at low risk of AI-assisted automation (0-30% chance of automation), 41% are at medium risk (30-70% chance of automation) and 44% are at high risk (70-100% chance of automation). If we make the assumption that the distribution of jobs in each of these categories (with respect to the probability of automation) is evenly balanced around the mid-point, this would give us an expected value of around 60% of jobs being automated. If we further assume that 50% of workers are able to find new jobs in the short term (before 2035) without retraining, we end up with 30% of workers losing their jobs due to automation in the absence of retraining. We started the process of job replacement in 2017 because this was the last year for which we had observed actual data on hours of employment. For this reason, the declines in employment compared to 2019 (which is the statistic referred to in the report) are slightly less than those mentioned here. See: Jae-Hee Chang & Phu Huynh. 2016. "ASEAN in Transformation: The Future of Jobs at Risk of Automation." International Labour Organization. [https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---act_emp/documents/publication/wcms_579554.pdf].

6 The exact rise is determined by simulation exercises conducted by EIU.

7 Total factor productivity growth rates from China are drawn from the period of 2011 onwards (the period when China's actual GDP per capita was the same as Thailand's projected GDP per capita in our model).

recent example of a country achieving strong industrial policy success, leading to higher exports, which is what we are assuming happens to Thailand in the “Ox” scenario. We applied the change to TFP so that we could allow the model to reflect the dynamics affecting labour and computer capital due to technological progress and worker replacement.

- For scenario 2: As in the other scenarios, 30% of workers are gradually replaced by computers by 2035, and the marginal productivity of computers rises significantly. However, due to industrial policy failures and declining demand for Thailand’s exports, which are assumed in this scenario, TFP declines gradually and is 10% lower than it would have otherwise been. Due to worker retraining and job placement efforts, 90% of workers who become unemployed transit into new jobs by 2035. We also assumed an increase in worker productivity in line with estimates from the literature on the productivity impact of worker training programmes, which would take place gradually, and the transition of 40% of the AI-replaced workers who do not find jobs immediately into new jobs by 2035 (so that 90% of laid-off workers will be in new jobs by 2035).
- For scenario 3: This scenario combines the positive aspects of the “Ox” and the “Bees” scenarios. Again, 30% of workers are gradually replaced by computers by 2035, and the marginal productivity of computers rises significantly. TFP growth transitions gradually towards China’s level of TFP growth at the same level of GDP per capita (from 2010 onwards). Due to worker retraining and job placement efforts, 90% of workers who become unemployed due to automation transit into new jobs by 2035, and worker productivity increases in line with estimates from the literature.

Appendix 2: Model Results

Table 1: The model outputs

Category	Indicator	Value in 2035			Elephant
		Baseline	Ox	Bees	
GDP	GDP	US\$772bn	US\$851bn	US\$726bn	US\$1,041bn
Sectoral value added	Agriculture	US\$48bn	US\$64bn	US\$58bn	US\$68bn
	Industry	US\$295bn	US\$272bn	US\$248bn	US\$361bn
	Services	US\$429bn	US\$515bn	US\$420bn	US\$612bn
Employment Full-time (equivalent)	Total employment	29.6m	27.3m	36.3m	36.3m
	Agriculture	8.6m	4.3m	8.1m	7.2m
	Industry	6.3m	8.8m	10.0m	12.3m
Productivity (US\$/hour)	Services	14.7m	14.2m	18.2m	16.8m
	Whole economy	\$13	\$16	\$10	\$15
	Agriculture	\$3	\$8	\$4	\$5
	Industry	\$24	\$16	\$13	\$15
	Services	\$15	\$19	\$12	\$19

- ^I Economist Intelligence Unit. 2018. “Risks and Rewards Scenarios Around the Economic Impact of Machine Learning.” [https://perspectives.eiu.com/sites/default/files/Risks_and_rewards_2018.2.7.pdf].
- ^{II} Jae-Hee Chang & Phu Huynh. 2016. “ASEAN in Transformation: The Future of Jobs at Risk of Automation.” International Labour Organization. [https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---act_emp/documents/publication/wcms_579554.pdf].
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