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Economic Impact of Artificial Intelligence: New Look for the Macroeconomic Assessment in Asia-Pacific Region

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ABSTRACT

Objective: To determine the impact of artificial intelligence (AI) on the selected economies in the Asia-Pacific region. **Methods:** This secondary research collected data from macroeconomic and AI-specific data sets. The sources of data from which insights were gained included digital technology sectors and corporations and their functions. The focus was on the need to assess the capability of AI on business operations The macroeconomic data was collected from data resources of international organizations' including the World Economic Forum, the Organization for Economic Co-operation and Development (OECD), the World Intellectual Property Organization (WIPO), and the International Telecommunication Union (ITU). In addition, this study has considered 19 economic indicators to analyze the economic outcome of AI in selected economies of Asia-Pacific. **Results:** From the results, the period between 2014 and 2016 witnessed China leading with over 25,000 citable documents on the AI topic. Regarding institutions that were observed to publish over 500 times on the AI topic, the countries in the ascending order include China (600), Hong Kong (1,100), and Singapore (2,000). As such, this study established that Asia-Pacific economies such as Hong Kong and Singapore though have smaller populations, but the majority of their higher education institutions have made a significant contribution to AI research; with the small economies also having a relatively higher number of computer scientists among the top 1,000 individuals. Additionally, through empirically analyses, during 1998–2016 with annual observations, it is found that various economic outcomes of AI were presented in 8 economies of targeted region. **Limitations:** At first, the future outlook of AI is just discussed in conceptual meaning while empirical context still needs to be examined in upcoming studies. At second, covering the overall South Asian region provides better findings with more generalization which is missing in current research. At third, other dimensions of AI and economy like implication of AI impact index and its relationship with macroeconomic variables is also missing in current research which could be reconsidered in coming studies. **Conclusion:** It is evident that AI exhibits the potential to be the main driver of Asia-Pacific's economic growth. Relative to the net and gross effect of AI on labor markets and the gross domestic product (GDP) of the top Asia-Pacific economies demonstrate that by 2030, AI might yield a 16-percent increase in output, translating into an estimated amount of $13 trillion. Overall, it is concluded that Asia-Pacific, when compared to developed regions such as North America, is lagging but the availability of a large pool of user data implies that the region can move ahead—given better resource and talent allocation.

1. INTRODUCTION

Artificial Intelligence (AI) has transformed almost all aspects of the human life in this knowledge millennium. The domains that have witnessed the growing influence of AI applications include the automobile industry with the emergence of driverless cars, media and communication through news feeds, business operations by influencing consumers' buying decisions and behaviors, and last, but not the least, in the field of telecommunication through digital device functionality [1]. Sectors that have incorporated AI concept in their operations include healthcare, law, transportation, education, retail, and financial firms, all of which have established and developed their in-house AI capabilities. Economically speaking, given that the introduction of such technologies calls for high levels of talent, time, and adaptability (as well as sizeable investments) [2], it becomes imperative to discern whether AI benefits (such as perceived cost reductions and the creation of new talent pools) have outweighed the costs incurred, especially in the Asia-Pacific.

AI has although endangered the risk of disruption due to automation, but it has stopped repetitive roles in sectors like healthcare, IT, financial services, manufacturing, transportation, retail packaging, and shipping. For instance, AI in retail is set to $340bn in

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cost-savings according to a new study by Capgemini. The report found that just 1% of retailers have so far managed to achieve this level of deployment and once more retailers adopt AI applications on sales and marketing across the value chain, there is likely to be a greater impact.

The impact of technology and automation has resulted in greater output and less time at a lower cost. Accounting firms and banks now need less time to handle bill paying, accounts receivable, financial reporting, and other accounting tasks. With the time saved, companies can reduce the number of accountants (manpower) or re-train the existing ones to work on more strategic tasks, thus giving rise to new talents and skills. As an estimate employees who saved 240 hours due to automation return $9,240 in value to their employers. In healthcare, for example, unnecessary tests and procedures cost U.S. consumers a $210 billion a year. A patient receives medical treatment from multiple service providers, making it difficult to effectively organize a treatment schedule. AI, however, can spot duplicate procedures in the scheduling process and reduces scheduling errors as well. Several hospitals and healthcare centers have automated up to 80 percent of their preregistration-related tasks, such as inputting new patients' health history. As a result, productivity has increased by 60 percent while errors have been reduced. Staffers time has been reallocated which was earlier spent on menial tasks

In general, some of the areas that have been projected to realize improvements, upon embracing AI, include sociopolitical dynamics, economics, and the uplifting of the standards of security [3]. This paper examines the concept of AI in relation to its capacity to shape the future of economics in Asia. A substantial economic distortion has been predicted to result from the AI market, especially in the Asia-Pacific context [4]. Studies between 2015 and 2017, suggested the reallocation of talent pool and skills within companies resulting in financial benefits from AI to stretch from $6 billion to $136 billion [5]. Based on these statistics, it is evident that the average annual growth in the Asia-Pacific context the AI market projections stand at 47.71%.

For instance, UNCTAD [6] and Agrawal, Gans, and Goldfarb [1] reiterate that sectors that have been hit the hardest include automobile and repetitive task-related operations such as administration, manufacturing, transport, and retail. Studies have also focused on predictions of the largest beneficiaries that might emerge from the projected growth of Asia-Pacific's AI markets. According to Berg, Furrer, Harmon, Rani, and Silberman [7], some of these areas include science and technology, business services, education, health care, and telecommunications. Indeed, these assertions are important whereby they increase the understanding about the projected trends in the Asia-Pacific AI market. A few areas might experience detrimental outcomes while other sectors are likely to experience positive results—relative to the perceived growth in the AI market.

Questions that arise are about the current trends in AI within Asia and the future of Asia's Economy in relation to the moderating role played by AI in the region. Given that some of the challenges facing Asia's major economic players (in relation to the incorporation of AI applications in various sectors of the economy) are yet to receive in-depth analysis, this study is poised to contribute to the literature by giving further insight into the debate of AI *versus* country and continental economics, which remains inconclusive.

In this paper, the motivation is to determine whether these trends might hold for Asia-Pacific in the entirety—regardless of country demographics and socio-economic and political statuses, or that the impact that AI might have on the economic might be country-specific and differ from one area to another. A question that arises is whether these trends operate in all countries, or each Asian zone exhibits unique characteristics regarding the relationship between AI implementation and a country's economy. It is also important to examine the challenges that these countries might face in relation to AI implementation in Asia-Pacific region. This study aims to discern some of these factors that might (otherwise) play a moderating or predictive role in shaping the correlation between AI and the futures of the Asia-Pacific countries' economies. These factors include such AI-based solutions like Automated Supply Chain Optimization, Infrastructural Maintenance System, Price Optimization & Costs Cutting, Remote Surveillance, and Curbing Global Warming. These factors could be explored through AI Applications like Supply Chain Management, Statistical Learning, Object Detection, Inventory Management, and Pattern Recognition, much useful for any economic infrastructure.

2. LITERATURE REVIEW

Carbonero, Ernst, and Weber [8] stated that in near future, Asia is likely to realize economic gains due to a significant increase in AI-powered products' consumer demand. Cockburn, Henderson, and Stern [9] reported further that China was likely to be the largest beneficiary as it dominates the AI market in Asia-Pacific by as high as 70 percent. These findings concur with those that were established by Cohen [10], who held AI-enabled automated transportation responsible for this increase; or by De Backer, DeStefano, Menon, and Suh [11] who also confirmed that China was likely to embrace fleet-wide traffic flow through AI applications, hence elevating congestion levels [1,12–18].

De Stefano [2], highlighting the AI led Systems, accounts for a projected benefit that China might experience. These studies lead to the understanding that there is likely to be a positive correlation between AI implementation and economic growth in China and other parts of the Asia-Pacific region. Also, the findings are important because they sensitize audiences regarding specific ways in which the boost in country economics might be realized, due to the leading role of AI-related systems. Despite the informative nature of these observations, these studies falter in their findings as they do not highlight such challenges that AI implementation might pose to the countries' economics; a gap worth addressing. Additionally, the studies also do not document some of the features that might play a moderating role in determining the perceived beneficial effects of AI on the economies of Asia-Pacific, an issue that this study strives to address by determining specific factors that are worth considering while seeking to predict the future of AI and its impact on a country's economy in the future of Asia-Pacific.

With most of the Asian countries relying heavily on manufacturing, studies have suggested that an implementation of automated supply chain optimization is likely to prove beneficial to their economic performance, especially due to the perceived capacity of the optimization to generate faster outputs, with the latter exhibiting a direct correlation with economic performance [19–22]. Apart from the economic motivation, a few studies have also focused on the immense potential of AI in alleviating some of the challenges

linked with human development in Asia. For instance, Fujii and Managi [23] stated that AI has the potential to address challenges linked to global warming, illiteracy, sanitation, and hunger in the Asian region. Similarly, Furman and Seamans [24] established that AI might be incorporated in areas such as infrastructural maintenance systems and implementation of smart grid operations in Asia. Grabher-Meyer and Gmyrek [25], avowed that AI solutions can aid in cutting costs and also ensured that settlements in rural zones can gain access to power. Graetz and Michaels [26] even stated that AI implementation might solve hunger problem via the remote surveillance of settlements—before establishing schedules through which resources might be allocated efficiently.

It is also understood that literacy has been linked to country economics, some studies have also examined how AI shapes the literacy rate in regions such as Asia-Pacific also affecting the economy of this region. For instance, Logg, Minson, and Moore [27], have established that AI promises to improve the literacy rates via the adoption of interactive chatbots, in Asian countries, especially when they are used in classroom contexts—as they promise engaging teaching-learning scenarios. Similarly, there are studies with insights about other variables such as global warming, which affects the economy of different countries (due to the resultant financial demand and burden—as they respond to and grapple with adversities). It is most likely that the issue of global warming can be curbed through AI implementation; with Asia-Pacific region unexceptional [3,28] claims AI is a solution to global warming which tends to operate in such a way that it makes predictions regarding possible severe weather patterns, after having monitored global temperatures. Schwab [4] added the AI is capable of addressing the issue of global warming and restoring economic growth in the Asia-Pacific, paving the way for evacuation of residents, especially from areas that are predicted to be affected.

AI has employed techniques like statistical learning, machine learning, object detection, natural language processing (NLP), computer vision, speech recognition, and pattern recognition [7]. These techniques are utilized in various tasks including sensing distances of vehicles, recognizing speech in audio clips, recognizing faces in photographs, and translating languages [9,29–35]. AI applications aid in the induction of some degree of "intelligence" to provide room for computers to make sense of the data with which they are presented [8]. Given the rapid increase in computing data and power in the wake of increasingly powerful analytics, Agrawal, Gans, and Goldfarb [1] observed that AI has accelerated the ability of machines to perform more complex tasks (and more precisely). For instance, machine learning algorithms constructed by computers can now make predictions and establish patterns from complex data without necessarily being taught or programmed by humans explicitly [10]. Similarly, deep learning has now been documented as a machine learning sub-branch operating under the overall AI field providing room for computers to mimic the neural networks of the humans [11].

It has been noticed that in Asia-Pacific region, Technology includes (Machine Learning, Deep Learning, NLP and Computer Vision; Solutions include Automated Supply Chain Optimization, Infrastructural Maintenance System, Price Optimization & Costs Cutting, Remote Surveillance and Curbing Global Warming; Applications include Supply Chain Management, Statistical Learning, Object Detection, Inventory Management and Pattern Recognition. The flow chart (Figure 1) attempts to summarize the applications, technology, and solutions possible through AI in Asia-Pacific Region.

In addition, in the healthcare sector in Asia-Pacific, AI is likely to make a more positive impact. Stiglitz [5] asserts that AI agents promise to offer early diagnoses which in turn account for prolonged life expectancies. With AI-enabled blockchain technologies increasing financial security, [6], AI exhibits a positive correlation with economic development by providing a room for workforces to live a more productive, happier, and healthier life.

Previous studies have also documented negative effects which AI is associated with, including those that are linked to a country economy. For instance, Agrawal, Gans, and Goldfarb [1] observed that at a macro level, AI implementation is projected to account for a boost in the global net capital, which is observed to stand at about $15.7 trillion, outweighing the perceived costs which the AI system adoption is associated with.

However, other studies caution that AI implementation is likely to compromise a country's economy, especially in the Asian context. Likewise, Berg, Furrer, Harmon, Rani, and Silberman [7] warned that AI implementation might displace people out of their current job market, a situation that Carbonero, Ernst, and Weber [8], too, observed to be compounded by less likelihood unless the displaced individuals re-skilled themselves. Based on these findings, Cockburn, Henderson, and Stern [9] stated that AI implementation in the Asia-Pacific context could end up leaving thousands of citizens jobless, with Cohen [10] cautioning that transportation and manufacturing sectors might be the worst hit areas. However, De Backer, DeStefano, Menon, and Suh [11] are optimistic that AI-related jobs might be injected into the market and which would be highly specialized and engineering-related tasks. De Stefano [2] also inferred that AI implementation, if not approached cautiously, might prompt or widen the income equality divide; with Frey and Osborne [20] affirming that this divide would be a predictor of unstable societies, with no country's economy an exception [36].

Some studies have however documented the perceived limitation of AI systems. For instance, Frey and Osborne [20] observed that predictions or inferences of AI systems are based on same-distribution data, implying that systems are unlikely to predict trends in data that emanates from a different distribution. Also, AI systems have been observed to work on stochastic or probabilistic models [23], which imply that 100 percent accuracy is unlikely to be achieved [24]. However, recent studies document that in the current classic predictive models, images can be classified successfully with nearly 99 percent accuracy [25,37]. Examples include cases in which image recognition as an AI application has been used to detect patterns that are unlikely to be observed by naked eyes (and perform medical image analyses), read and interpret traffic signs (especially among autonomous cars), and locate fugitives (among law enforcement groups) [26,38,39].

For AI branches such as computer vision, the last six decades have witnessed increasing scholarly attention and support in many types of data. By feeding data to make predictions and train models, some of the AI-led evolutionary applications (especially those that are associated with machine learning as an AI application) include tsunami and earthquake prediction relative to the sequential data that is fed to AI systems, predictive maintenance of infrastructure, and financial analysis [27]. In Asia, many studies have documented that a majority of countries depend on outdated natural disaster

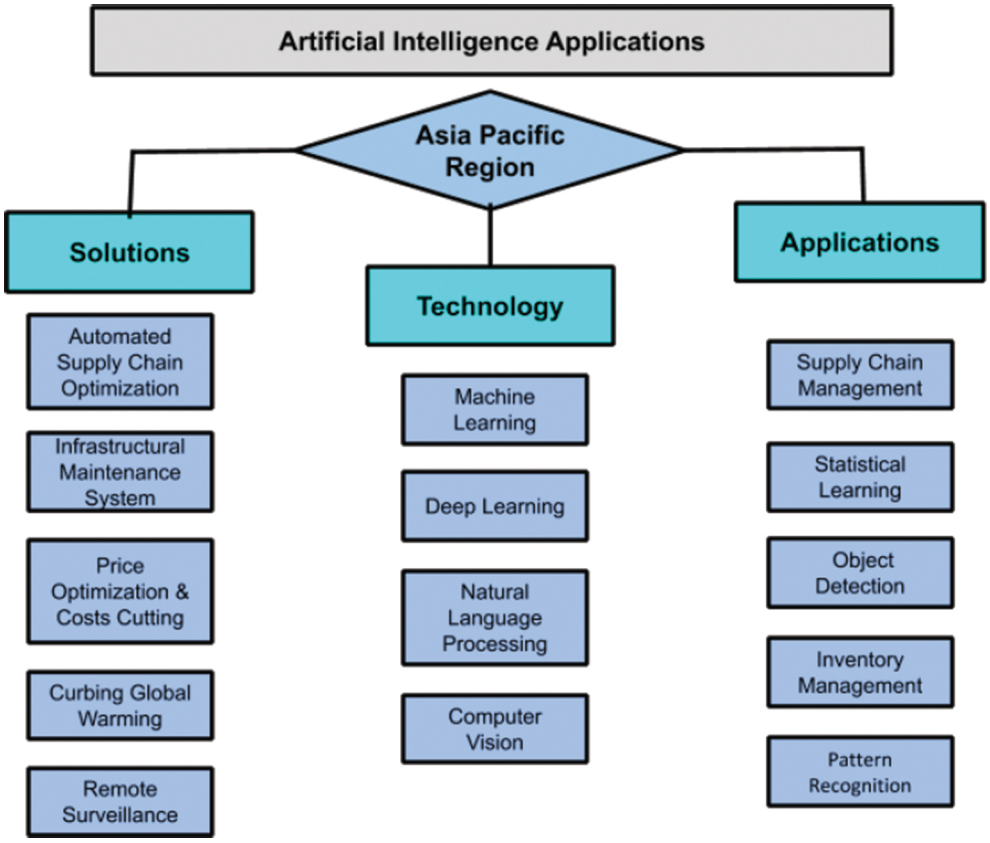

Figure 1 | Flow chart showing applications, technology, and solutions through artificial intelligence in Asia-Pacific region.
***Source*:** Researcher

prevention systems or infrastructure monitoring systems, implying that AI-led predictive infrastructural maintenance and earthquake predictions come in handy [28].

Fujii and Managi [23] affirmed that new incoming technologies might develop in response to AI implementation. If this happens, AI will not land in the hands of hackers and this challenge will be met. Given that the prevention of hacking also demands finances, Furman and Seamans [24] indicated that the relationship between AI implementation and the future of a country's economy in Asia-Pacific region remains balanced. From the perspective of comparative studies, some scholarly investigations have focused on the role of geographical characteristics and the future of the AI-based economy correlation. In one of such investigations, Grabher-Meyer and Gmyrek [25] sought to unearth how Asian regions can be compared with North America. Findings reveal that in the next decade, North America would be ahead of Asia—in relation to the rate of AI progress in talent acquisition. These findings are consistent with those reported by Graetz and Michaels [26], who stated that in Asia, one of the biggest setbacks facing AI implementation, was associated with the crippling AI talent shortage.

In order to justify these statistics, which suggest a perceived positive correlation between AI implementation and economic progress being superior in North America compared to the Asia-Pacific context, Logg, Minson, and Moore [27] stated that although, Canada and the U.S. collectively have over 10,000 AI specialists, India and China trail them with just 1,000 AI specialists. The MGI [28] established that China made an effort to catch up in relation to the volume of patents and publications in the AI space. However, Asia's highest priority is to secure better lifestyle and wages, issues which reportedly have stalled progress, especially due to the need for infrastructural and monetary investment by the Asian governments.

This Literature Review has given the opportunity to examine the current trends in AI implementation; hence this paper aims to give insights into future economies of the Asia-Pacific region, especially relative to the role of AI systems in shaping infrastructural systems such as trade, transportation, manufacturing, education, and health care services.

Figure 2 illustrates a 10-year projection of AI market revenues in Asia-Pacific. This shows a steady growth can be predicted in AI market revenues. However, several issues remain inconclusive. For instance, these projections do not highlight factors that might account for steady economic growth. Also, these projections do not give insight into challenges which the Asian countries' economies might face in relation to AI implementation. Lastly, the projections also falter as they do not determine whether the perceived steady growth in Asia-Pacific's AI market revenues (if it might hold) is likely to exhibit a direct or inverse correlation with the economic performance of the affected countries. Hence, there is a need to contribute to this inconclusive debate.

3. METHODOLOGY

With the primary aim being the examination of the potential impact of AI implementation on the future of a country's economy in Asia-Pacific, this secondary research collected data from macroeconomic and AI-specific data sets. The sources of data from which insights were gained entailed digital technology sectors and corporations. Additional data sources from which insights were gained included AI-based cases across functions and industries, especially due to the need to assess the impact of AI on business operations. For the collection of macroeconomic data, the study relied on international organizations' statistics concerning the AI-economic performance correlation. Specific data sources belonging to the latter category included the World Economic Forum, the Organization for Economic Co-operation and Development (OECD), the World Intellectual Property Organization (WIPO), and the International Telecommunication Union (ITU).

This study also examined the performance of tech startups in the Asian economy in the recent years, especially those that have been acquired, merged, or those that have received international funding. Since 2012, nearly $208B has been invested across over 8,500 equity deals to tech startups in Asia and the Pacific region, which stretches from China to New Zealand. A growing number of tech startups like Mercari, Go-JEK, Grab and Coupang have been revived in the Asia-Pacific region. Companies have devised new recruitment strategies for talent acquisition through their "aggressive" hiring plans. The principal recruitment and talent acquaiition is done in Asia-Pacific economies including Australia, China, Hong Kong, India, Japan, Singapore, South Korea, and Taiwan [7,20].

According to a Deloitte survey, new companies are founded with international funding. Gojek and Tokopedia, for example, are two local startups and a logistics company Lalamove in Hong Kong has already earned the market valuation of a unicorn and thus are able to compete on an international level as well. One of the most successful new companies in China "Ant Financial" has already been funded with about 14 billion U.S. dollars and the business-wide funding of startups in India amounted to 13.7 billion U.S. dollars [7,20].

This study has also relied on other secondary sources that have employed economic modeling and simulation technique because these approaches aid in discerning and predicting the possible impact that AI poses on the economy, especially in response to selected inputs and assumptions. These predictions have been conducted at the company, sector, and economic levels. It is also notable that this study's secondary sources of data that will be selected are those associated with solid results, having implemented multi-sample and double blinded approaches.

From the perspective of the study's methodological limitations and ethical issues, it is imperative to highlight that most of the secondary sources of data on which this study relies have embraced firm-level simulation. It is therefore imperative to indicate that this approach depends on the quality of the survey data used as inputs [3]. Two specific limitations were associated with firm-level simulations, which were used in this study's selected secondary sources of data. Firstly, the perception and knowledge of the respondents determined the responses of the survey questions. Given that the level of the participants' understanding of the AI concept (and how it shapes the economic performance of organizations) tends to vary, the quality of the insights gained from the selected secondary sources might be affected, with the data gathered through the survey. Secondly, most of the data obtained from previous survey results, which forms the backbone of this study, could be skewed towards early movers. According to Schwab [4], insight extrapolation from such findings tends to cause an overestimation of the impact of AI on country economics in settings such as Asia-Pacific, especially due to the affirmation that future waves of companies that might embrace AI are likely to exhibit different AI adoption behavior patterns. Hence, this study's results will be treated as those

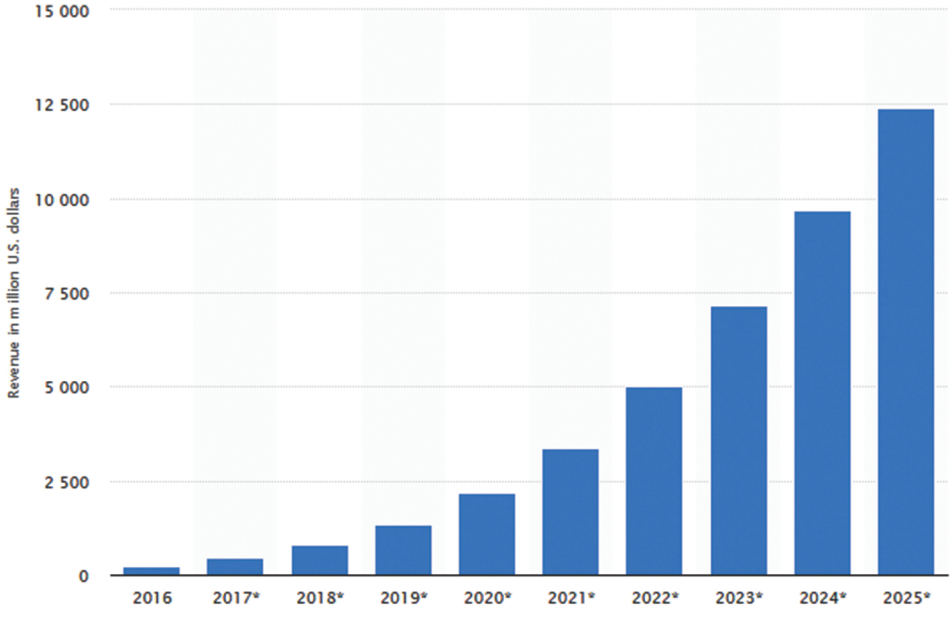

Figure 2 | Projected artificial intelligence (AI) market revenues for Asia-Pacific (between 2016 and 2025).
***Source*:** Agrawal, Gans, and Goldfarb [1].

that represent the upper bound of the estimated economic impact of AI implementation in Asia-Pacific, especially with the focus on the future of the region.

To address the limitations above, secondary sources of data were randomly selected. The eventuality is that results might be representative and worth relating to the rest of the research context and any sampling frame. Also, most of the results that were revealed secondary data from research processes that were funded by governments, agencies, or organizations, and which most likely focused on large sample sizes, hence carrying higher chances of reliability and reproducibility.

In the second phase, study has considered 18 macroeconomic indicators to check the economic outcome of AI with them. Time duration of the study considers the span of 1998 to 2016 with annual observations.

4. RESULTS

In this study, one of the specific areas under investigation entails AI preparedness of the economies of the Asian-Pacific region, as well as the impact that AI implementation might have on their future economics. Notably, the AI preparedness of these economies refers to their ability to exploit opportunities accruing from AI. The study has analyzed four key dimensions, which include AI publication volume, students enrolled science, technology, engineering, and mathematics (STEM) subjects of top-ranked universities', the venture capital accruing from leading AI startups in Asia, and the prevalence of overall startup activity. To measure startup activity, this study relied on the number of tech startups in the Asian economy, especially those that have been acquired and those that have received funding.

Based on previous surveys conducted by scholarly studies and reported by government institutions, most AI startups exist in India, followed by those in China. However, the number of tech startups in a developed setting such as the U.S. is about ten times of which was reported in these emerging economies [5]. Some of the other Asian economies that come after India and China include Singapore, Japan, and Taiwan. Whereas the latter economies exhibit similar numbers of tech startups, there is a relatively wide gap between their AI institutions and those in the top two economies.

Figure 3 summarizes these findings.

The results above were obtained from startups that focused on deep learning, machine learning, as AI applications, and those that have publicly disclosed equity funding for these areas. Such solutions like

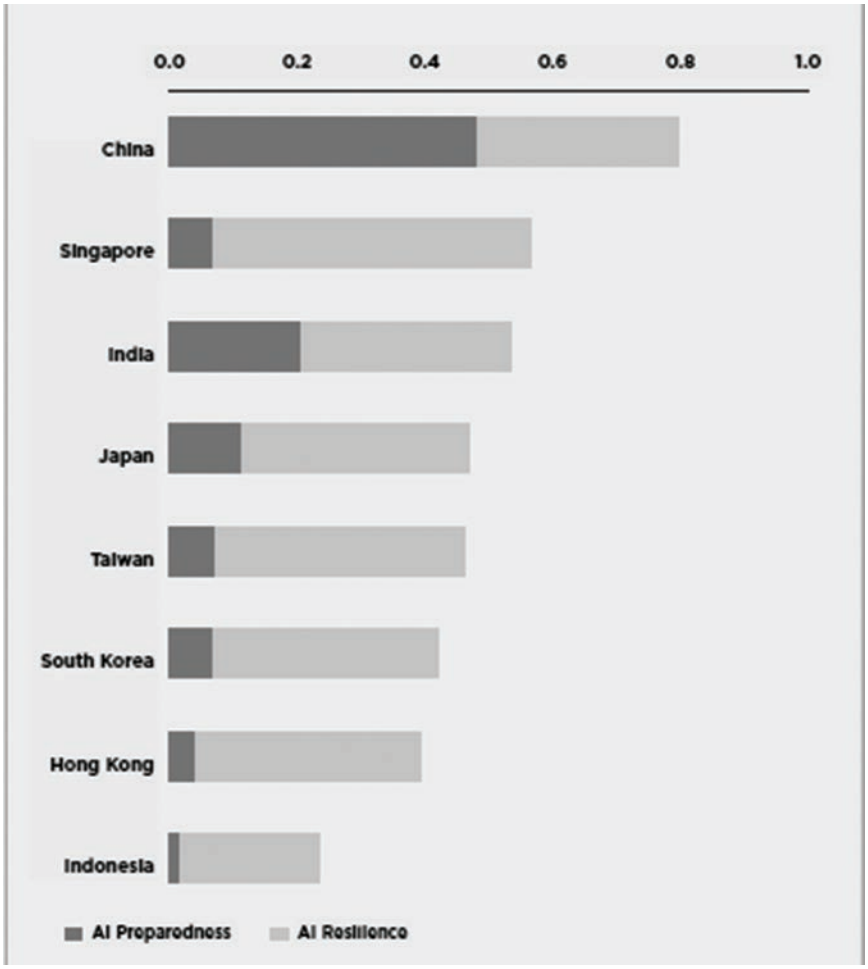

Figure 3 | Distribution of artificial intelligence (AI) tech startups in Asia's selected economies 2017.
***Source*:** Carbonero, Ernst, and Weber [8].

Automated Supply Chain Optimization, Infrastructural Maintenance System, Price Optimization & Costs Cutting were attempted by these startups to contribute to the economy of the region. Several AI applications were deployed including Supply Chain Management, Statistical Learning, Object Detection, Inventory Management, and Pattern Recognition.

To determine AI innovation quality, most of the previous scholarly surveys have used the number, quantity, or volume of citable documents; especially those that emphasize the AI topic in Scopus, which remains the largest database in the world—with peer-reviewed scientific publications (such as conference papers, reviews, and articles). From the results of the period between 2014 and 2016 China led with over 25,000 citable documents on the AI topic. Regarding institutions that were observed to publish over 500 times on the AI topic, countries in the ascending order include China (600), Hong Kong (1,100), and Singapore (2,000). As such, this study has established that Asia-Pacific economies such as Hong Kong and Singapore have smaller populations but the majority of their higher education institutions have made a significant contribution to AI research; with the small economies also having a relatively higher number of computer scientists among the top 1,000 individuals (Figure 4).

This study also investigated AI resilience among Asia-Pacific economies. The main objective was to determine the future ability of these economies to withstand and adapt to broader structural changes that AI might bring about, upon which the impact on their economies could be predicted. The role of the respective national governments' policies regarding AI implementation was particularly found to play a moderating role in determining the impact of AI on future economics of these countries.

Another factor that was discussed included the employment structures of these economies, especially those involving semi-skilled work employees; as these workforces have been documented to be vulnerable to AI disruption, hence economic shake-up had resulted [6]. In ascending order, findings revealed that South Korea, Japan, Hong Kong, Taiwan, and Singapore are more resilient to changes induced by AI. In the case of India, findings from previous surveys reveal that employment structure is less likely to be disrupted (immediately) by AI, yet it has less concrete policies. In relation to the Chinese context, surveys show that its economy exhibits more proactive policies towards AI advancement, yet its overall employment structure is more vulnerable to AI disruptions [40].

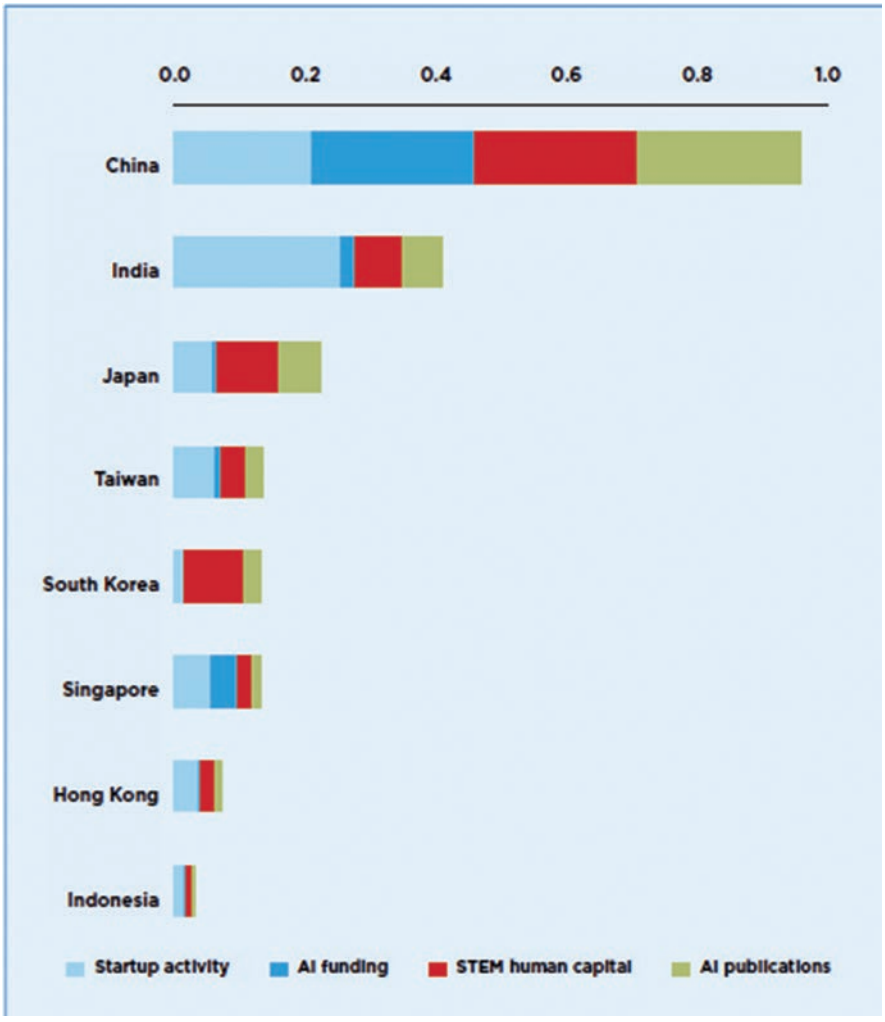

Figure 4 State of artificial intelligence (AI) preparedness in selected Asia-Pacific economies.
***Source*:** Cohen [10].

To arrive at these inferences, areas of government policy that this study has considered include government funding for AI development, AI-related tax subsidies or credits, and data openness. Additional parameters that this study has analyzed to discern the degree of AI preparedness among selected Asia-Pacific economies, which predicts possible economic disruption(s), include the AI systems' legal responsibility, social; safety nets, and policies related to job displacement. From the composite scores linked to these policies, which ranked the economies as having high, medium, or low AI resilience levels, the resultant outcomes have been summarized in Figure 5.

Based on Figure 5, sub-index results regarding the future of AI in Asia-Pacific holds that in ascending order, China, Japan, Singapore, and South Korea reflect more resilient economies with the most proactive government policies, which implies that they might be less disrupted by some of the AI-induced changes that might accrue (Figure 6).

5. DISCUSSION

From the results obtained in this study, it is evident that AI exhibits the potential to be the main driver of Asia-Pacific's economic growth. Relative to the net and gross effect of AI on labor markets and the gross domestic product (GDP) of the top Asia-Pacific economies demonstrate that by 2030, AI might yield a 16-percent increase in output, translating into an estimated amount of $13 trillion. Regarding activity growth, the results demonstrate that there might be about 1.2 percent increase due to elements such as the economic activities' negative externality-related baseline (including lost consumption during unemployment), technology implementation (including deploying AI solutions), technology transition costs (linked to an issue such as labor displacement), and AI-driven increase in GDP growth [4,24].

If the scenarios above materialize, the study predicts a significant impact of AI on Asia-Pacific economies. A specific area that is projected to gain from AI implementation involves economic prosperity. In Asia-Pacific, hunger could be eradicated via AI integration, especially through reforms in agricultural logistics, food production, and other operations of the agricultural sector. Specifically, it is predicted that sensor technologies, robotics, and AI incorporation will steer improvements in crop management and plant breeding. In transportation, AI incorporation is poised to improve safety in Asia-Pacific, especially based on the current signaling on tracks via advanced analytics and smart sensor technological applications.

A specific form of AI that might yield this beneficial effect is the case of Starling Crossing, which relies on several neural networks

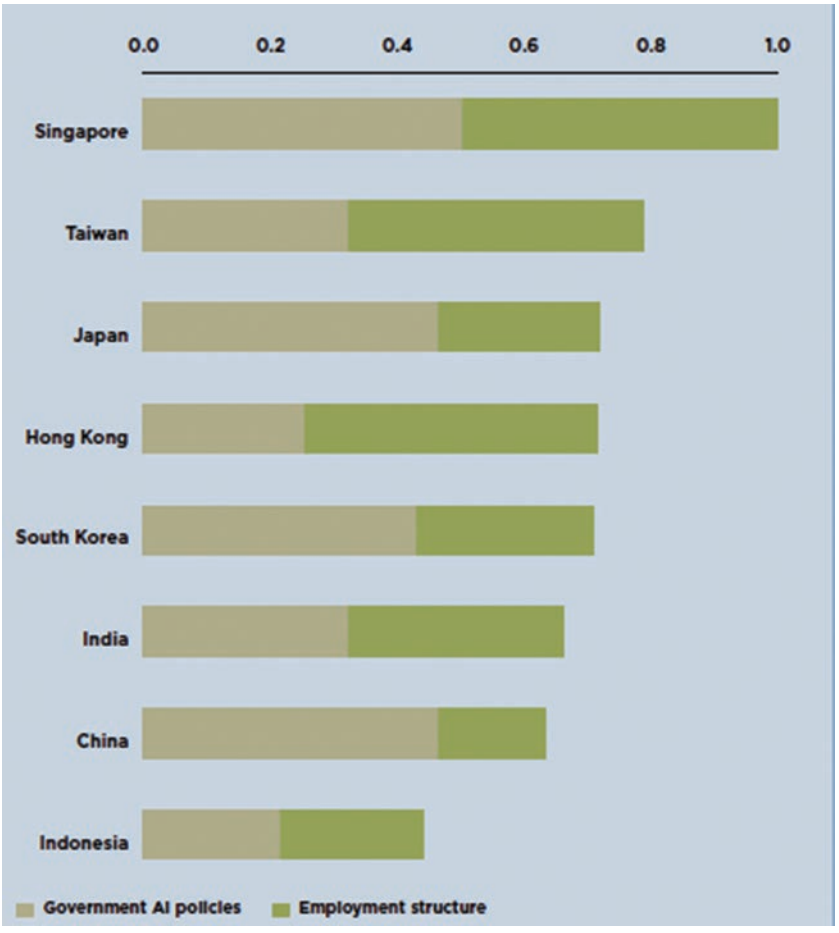

Figure 5 Composite scores depicting artificial intelligence (AI) resilience in selected Asia-Pacific economies.
***Source*:** De Stefano [2].

Figure 6 | Projected artificial intelligence (AI) value in different sectors of Asia-Pacific economies.
***Source*:** Fujii and Managi [23].

and cameras to monitor, vehicles, pedestrians, and other moving objects. Starling Crossing is essentially a road surface located in the south of London made up of LED-embedded plastic panels which illuminate crossing markings and warning sign in real time to different pedestrian and traffic conditions by modifying the configuration, patterns, and layout. It also judges the orientation and size of pedestrian crossings to make their safety a priority with the help of cameras connected to LEDs using neural network frameworks. The framework can distinguish between cars, bikes, and pedestrians through their trajectories, velocities, and exact locations. Through enhanced traffic flow, such AI applications can poise to improve economic productivity in Asia-Pacific.

AI integration into economic operations of a country's economy in Asia-Pacific is also projected to enhance environmental protection resulting in improved economic production. For instance, AI is likely to foster the efficient management of natural resources and also ensure that harmful activities are countered. AI can be exploited to optimize ecological control systems and water supplies by supplementing traditional infrastructural intelligence with digital intelligence. Companies like Pluto AI, IntelliFlux, Xaqt, and Rapid Flow Technologies offer predictive performance monitoring solutions for industrial processes and maintenance of assets. Their platform offers predictive analytics on water treatment for a better processing. For instance, Pluto exploits modern sensors for water treatment, optimizing in-house flows and managing in-house leakages. Pluto's predictive analytics for industry enables wastewater systems has optimized process automation technologies resulting in greater energy efficiency and lower operational costs. Hence with water, money, and time saved, AI systems are capable of boosting the selected economies of the region.

5.1. Empirical Assessment of Economic Impact of AI

To examine the empirical outcome of economic impact of AI in selected economies, comprehensive causal regression analyses are conducted and presented. Table 1 predicts the impact of AI on various economic dynamics in selected economies of Asia-Pacific. From overall economy of each state, total 19 macroeconomic indicators were selected, and effect of AI is observed. For energy and mining in Chinese economy, effect of AI is highly significant and negative, means that more productivity in the form of AI in Chinese economy is leading towards adversely affecting the energy and mining sector. For manufacturing and construction, this effect is significantly positive, means that more AI and related innovation has its constructive influence on overall manufacturing and construction sector of China. However, for transport and logistic, agriculture and forestry and fishing sector, impact of AI is significantly negative. For economic growth in terms of annual percentage value, AI has a positive and significant influence in China which means that more AI means more GDP growth and overall economic prosperity. Additionally, for the labor force it has an adverse effect, defending the argument that AI has reduced the labor efforts and workforce in Chinese economy. Meanwhile in health sector, it has a positive influence showing the evidence that it has a positive role towards health-related services in the form of advance equipment's and health care machinery. For overall social development, AI has shown an adverse effect. As the adverse effect on labor force is observed, it is further leading towards lower social development with less job opportunity due to higher innovative and automation work-related practices. additionally, high technology and exports have observed an increase due to AI in China, meaning that as a percentage of manufactured goods, high technology is directly influenced by AI.

In the economy of Singapore, sectors like energy and mining, manufacturing and construction, agriculture and forestry, GDP growth, labor force health sector, social development, and high-technology exports have shown a positive influence from AI. It means that out of first 9 sectors, eight have observed a constrictive effect with the increasing value of AI in Singapore. This empirical fact explains that the in the economy of Singapore, AI is playing its positive role with more economic outcomes and better economic growth rate. However, in the economy of India insignificant impact of AI on energy and mining and manufacturing and construction and social development is observed. Whereas other sector except labor force total have shown their adverse and negative influence by AI. It means that higher AI advancement in Indian economy has also negatively affected the labor market with low job opportunity and more unemployment. In the economy of Japan, economic trends of AI are found to be positive and significant for energy and mining sector, agriculture, forestry and fishing, GDP growth, health sector, social development, and high technology as well. Whereas, the sector like manufacturing and construction, transportation and logistics.

Table 2 provides the economic effect of AI on second panel of the study. It is observed that for Taiwan's economy effect on energy and mining, transportation and logistics, and social development is significantly negative by AI. While effect on GDP growth, health sector and high-technology export is found to be significantly positive, which states that all these sectors have observed a direct and positive influence by AI in the economy over a period of study. In addition, the economy of South Korea has observed a significant and positive economic outcome from AI in all first nine indicators. It means that selected sectors in South Korea are directly influenced by AI and advancement in Innovative capabilities which is causing an increasing in the economic growth, social development, exports of high technology, and other sector as well. However, in the economy of Hong Kong only the factors of social development, and economic growth and found to be positively and significantly determined by AI. It means that higher economic growth and more social development are the only two economic outcomes in Hong Kong as defined by AI. In the economy of Indonesia, the factor of economic growth in terms of GDP and health sector are positively and significantly affected by AI. It shows that more economic output and health-related facilities are observed in the Indonesian economy because of innovative capabilities and usage of robotic technology. However, rest of the sectors have shown their insignificant relationship with AI.

Table 3 provides the economic impact of AI while observing the remaining nine indicators for both Panel 1 and 2. In China, effect of AI on technology and media is found to be significantly negative which demonstrates its adverse influence. Similar case is observed for the overall industry of consumer goods, where AI impact is not good [41]. Additionally, in financial sector again the effect of AI is significantly negative [42]. However, for whole sale and retail industry, effect of AI is .941, showing a positive and significant influence at 1 percent. It means more usage of robotic technology means positive impact on wholesaling and retailing industry in China. In the economy of Singapore, it is observed that AI has a positive economic output while affecting consumer goods, wholesale and retailing industry, real estate, professional service, R&D and administrative service. This effect significantly indicates that under 2nd panel, most of the economic indicators are positively affected by AI in the economy of Singapore. Similarly, in Indian economy, this trend is significant and positive for the first four measures (technology, media and communication, consumer goods, financial sector, wholesaling and retailing) and for professional service and R&D as well [43]. However, the economy of Japan shows that economic impact of AI is only positive and significant for consumer goods and professional service with the coefficients of 2.410 and .0173 respectively.

Table 4 provides the economic impact of AI for the 2nd panel of the study. For Taiwan's economy impact of AI is found to be significantly positive for technology and media, consumer goods, financial sector, wholesaling and retailing, real estate, education sector, professional services and R&D. It states that all these sectors in Taiwan have a positive influence from innovation and usage of robotic services in terms of AI. However, overall administrative activities are significantly and negatively affected by AI in Taiwan with the coefficient of −.635 and standard error of .162. For South Korea, effect of AI on consumer goods and real estate, with R&D is found to be positively significant while effect on wholesaling and retailing, education, and professional services is found to be negative and significant. In addition, in the region of Hong Kong, economic effect of AI on technology and media, consumer goods, financial sector, wholesaling and retailing education and professional service is significantly negative. It means that there is an adverse economic effect of AI in the region of Hong Kong. For the economy of Indonesia, impact of AI on professional service, R&D and administrative activ-

Table 1 | Economic impact of AI (Panel 1).

VARIABLES	(1) Energy and Mining	(2) Manufacturing and Construction	(3) Transport and Logistics	(4) Agriculture, Forestry, and Fishing	(5) GDP Growth (Annual %)	(6) Labor Force, Total	(7) Health Sector	(8) Social Development	(9) High-Technology Exports (% of Manufactured Exports)
Economic Impact of AI For China									
AI	−2.708***	1.609***	−0.107***	−0.496**	2.089***	−1.512***	3.166**	−0.240**	5.094e+06**
	(0.616)	(0.316)	(0.0174)	(0.202)	(0.411)	(0.265)	(1.307)	(0.0944)	(2.061e+06)
Constant	24.57***	14.50***	0.908***	4.284**	18.23***	12.92***	2.668***	2.084***	4.344e+07**
	(4.308)	(2.212)	(0.122)	(1.416)	(2.878)	(1.854)	(0.412)	(0.661)	(1.442e+07)
Observations	18	18	18	18	18	18	18	18	18
R-squared	0.617	0.683	0.759	0.333	0.682	0.731	0.677	0.350	0.337
Economic Impact of AI: Singapore									
AI	0.278***	0.201**	−0.000405	0.0636**	0.193***	0.153**	2.275e+07***	0.0303***	3.762e+06***
	(0.0853)	(0.0764)	(0.000694)	(0.0248)	(0.0599)	(0.0550)	(7.343e+06)	(0.00886)	(1.068e+06)
Constant	−1.816	−1.207	0.0225**	−0.572*	−1.619*	−1.248	−2.085e+08**	−0.277**	−3.479e+07**
	(1.125)	(1.006)	(0.00915)	(0.327)	(0.789)	(0.725)	(9.680e+07)	(0.117)	(1.408e+07)
Observations	18	18	18	18	18	18	18	18	18
R-squared	0.399	0.303	0.021	0.291	0.394	0.327	0.375	0.423	0.437
Economic Impact of AI: India									
AI	−0.0219	0.303	0.475***	12.02***	26.43*	−0.159***	12.44***	3.185	0.190**
	(0.0206)	(0.231)	(0.0392)	(0.965)	(12.50)	(0.0413)	(2.550)	(6.285)	(0.0858)
Constant	2.826***	37.31***	28.79***	721.0***	2,403***	6.534***	716.4***	852.9***	17.38***
	(0.346)	(3.873)	(0.656)	(16.16)	(209.4)	(0.691)	(42.72)	(105.3)	(1.437)
Observations	18	18	18	18	18	18	18	18	18
R-squared	0.086	0.125	0.925	0.928	0.271	0.553	0.665	0.021	0.290
Economic Impact of AI: Japan									
AI	1.883**	0.0304	0.0304	1.773***	20.48***	0.0165***	3.527***	12.46***	0.0482***
	(0.699)	(0.136)	(0.136)	(0.273)	(6.433)	(0.00481)	(0.402)	(3.747)	(0.0158)
Constant	−13.91	66.18***	66.18***	−10.73	2,958***	0.168	584.5***	1,286***	12.65***
	(30.38)	(5.898)	(5.898)	(11.87)	(279.5)	(0.209)	(17.47)	(162.8)	(0.687)
Observations	18	18	18	18	18	18	18	18	18
R-squared	0.312	0.003	0.003	0.725	0.388	0.422	0.828	0.409	0.367

Notes. AI = artificial intelligence, GDP = gross domestic product
* 1%, ** 5%, *** 10%.

Table 2 | Economic impact of AI (Panel 2).

VARIABLES	(1) Energy and Mining	(2) Manufacturing and Construction	(3) Transport and Logistics	(4) Agriculture, Forestry, and Fishing	(5) GDP Growth (Annual %)	(6) Labor Force, Total	(7) Health Sector	(8) Social Development	(9) High-Technology Exports (% of Manufactured Exports)
Economic Impact of AI: Taiwan									
AI	−0.0119**	−0.00460	−0.000762*	0.00391	0.00732***	−0.0228***	0.000144	−0.00378**	0.00305***
	(0.00506)	(0.00683)	(0.000356)	(0.00232)	(0.00124)	(0.00659)	(0.000116)	(0.00129)	(0.000809)
Constant	19.74***	20.78***	1.422***	4.986***	3.403***	0.998***	0.116***	1.700***	1.557***
	(0.683)	(0.922)	(0.0480)	(0.313)	(0.167)	(0.0890)	(0.0156)	(0.175)	(0.109)
Observations	18	18	18	18	18	18	18	18	18
R-squared	0.317	0.036	0.276	0.192	0.744	0.499	0.115	0.416	0.542
Economic Impact of AI: South Korea									
AI	0.189***	0.0769***	0.00431***	0.0431*	0.0348**	0.00674***	0.00300***	0.0374***	0.0115*
	(0.0285)	(0.0219)	(0.00140)	(0.0216)	(0.0151)	(0.00132)	(0.000448)	(0.0104)	(0.00589)
Constant	17.31***	22.96***	1.249***	10.29***	4.707***	1.068***	0.208***	2.319***	2.082***
	(1.751)	(1.350)	(0.0862)	(1.330)	(0.928)	(0.0810)	(0.0276)	(0.638)	(0.363)
Observations	18	18	18	18	18	18	18	18	18
R-squared	0.733	0.434	0.371	0.199	0.250	0.621	0.736	0.448	0.192
Economic Impact of AI: Hong Kong									
AI	0.0245	4.244e+06	0.00345	−1.362e+07	0.392***	3.402	0.190	98.52***	−44.68
	(0.0228)	(5.894e+07)	(0.00791)	(2.130e+07)	(0.0397)	(30.97)	(0.145)	(22.3)	(558.0)
Constant	0.452	2.287e+09**	0.371***	1.450e+09***	3.234***	2,264***	20.90***	25,486***	84,399***
	(0.322)	(8.297e+08)	(0.111)	(2.998e+08)	(0.560)	(436.0)	(2.036)	(3,228)	(7,855)
Observations	18	18	18	18	18	18	18	18	18
R-squared	0.088	0.000	0.016	0.033	0.075	0.001	0.126	0.015	0.001
Economic Impact of AI: Indonesia									
AI	0.00208	2.746e+07	0.00622	5.881e+07	0.107***	0.767	6.615***	−25.47	7.550
	(0.00172)	(2.933e+07)	(0.00551)	(8.134e+07)	(0.0247)	(5.057)	(2.54)	(132.0)	(89.02)
Constant	0.890***	7.880e+09***	1.332***	1.480e+10**	8.051***	4,208***	3,768*	19,639**	105,431***
	(0.109)	(1.859e+09)	(0.350)	(5.156e+09)	(1.564)	(320.6)	(1,873)	(8,369)	(5,644)
Observations	18	18	18	18	18	18	18	18	18
R-squared	0.084	0.052	0.074	0.032	0.120	0.191	0.173	0.122	0.170

Notes. AI = artificial intelligence, GDP = gross domestic product
Standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3 | Economic impact of AI (Panel 1).

VARIABLES	(1) Technology, Media, and Communications	(2) Consumer Goods	(3) Financial Sector	(4) Whole and Retail	(5) Real Estate	(6) Education	(7) Professional Service	(8) R&D	(9) Administrative Activities
Economic Impact of AI : China									
AI	−0.0818**	−61.19***	−113.9***	0.941***	−0.0446	−0.0516	−0.0327	−0.108	0.0561
	(0.0354)	(17.89)	(33.27)	(0.275)	(0.0607)	(0.0447)	(0.0244)	(0.0872)	(0.0505)
Constant	14.11***	3,730***	6,939***	32.45**	74.24***	15.82***	2.119*	−3.499	92.19***
	(1.462)	(739.1)	(1,374)	(11.37)	(2.509)	(1.845)	(1.007)	(3.603)	(2.084)
Observations	18	18	18	18	18	18	18	18	18
R-squared	0.250	0.422	0.423	0.422	0.033	0.077	0.101	0.088	0.072
Economic Impact of AI: Singapore									
AI	0.722	1.558***	2.099	0.198***	0.0798**	0.0248	0.0418***	0.115**	0.0939**
	(0.582)	(0.214)	(1.575)	(0.0568)	(0.0340)	(0.0177)	(0.00566)	(0.0394)	(0.0411)
Constant	1.683	−0.515	2.791	−0.290*	−0.111	−0.0217	−0.101***	−0.169	−0.117
	(1.599)	(0.588)	(4.328)	(0.156)	(0.0935)	(0.0487)	(0.0156)	(0.108)	(0.113)
Observations	14	14	14	14	14	14	14	14	14
R-squared	0.114	0.815	0.129	0.503	0.315	0.141	0.819	0.417	0.303
Economic Impact of AI: India									
AI	2.449***	1.189***	5.629***	0.151***	0.0416	0.0247	0.0499***	0.0853**	0.0631
	(0.521)	(0.0851)	(1.224)	(0.0508)	(0.0275)	(0.0204)	(0.00363)	(0.0379)	(0.0393)
Constant	−1.536	0.255	−3.427	−0.0509	0.0342	0.0311	−0.104***	0.00257	0.0475
	(1.442)	(0.235)	(3.384)	(0.140)	(0.0760)	(0.0565)	(0.0100)	(0.105)	(0.109)
Observations	18	18	18	18	18	18	18	18	18
R-squared	0.580	0.924	0.569	0.355	0.125	0.084	0.922	0.241	0.139
Economic Impact of AI: Japan									
AI	−1.322	2.410***	−4.095	−0.228	−0.0773	−0.0343	0.0173***	−0.161	−0.172
	(1.088)	(0.464)	(2.962)	(0.151)	(0.0926)	(0.0426)	(0.00498)	(0.112)	(0.113)
Constant	10.39**	−2.272	32.75***	1.277**	0.394	0.209	−0.0383**	0.813*	0.843**
	(3.709)	(1.583)	(10.10)	(0.515)	(0.316)	(0.145)	(0.0170)	(0.381)	(0.384)
Observations	14	14	14	14	14	14	14	14	14
R-squared	0.110	0.692	0.137	0.159	0.055	0.051	0.501	0.147	0.163

Note. AI = artificial intelligence
* 1%, ** 5%, *** 10%.

Table 4 | Economic impact of AI (Panel 2).

VARIABLES	(1) Technology, Media, and Communications	(2) Consumer Goods	(3) Financial Sector	(4) Whole and Retail	(5) Real Estate	(6) Education	(7) Professional Service	(8) R&D	(9) Administrative activities
Economic Impact of AI: Taiwan									
AI	10,039***	12.51***	103,756***	703,732***	4.534***	1,204***	1,459***	0.584***	−0.635***
	(569.1)	(0.837)	(6,495)	(68,620)	(0.585)	(79.21)	(122.3)	(0.0333)	(0.165)
Constant	−29,077***	−31.19***	−297,643***	−1.978e+06***	−12.89***	−3,452***	4,264***	−1.263***	2.398**
	(2,937)	(4.320)	(33,521)	(354,130)	(3.020)	(408.8)	(631.4)	(0.172)	(0.853)
Observations	18	18	18	18	18	18	18	18	18
R-squared	0.951	0.933	0.941	0.868	0.790	0.935	0.899	0.950	0.480
Economic Impact of AI: South Korea									
AI	0.0593	14.55***	−0.138	−0.141***	4.886*	−0.515***	−0.710***	0.185*	−10,153
	(0.153)	(2.155)	(0.202)	(0.0271)	(2.762)	(0.0684)	(0.0655)	(0.0994)	(7,681)
Constant	32.33***	102.8***	59.00***	1.877***	−142.3***	8.531***	8.361***	52.01***	76,630*
	(0.773)	(10.87)	(1.021)	(0.137)	(13.93)	(0.345)	(0.330)	(0.502)	(38,745)
Observations	18	18	18	18	18	18	18	18	18
R-squared	0.008	0.706	0.024	0.586	0.141	0.749	0.861	0.154	0.084
Economic Impact of AI: Hong Kong									
AI	−11,446***	−10.92***	−104,764***	−647,306***	15.36***	−1,332***	−1,924***	3.222	2.600
	(1,696)	(1.401)	(13,127)	(91,011)	(2.022)	(186.8)	(282.9)	(2.264)	(2.089)
Constant	98,510***	101.1***	897,619***	5.562e+06***	−77.07***	11,484***	16,561***	−14.93	−11.39
	(12,855)	(10.62)	(99,479)	(689,715)	(15.32)	(1,416)	(2,144)	(17.16)	(15.83)
Observations	14	14	14	14	14	14	14	14	14
R-squared	0.791	0.835	0.841	0.808	0.828	0.809	0.794	0.144	0.114
Impact of AI: Indonesia									
AI	1.012***	−1.162***	0.140***	0.234**	1.060***	1.222***	−0.0611	−463.7	−520.8
	(0.0711)	(0.322)	(0.0163)	(0.0978)	(0.326)	(0.117)	(0.343)	(2,482)	(6,979)
Constant	25.19***	22.74***	6.089***	9.780***	46.80***	24.06***	16.11***	64,949***	179,063***
	(0.359)	(1.623)	(0.0840)	(0.493)	(1.644)	(0.591)	(1.729)	(12,521)	(35,206)
Observations	21	21	20	21	21	21	21	21	21
R-squared	0.914	0.407	0.803	0.231	0.357	0.851	0.002	0.002	0.000

Note. AI = artificial intelligence

* 1%, ** 5%, *** 10%.

ities is negatively insignificant. While remaining factors have shown their positive influence during the period of study.

6. CONCLUSION

In conclusion, Asia-Pacific's capacity to exploit AI, a largely untapped technology in the emerging economies, requires a large investment in research and development; which will make the region resilient to AI revolution (which is inevitable). In this way the benefited economies would be able to establish advanced technological infrastructures aiming to achieve AI research, with a particular focus on AI talent retention. In doing so, this study predicts that there will be capacity-building, besides driving down the cost of AI-enabled products. Overall, it is concluded that Asia-Pacific, when compared to developed regions such as North America, is lagging but the availability of a large pool of user data implies that the region can move ahead—given better resource and talent allocation. In addition, this study has empirically investigated the economic impact of AI in selected economies. To examine this relationship, nine economic indicators from various industries were selected and impact of AI was observed under two panel folding approach. Panel 1 consists of China, Singapore, India, and Japan. Whereas Panel 2 considers Taiwan, South Korea, Hong Kong, and Indonesia. Under panel 1, effect of AI on energy and mining is significantly negative for China and Taiwan, positive for Singapore, Japan, and South Korea. The economic impact of AI in the form of manufacturing and construction is significantly positive for China, Singapore, and South Korea. Meanwhile for transportation and logistics, economic effect of AI is negative for China, and Taiwan. For agriculture forestry and fishing, significant positive impact of AI is observed for Singapore, India, japan, and South Korea and negatively significant for China only. In terms of GDP growth, country like China, Singapore, India, Japan, Taiwan, South Korea, Hong Kong, and Indonesia have observed a significant and positive impact from AI. While negative influence for labor force is observed in China, India, and Taiwan. For the labor force, China, India, and Taiwan has observed the fact that AI has a negative influence. However, the factor of social development and high-technology exports have shown mixed economic outcome due to direct and indirect effect from AI. Additionally, economic effect of AI through technology and media, consumer goods, financial services wholesaling and retailing, real estate, education, professional services, R&D and administrative activities have also shown a mixed trend for all the entities under observation. These findings provides a significant evidence for theoretical, managerial, practical, and academic implications in current and future perspective. However, study has several limitations. At first, the future outlook of AI is just discussed in conceptual meaning while empirical context still needs to be examined in upcoming studies. At second, covering the overall South Asian region provides better findings with more generalization which is missing in current research. At third, other dimensions of AI and economy like implication of AI impact index and its relationship with macroeconomic variables is also missing in current research which could be reconsidered in coming studies.

CONFLICT OF INTEREST

There is no conflict of interest

AUTHORS' CONTRIBUTIONS

All the authors have equal contributions

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