

AI: Prosperity and Challenges

By the end of January 2023, just two months after the launch of ChatGPT, it had garnered 100 million monthly active users. Comparatively, TikTok took nine months to achieve the same user base. The unprecedented speed at which generative AI has exploded onto the global stage has sparked widespread interest in its potential to drive economic growth and catalyze a new technological revolution. However, echoing Robert Solow's famed "productivity paradox", despite AI's omnipresence, its impact is yet to be reflected in widespread profitability or productivity statistics. This paper delves into the evaluation of cutting-edge technology's future trends, drawing from existing theories and empirical evidence to analyze AI's effects on the economy, labor markets, and income equality. Moreover, it provides strategic policy recommendations for governments.

AI Driving Economic Growth

Economic growth traditionally hinges on three components: capital input, labor input, and technological progress. Over the long term, sustaining economic growth through heightened investment in capital input is impractical due to diminishing marginal returns. Additionally, labor force growth is constrained, due to the aging of the population and a substantial decline in fertility intentions at present. Consequently, long-term economic growth is primarily propelled by technological progress, which doesn't have diminishing marginal returns. Properly gauging technological progress enables us to predict the economic growth achievable by a country with locked-in capital and labor inputs.

Establishing a new classical production function under technological progress conditions ($Y=A(t)F(K,L)$), we can derive an economic growth model. This model indicates that the economic growth rate is determined by the growth rates of capital and labor, the output elasticities of capital and labor, and the changing technological conditions over time. Changes in technological conditions inevitably result in new production function. While the Cobb-Douglas production function treats technological progress as an exogenous factor in economic growth, the "new economics" internal growth theory formed in the 1990s argues that the long-term growth rate is explained by endogenous factors. These include human capital in the labor input process and technological progress formed through activities such as research and development and innovation. Technological progress leads to increasing factor returns, resulting in a positive long-term growth rate.

AI represents a significant advancement in science and technology, and it has the potential to become a key factor in global economic escape from slow growth. Numerous studies have used economic growth models to predict how AI will impact economic growth, including R&D endogenous growth model (Romer 1990, Aghion and Howitt 1992), automation substitution effects (Hanson 2001, Frey and Osborne 2017), task-based productivity effects (Acemoglu and Restrepo, 2018), skill premiums

(Lankisch, 2017), and AI endogenous growth model (Lu, 2021). In 2018, McKinsey modeled the global average level of AI technology adoption and absorption, estimating that AI could bring about an additional \$13 trillion in global economic activity by 2030, with cumulative GDP growth of around 16%, equivalent to an annual GDP growth of 1.2%. In 2023, based on the rapid progress of generative AI, McKinsey predicts that AI will generate annual global corporate profits of \$2.6 trillion to \$4.4 trillion (compared to Germany's 2021 GDP of \$4.36 trillion), excluding the business model and industry reshaping effects triggered by AI.

Despite limited data availability, existing research generally supports the positive productivity effects of AI. For example, Brynjolfsson and Hitt (2003) studied 527 U.S. stock data, Graetz and Michaels (2018) researched industry panel data on industrial robot automation in 17 countries, and He (2019), Fan and Liu (2021) studied provincial-level economic growth data in the country. Looking at the performance of the U.S. stock market in 2023, technology stocks repeatedly reached new highs, with seven technology stocks accounting for 85% of the Nasdaq's gains. NVIDIA rose more than 230% since the beginning of the year, confirming the wealth creation effects of AI's new technological innovations. Microsoft's leading advantage in AI is evident in its data, with the company revealing in the third quarter of 2023 that the use of AI technology increased Azure's revenue by 3%. While AI has not yet appeared on the income statement, it is expected that companies will increasingly disclose the measurable impact of AI on revenue in the future.

CUBE Research 'Q3 2023 IaaS Estimates vs "Actual"'							Key Points
Big 4 \$B	Wikibon Q3 '23 Estimate	Q3 '23 Actual*	Q3 '23 Growth Estimate	Q3 Actual* Growth	2023 Full Year Revenue (E)	2023 Y/Y Growth (E)	
AWS	\$23.2	\$23.1	13%	12%	\$91.6	14%	<p>'23 Big 4 total is 10% lower than our early '22 projections due to Azure re-statement</p> <p>Cloud optimization is still a thing; working against AI tailwinds</p> <p>Only Microsoft cited clear AI revenue impact of 300 Azure BPs this quarter</p> <p>We assume AI shows up in the Q4 #'s with a more meaningful contribution in 2024</p>
Azure	\$10.8	\$10.9	27%	28%	\$52.3	29%	
GCP	\$4.0	\$3.9	25%	23%	\$15.4	25%	
BABA	\$3.4E	\$3.4E	10%	10%	\$12.5	5%	
Total	\$41.3	\$41.2	17%	17%	\$171.8	19%	

Source: Wikibon 10/2023 based on company earnings reports & ETR survey data
 *Data in constant currency. Currency fluctuations & rounding may create variances from previously reported company financials

Reshaping the Labor Market

AI has four main effects on the labor market. Firstly, automation can directly replace labor. Secondly, AI can create new professions in emerging fields. Thirdly, AI helps some positions achieve higher work efficiency, enhancing production efficiency and reducing costs through its powerful data processing and predictive capabilities. Lastly,

income growth may increase the overall demand for employment in the economy. According to the "Future of Jobs: Big Language Models and Employment" white paper released by the World Economic Forum and Accenture in 2023, within the next five years, 23% of global employment positions will undergo significant changes, some positions will be replaced by AI to achieve automation, while at the same time, new professions such as AI data managers will be created. However, the impact of AI on the labor market is complex and interrelated, varying depending on region, industry, and employee skill levels. There are significant differences in the development level of AI, production elasticity, and labor supply elasticity in different countries, leading to diverse outcomes in the labor market impact.

Another point worth noting is that efficiency improvement and cost reduction do not necessarily stimulate more consumption. Human material needs have saturation points, but spiritual needs are difficult to measure. Future work will be disruptive, and we recommend modeling and predicting data on consumption of spiritual needs to assess the future economic value of this aspect.

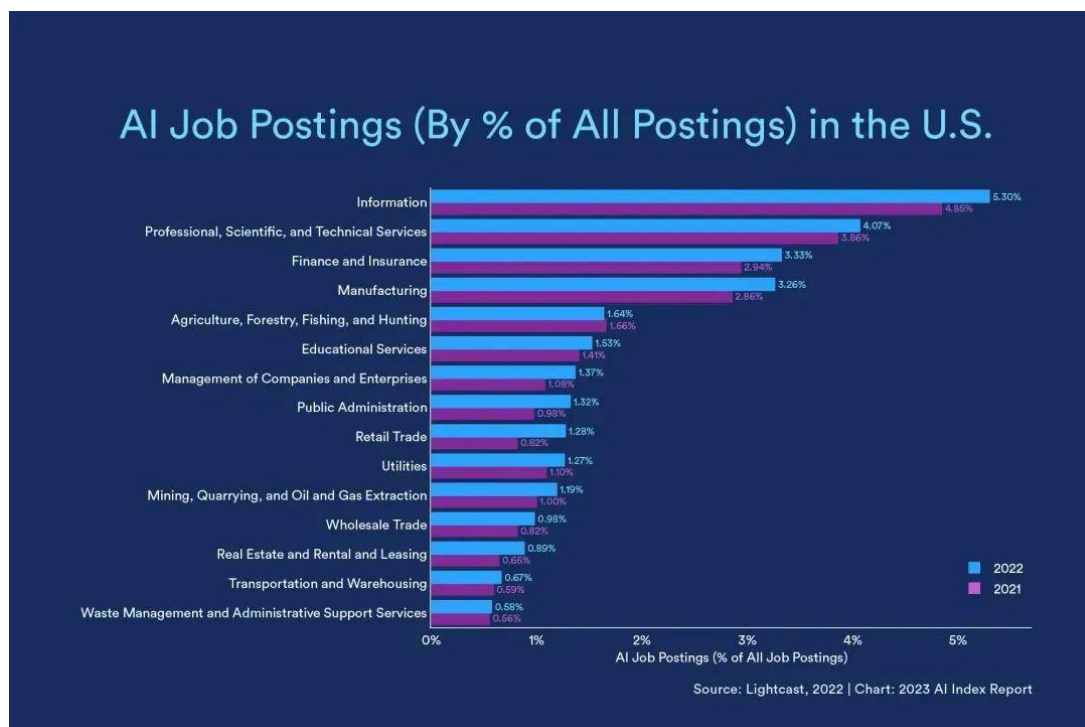


Image: Growing trend in AI Job

Source: Artificial Intelligence Index Report 2023 (Stanford Institute for Human-Centered Artificial Intelligence)

Exacerbating Economic Inequality

Based on the above analysis, it is evident that AI will accelerate the trend of wealth inequality. Regionally, automation will reduce the labor replacement cost, causing low-wage countries to lose cost advantages. Developed countries may shift production to automated factories, and the substitution of labor by robots will reduce the relative wages of labor-exporting countries, thereby changing global production allocation. In addition, countries without digital infrastructure will be at a disadvantage in AI development.

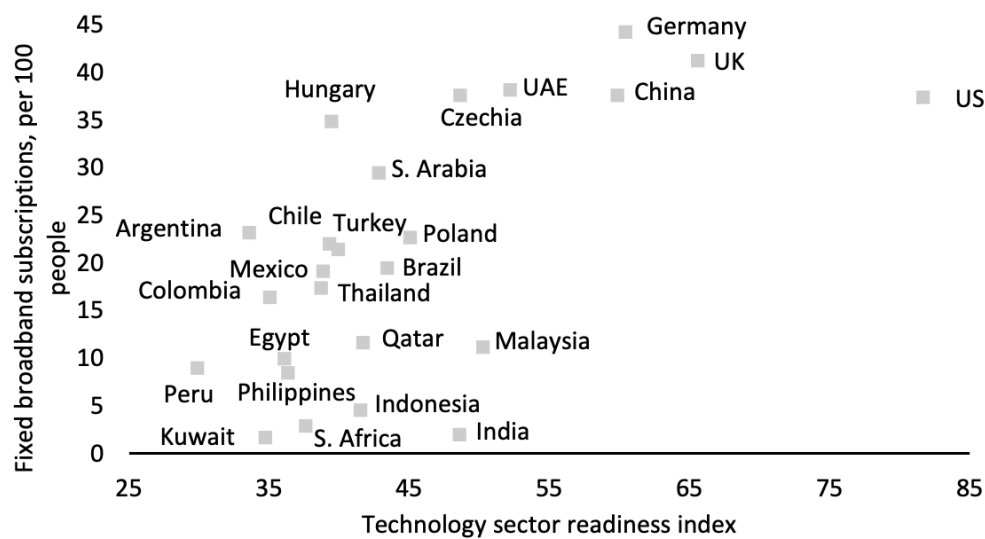


Image: Developing countries lag behind in government AI readiness indicators.
Source: World Bank, Oxford Insights, Credit Suisse, as of May 2023

For individual workers, according to the neoclassical economic model, the gap between capital and labor income depends on the substitutability elasticity of the two, the development of AI and automation will increase the ratio of capital input to robots, causing capital and its returns to account for a higher proportion in the total production relationship, this squeezes labor wage returns, contribute to the widening wealth gap (DeCanio 2016, Berg 2016, Bessen 2018, Graetz and Michaels 2017). Besides, the capital redistribution effect further contributes to the wage gap between high-skilled and low-skilled workers (Lankisch 2017), which implies that workers with repetitive and low digital skills face unemployment and wage cuts.

Policy Recommendations

The coexistence of the potential and challenges of AI as a new economic engine necessitates government intervention to seize opportunities while mitigating risks. The proposed strategies include:

1. **Eliminating Regional Inequality:** Establishing dedicated AI institutions for researching universal economic indicators, accumulating comprehensive datasets, promoting multilateral cooperation, and ensuring equitable AI coverage and benefits across diverse populations and regions. Notably, The United Nations has established a high-level advisory body on artificial intelligence consisting of 38 member countries. Several countries, including the United States, the United Kingdom, Saudi Arabia, Singapore, and the United Arab Emirates, have established their own national AI agencies. However, most developing countries have not yet followed suit. Specialized AI agencies and multilateral cooperation contribute to enhancing the economic value of the country, assisting workers in coping with an increasingly automated market, achieving fair global governance, continually bridging the technology gap, and promoting equitable distribution.
2. **Mitigating AI's Impact on the Labor Market:** Countries must prioritize enhancing

education and training programs to facilitate workforce adaptation to AI technologies. Implementing educational policies that support seamless workforce transitions through skills upgrading initiatives and occupational retraining is essential. Additionally, governments should formulate policies encouraging workers' movement from low-skilled industries towards high-skilled sectors to strike a balance between labor supply and demand.

3. Guiding fair distribution: Safeguarding social welfare and enhancing unemployment protection. In contrast to concerns regarding the exorbitant costs and potential disincentives for employment innovation associated with Universal Basic Income (UBI), exploring alternatives such as employment subsidies, tax policies, and transfer payment strategies may present a more viable option. Research conducted by Eissa and Liebman (1996) as well as Hotz, Mullin, and Scholz (2006) suggests that the Earned Income Tax Credit policy (EITC) can bolster labor force participation. With regards to taxation policies, levying taxes on robot-generated income while redistributing it among asset-less workers could mitigate income inequality while fostering stable per capita capital and output levels (Abbott and Bogenschneider 2017, Gasteiger and Prettnner 2020).

If harnessed effectively and safely, technology has the potential to serve as an immensely positive force for humanity.

References

1. On the mechanics of economic development
J. Monetary Econ. MinoK. (1988)
2. A general two sector model of endogenous growth with human and physical capital: Balanced growth and transitional dynamics
J. Econom. Theory LucasR. (1996)
3. Low-skill and high-skill automation NBER Working Paper 24119 AcemogluD. *et al.* (2017)
4. Artificial Intelligence, Automation and Work NBER Working Paper 24196 AcemogluD. *et al.* (2018)
5. A model of growth through creative destruction
Econometrica AghionP. *et al.* (1992)
6. The race between man and machine: implications of technology for growth, factor shares and employment
Amer. Econ. Rev. AghionP. *et al.* (2018)

7. The impact of artificial intelligence on economic growth and welfare, *Journal of Macroeconomics*, Volume 69, September 2021, 103342, Chia-Hui Lu
8. On the Impact of Artificial Intelligence on Economy, June 2022, *Science Insights* 41(1):501-560, DOI:10.15354/si.22.re066 Wein K. Solos Joel Leonard
9. Hanson R. Economic growth given machine intelligence. *J Artif Intellig Res* 2001; 2001: 1-13
10. Frey CB, Osborne MA. The future of employment: How susceptible are jobs to computerisation? September 17, 2013.
11. Acemoglu D, Restrepo P. Automation and new tasks: How technology displaces and reinstates labor. NBER Working Paper No. 25684, March 2019 JEL No. J23, J24
12. Lankisch C, Prettnner K, Prskawetz A. Robots and the skill premium: An automation-based explanation of wage inequality. *Hohenheim Discussion Papers in Business, Economics and Social Sciences*, No. 29-2017, Universität Hohenheim, Fakultät Wirtschafts- und Sozialwissenschaften, Stuttgart. 2017.
13. McKinsey Global Institute Notes from the AI frontier: Modeling the impact of AI on the world economy, Jacques Bughin, Jeongmin Seong, James Manyika, Michael Chui, and Raoul Joshi, September 4, 2018
14. McKinsey Global Institute : AI could increase corporate profits by \$4.4 trillion a year, according to new research, *Fast Company* , Michael Chui and Lareina Yee, July 7, 2023
15. Brynjolfsson E, Hitt L. Computing productivity: Firm-level evidence. *The Review of Economics and Statistics*. 2003; 85:793-808.
16. Graetz G, Michaels G. Robots at work. *Rev Econ Stat* 2018; 100.
17. Implications of AI innovation on economic growth: a panel data study, *Journal of Economic Structures* volume 12, Article number: 13 (2023), Julius Tan Gonzales
18. He Y (2019) The effect of artificial intelligence on economic growth: evidence from cross-province panel data. *Korea J Artif Intell* 7(2):9–12.
19. Fan D, Liu K (2021) The relationship between artificial intelligence and China's sustainable economic growth: focused on the mediating effects of industrial structural change. *Sustainability* 13(20):11542.

20. IaaS Estimates vs “Actual”: Wikibon 10/2023 based on company earnings reports
8 ETR survey data, CUBE Research Q3 2023
21. Jobs of Tomorrow: Large Language Models and Jobs – A Business Toolkit, white paper written by the World Economic Forum, in collaboration with Accenture, 19 December 2023
22. Artificial Intelligence Index Report 2023, Stanford Institute for Human-Centered Artificial Intelligence
23. Government AI Readiness Index 2023, Oxford Insights
24. Robots and humans-complements or substitutes? [J]. *Journal of Macroeconomics*, 2016, 49: 280–291. DeCanio S J.
25. Robots, growth, and inequality: The robot revolution could have profound negative implications for equality [J]. *Finance & Development*, 2016, 53(3): 10–13. Berg A, Buffie E F, Zanna L F.
26. AI And Jobs: The Role of Demand, J.Bessen(2018)
27. Is modern technology responsible for jobless recoveries? [J]. *American Economic Review*, 2017, 107(5): 168–173. Graetz G, Michaels G.
28. Lankisch C, Prettnner K, Prskawetz A. Robots and the skill premium: An automation-based explanation of wage inequality. *Hohenheim Discussion Papers in Business, Economics and Social Sciences*, No. 29-2017, Universität Hohenheim, Fakultät Wirtschafts- und Sozialwissenschaften, Stuttgart. 2017
29. AI and the Economy, *Economics, Computer Science, Innovation Policy* 29 May 2018, Jason Furman, Robert C. Seamans
30. Eissa, Nada and Jeffrey B. Liebman. 1996. “Labor Supply Response to the Earned Income Tax Credit.” *Quarterly Journal of Economics* 111(2): 605-37
31. Hotz, V. Joseph, Charles H. Mullin, and John Karl Scholz. 2006. “Examining the Effect of the Earned Income Tax Credit on the Labor Market Participation of Families on Welfare.” National Bureau of Economic Research working paper No. 11968
32. Abbott R, Bogenschneider B. Should Robots Pay Taxes? *Tax Policy in the Age of Automation*, 12 *HARV. L. & POL. REV.* 145 (2018). SSRN Elect J 2017
33. Gasteiger E, Prettnner K. automation, stagnation, and the implications of a robot tax. *Macroecon Dynam* 2020; 1-32.