The Global Economic Outlook in the 2020s: The Era of Artificial General Intelligence

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The 2020s heralds a new epoch in the annals of global economics, characterized by the pervasive influence of Artificial Intelligence (AI). As we traverse this decade, we are witnessing a paradigm shift in economic structures, driven by the rapid proliferation of AI technologies.

AI, as a general-purpose technology, is engendering a transformative impact on productivity and economic growth. It is catalyzing a new wave of what Schumpeter termed "creative destruction", engendering novel industries while disrupting existing ones. The economic implications of this shift are manifold and complex, necessitating a rigorous analysis.

Firstly, AI is poised to significantly augment labor productivity. By automating routine tasks, AI liberates human capital to focus on more complex, creative, and strategic endeavors. This phenomenon, reminiscent of the Solow-Swan model's emphasis on technological progress as a driver of long-term growth, could potentially lead to a surge in total factor productivity.

However, the diffusion of AI also presents challenges. The 'race against the machine' narrative posits that AI could exacerbate income inequality by displacing low-skilled labor, a concern rooted in the classical labor-capital dichotomy. This necessitates proactive labor market policies and reskilling initiatives to ensure an inclusive AI-driven economy.

Furthermore, AI has profound implications for international trade. The 'gravity model' of trade, which posits that trade is inversely proportional to the distance between countries, may be disrupted as AI reduces the cost of coordination and communication, thereby potentially reshaping global supply chains.

From a macroeconomic perspective, AI could engender 'secular stagnation' if the displacement of jobs outpaces the creation of new ones, leading to reduced aggregate demand. Policymakers must therefore strike a delicate balance between harnessing the productivity benefits of AI and mitigating its potential deflationary impact.

Lastly, the rise of AI necessitates a rethinking of monetary and fiscal policy. Central banks may need to consider the impact of AI on the natural rate of interest, while governments grapple with the fiscal implications of AI, such as potential changes in tax revenue due to automation.

In conclusion, the 2020s will be a pivotal decade for the global economy as it navigates the opportunities and challenges presented by AI. As we stand on the precipice of this new era, it is incumbent upon us, as economists, policymakers, and society at large, to guide this transition towards a prosperous and equitable future.

-Labor Productivity and AI

The impact of AI on labor productivity can be analyzed through the lens of the Cobb-Douglas production function, which posits that output (Y) is a function of labor (L) and capital (K), with technology (A) as a multiplicative factor: $Y = A * K^\alpha * L^(1-\alpha)$. In the context of AI, the technology factor (A) is expected to increase significantly, leading to a potential surge in output. However, the distribution of this increased output is contingent on the relative shares of labor and capital, represented by the parameters α and $(1-\alpha)$. If AI is considered a form of capital, its proliferation could lead to a higher α, implying a larger share of output accruing to capital at the expense of labor. This underscores the potential inequality concerns associated with AI.

-AI and International Trade

The traditional Heckscher-Ohlin model of international trade posits that countries export goods that use their abundant factors intensively. However, in the era of AI, the abundance of digital data and AI expertise could become significant determinants of comparative advantage. Countries with advanced AI capabilities could potentially export AI-intensive goods and services, reshaping the global trade landscape.

-Macroeconomic Implications of AI

From a macroeconomic perspective, the Keynesian IS-LM model provides a useful framework to analyze the impact of AI. If AI leads to job displacement and reduced consumer spending, this could shift the IS curve to the left, leading to lower output and interest rates, a scenario akin to 'secicualar stagnation'. On the other hand, if AI leads to increased productivity and investment, this could shift the IS curve to the right, leading to higher output and interest rates.

-Monetary and Fiscal Policy in the AI Era

The advent of AI also has significant implications for monetary and fiscal policy. The Taylor rule, a guideline for monetary policy, suggests that central banks adjust the nominal interest rate in response to deviations of inflation from its target and output from its potential. In the era of AI, both potential output and the natural rate of interest could be significantly affected, necessitating a rethinking of monetary policy.

From a fiscal perspective, the Laffer curve, which illustrates the relationship between tax rates and tax revenue, could be impacted by AI. If AI leads to job displacement and reduced income, this could move the economy towards the downward-sloping portion of the Laffer curve, leading to reduced tax revenue for a given tax rate.

-AI and Market Structures

The impact of AI on market structures is profound. In industries where AI becomes a dominant technology, we may witness a shift towards oligopolistic or even monopolistic structures. This is due to the 'network effects' and 'data feedback loops' inherent in AI technologies. As more users adopt an AI product or service, the quality of the AI improves due to increased data, attracting even more users. This self-reinforcing cycle can lead to a concentration of market power, raising concerns about market competition and consumer welfare.

$15.7 trillion

According to a report by PwC, AI could contribute up to $15.7 trillion to the global economy by 2030.

14%

The same PwC report suggests that AI could increase global GDP by up to 14% between now and 2030, which they equate to an average boost of about $1.2 trillion per year.

$3.9 trillion

Gartner predicts that the business value created by AI will reach $3.9 trillion in 2022.

70%

According to a survey by McKinsey, about 70% of companies will have adopted at least one type of AI technology by 2030.

2.3 million

Gartner predicts that AI will create 2.3 million jobs by 2022, while eliminating 1.8 million, for a net gain of 500,000 new jobs.

50%

Gartner predicts that by 2025, 50% of all business analytics software will include prescriptive analytics built on causality and decision intelligence.

-AI and Economic Growth

The Solow growth model, a cornerstone of growth theory, posits that long-term economic growth arises from three sources: increases in labor (population growth), capital (savings and investment), and technological progress (innovation). AI, as a form of technological progress, could potentially drive economic growth in the long run. However, the model also suggests that without continuous innovation, economies will eventually converge to a steady-state growth rate determined by the rates of population growth and depreciation. This underscores the importance of continuous innovation in AI and related technologies to sustain long-term economic growth.

-AI and Economic Inequality

The Kuznets curve hypothesizes an inverted-U relationship between economic development and income inequality: as an economy develops, inequality first increases, then decreases after a certain average income is reached. In the context of AI, we might witness a similar trajectory. In the early stages of AI adoption, inequality might increase as high-skilled workers and capital owners reap the majority of the benefits. However, as AI becomes more widespread and accessible, and as policies and institutions adapt, the benefits of AI could potentially become more evenly distributed, leading to a decrease in inequality.

-AI and Economic Policy

The advent of AI also necessitates a rethinking of economic policy. Policymakers need to grapple with new challenges, such as data privacy and security, algorithmic bias, and the concentration of market power. At the same time, they need to harness the potential of AI to improve policy effectiveness. For example, AI can be used to enhance tax compliance, improve public service delivery, and strengthen financial regulation.

-AI and the Financial Sector

The financial sector is undergoing a seismic shift due to the advent of AI. The application of machine learning algorithms in areas such as credit scoring, fraud detection, algorithmic trading, and risk management is transforming traditional financial services.

This phenomenon, often referred to as 'fintech', is reducing costs, improving efficiency, and enhancing customer experience. However, it also raises new challenges in terms of financial stability and consumer protection. Regulators need to strike a delicate balance between fostering innovation and managing risks, a concept often referred to as 'regtech'.

-AI and the Labor Market

The impact of AI on the labor market is a topic of intense debate among economists. The 'skill-biased technological change' hypothesis suggests that AI, like previous technologies, will disproportionately benefit high-skilled workers, potentially exacerbating wage inequality. On the other hand, the 'routine-biased technological change' hypothesis posits that AI will primarily displace routine jobs, both high-skilled and low-skilled, leading to a 'polarization' of the labor market. Policymakers need to anticipate these changes and implement appropriate education, training, and social protection policies to ensure a just transition to an AI-driven economy.

-AI and the Environment

AI also has significant implications for environmental sustainability. On the one hand, AI can contribute to 'green growth' by improving energy efficiency, optimizing resource use, and enabling innovative solutions such as smart grids and precision agriculture. On the other hand, the production and use of AI technologies can be energy-intensive, contributing to carbon emissions. Policymakers need to harness the potential of AI to achieve environmental goals while managing its environmental footprint.

-AI and the Public Sector

The public sector is another area where AI is expected to have a transformative impact. AI can enhance public service delivery, improve policy design and implementation, and strengthen governance and accountability. However, the use of AI in the public sector also raises important issues related to data privacy, algorithmic transparency, and public trust.

-AI and Social Structures

The advent of AI is not only transforming economic structures but also societal ones. The rise of AI has significant implications for social mobility. As AI and automation change the nature of work, there is a risk that individuals without the necessary skills or access to technology could be left behind, potentially leading to a 'digital divide'. Policymakers need to ensure that education and training systems are adapted to provide the skills needed in an AI-driven economy, and that access to digital technologies is equitable.

-AI and Global Cooperation

The global nature of AI also necessitates international cooperation. Issues such as data privacy, cyber security, and AI ethics transcend national borders and require global solutions. International standards and norms for AI need to be developed, and global governance structures need to be strengthened. The 'global public good' nature of AI also suggests a role for international financial institutions in supporting AI development and diffusion, particularly in developing countries.

-AI and Economic Forecasting

AI also has the potential to revolutionize economic forecasting. Machine learning algorithms can process vast amounts of data, detect complex patterns, and make predictions. This could enhance the accuracy and timeliness of economic forecasts, improving policy planning and decision-making. However, the 'black box' nature of some AI models raises issues of interpretability and transparency.

-AI and Economic Research

Finally, AI is transforming economic research. New methods such as 'econometrics of machine learning' are being developed, and vast amounts of 'big data' are being used to test economic theories and inform policy debates. However, this also raises new methodological and ethical challenges that need to be addressed.

-AI and Future Economic Theories

The rise of AI is likely to spur the development of new economic theories. Traditional economic models, based on the assumption of rationality and equilibrium, may need to be revised to account for the ways in which AI can change human behavior and market dynamics. For instance, the rise of AI could lead to new forms of 'bounded rationality', as individuals increasingly rely on AI for decision-making. Similarly, AI could disrupt market equilibrium by accelerating the speed of transactions and changing the nature of competition.

-The Role of Economists in the AI Era

The advent of AI also changes the role of economists. In addition to their traditional roles in policy advice and economic forecasting, economists will increasingly need to understand and shape the development of AI technologies. This will require a deep understanding of AI and related technologies, as well as the ability to communicate complex economic concepts to technologists, policymakers, and the public.

-AI and Economic Education

The rise of AI also has implications for economic education. Future economists will need to be trained not only in traditional economic theory and econometrics, but also in machine learning, data science, and AI ethics. This will require a rethinking of economic curricula and pedagogy.

-AI and Economic Policy

Finally, the rise of AI presents new challenges and opportunities for economic policy. Policymakers will need to grapple with issues such as AI regulation, data privacy, and the impact of AI on employment and income distribution. At the same time, AI can be a powerful tool for policymakers, enabling more effective and responsive policy interventions.

Examples: AI & Machine Learning Model

These are just a few examples of how the latest machine learning models and techniques are being used. The field of AI is rapidly evolving, and new applications are being discovered all the time.

-Automated Machine Learning (AutoML): AutoML refers to the automated process of selecting and tuning machine learning models. It includes techniques like hyperparameter optimization, feature engineering, and model selection. AutoML is particularly useful in scenarios where there is a lack of expert knowledge to manually tune the models. It is being used in various fields, including healthcare for disease prediction, in finance for credit scoring, and in retail for customer segmentation.

-AI-enabled Conceptual Design: AI models like DALL·E and CLIP are capable of generating images from textual descriptions and understanding the relationship between textual and visual data. These models are being used in creative fields like graphic design and advertising, where they can generate unique visual content based on specific requirements.

-Multi-modal Learning: Multi-modal learning involves training models on data from multiple sources or modalities, such as text, images, and audio. This approach can lead to more robust and versatile models. For example, in healthcare, a multi-modal model could use both medical imaging data and patient records to make more accurate diagnoses.

-Models that can Achieve Multiple Objectives: These models are designed to optimize multiple objectives simultaneously. For example, in autonomous driving, a model might need to optimize for safety, efficiency, and passenger comfort all at the same time.

-AI-based Cybersecurity: Machine learning models are being used to detect and respond to cybersecurity threats. These models can analyze patterns in network traffic to identify potential threats, and they can also be used to predict and prevent future attacks.

-Improved Language Modeling: Language models like GPT-4 are capable of generating human-like text based on a given prompt. These models are being used in a variety of applications, from chatbots and virtual assistants to content generation and translation.

-Computer Vision in Business: Computer vision models are used to analyze and interpret visual data. In business, these models are used for tasks like object detection in surveillance video, image recognition for product identification in retail, and defect detection in manufacturing.

-Democratized AI: Tools and platforms are being developed to make AI more accessible to non-experts. These tools often include user-friendly interfaces and pre-trained models that can be fine-tuned for specific tasks.

-Bias Removal in ML: Techniques are being developed to identify and mitigate bias in machine learning models. This is particularly important in fields like hiring and lending, where biased models could lead to unfair outcomes.

-Digital Twins Drive the Industrial Metaverse: Digital twins are virtual replicas of physical systems. They are used in fields like manufacturing and logistics to simulate and optimize processes. With the rise of the metaverse, digital twins could also be used to create virtual replicas of real-world locations for use in virtual reality environments.

The Era of Artificial General Intelligence

Artificial General Intelligence (AGI) is a type of artificial intelligence that has the ability to understand, learn, and apply knowledge across a wide range of tasks at a level equal to or beyond a human being. This is in contrast to conventional AI, also known as Narrow AI, which is designed to perform specific tasks, such as voice recognition, image recognition, or driving a car. While Narrow AI excels at the specific tasks it's designed for, it lacks the ability to perform tasks outside of its specific domain.

The advent of AGI could have profound implications for the world economy:

-Productivity and Economic Growth: AGI could lead to a significant increase in productivity, as it can automate not only routine tasks but also complex problem-solving and creative tasks. This could lead to a substantial increase in economic output and growth.

-Labor Market Transformation: AGI could transform the labor market by automating a wide range of jobs, leading to significant job displacement. At the same time, it could also create new types of jobs that we can't even imagine today, much like how the advent of the internet created entirely new industries and jobs.

-Income and Wealth Inequality: The economic benefits of AGI could be highly concentrated, potentially leading to increased income and wealth inequality. The owners of AGI technologies could reap a large share of the economic benefits, while those whose jobs are automated could face income losses.

-Global Economic Dynamics: AGI could alter global economic dynamics. Countries that are at the forefront of AGI development and deployment could gain significant economic advantages, potentially leading to shifts in global economic power.

-Public Policy and Governance: The advent of AGI could pose significant challenges for public policy and governance. Policymakers would need to address a range of issues, from job displacement and income inequality to data privacy and security. The ability of governments to regulate and manage the impacts of AGI could become a key determinant of economic performance.

-Innovation and Technological Progress: AGI could drive a new wave of innovation and technological progress. By automating complex problem-solving and creative tasks, AGI could accelerate the pace of scientific discovery and technological innovation. This could lead to breakthroughs in fields ranging from medicine and biotechnology to energy and materials science.

-Education and Skill Requirements: The advent of AGI could change the skills that are in demand in the labor market. Jobs that involve routine tasks or tasks that can be easily automated could decline, while jobs that involve complex problem-solving, creativity, and social and emotional skills could become more important. This could have implications for education and training systems, which would need to adapt to these changing skill requirements.

-Consumer Markets: AGI could transform consumer markets by enabling new products and services. For example, AGI could enable more personalized and convenient services, from personalized learning and health care to autonomous transportation and personalized entertainment.

-Resource Allocation and Efficiency: AGI could improve the efficiency of resource allocation in the economy. By enabling more accurate predictions and optimizations, AGI could help to allocate resources more efficiently, from capital and labor in the economy to energy and materials in production processes.

-Sustainability and the Environment: AGI could help to address environmental challenges and promote sustainability. For example, AGI could enable more efficient use of energy and resources, help to optimize renewable energy systems, and enable more accurate modeling and prediction of environmental and climate phenomena.

In conclusion, while the advent of AGI could pose significant challenges, it also presents enormous opportunities. As we navigate this uncharted territory, it's crucial that we harness the potential of AGI to drive economic growth and societal progress, while managing its risks and challenges. This will require not only technical innovation, but also policy innovation, to ensure that the benefits of AGI are widely shared and that its risks are effectively managed.

’Superintelligence is one trillion to the trillionth (10^24) of human intelligence.’

Hugo de Garis

Way to Artificial General Intelligence

Artificial General Intelligence (AGI), often referred to as "strong AI," is the kind of artificial intelligence that can understand, learn, and apply knowledge across a wide range of tasks at a level equal to or beyond a human being. While we have yet to achieve AGI, several approaches are being pursued in the scientific community:

-Neuroscience-Inspired AGI: This approach seeks to replicate human intelligence by building models that closely mimic the structure and function of the human brain. It involves studying the biological brain at various levels of abstraction, from individual neurons to large-scale brain systems, and then developing computational models that replicate these structures. This approach is grounded in the belief that since the human brain is the only existing proof of a general intelligence system, emulating its structure and function could be a viable path to AGI. However, this approach is limited by our current understanding of the brain, which, despite significant advances, remains incomplete.

-Symbolic AI: This approach, also known as "Good Old-Fashioned AI" (GOFAI), involves creating explicit symbolic representations of the world and using logical inference systems to manipulate these symbols. This approach was popular in the early days of AI research and led to the development of expert systems. While symbolic AI has fallen out of favor compared to machine learning approaches, some researchers believe that a return to symbolic methods, perhaps in combination with machine learning, could be a path to AGI.

-Hybrid AI: This approach involves combining different AI techniques, such as machine learning, symbolic reasoning, and evolutionary algorithms, in an integrated system. The idea is to leverage the strengths of each technique and mitigate their weaknesses. For example, machine learning could be used for perception tasks, symbolic reasoning for high-level planning, and evolutionary algorithms for optimization.

-Whole Brain Emulation: This approach involves creating a high-fidelity computational model of an entire biological brain. This would involve scanning a brain in detail, mapping out the connections between neurons (the "connectome"), and then simulating this structure on a computer. While this approach is theoretically possible, it is currently beyond our technological capabilities due to the immense complexity of the brain and the lack of adequate brain scanning technologies.

-Evolutionary and Genetic Algorithms: This approach involves using evolutionary algorithms to evolve AI systems over many generations. These algorithms use mechanisms inspired by biological evolution, such as reproduction, mutation, recombination, and selection. The idea is that over many generations, AI systems could evolve to exhibit general intelligence.

-Reinforcement Learning: This approach involves training AI systems through a process of trial and error. AI systems are given a goal and learn to achieve this goal by interacting with their environment, receiving positive or negative feedback (rewards or punishments), and adjusting their behavior accordingly. Some researchers believe that reinforcement learning, possibly in combination with other techniques, could be a path to AGI.

Each of these approaches has its strengths and weaknesses, and it's still an open question which, if any, will lead to AGI. It's also possible that AGI will require entirely new approaches that have yet to be conceived. As we continue to explore these approaches, it's crucial to consider not only the technical challenges of AGI but also the ethical and societal implications of creating machines with human-level intelligence.

Timeline Predictions

In a seminal 2016 survey conducted by the Future of Humanity Institute at the University of Oxford, researchers Vincent C. Müller and Nick Bostrom polled hundreds of AI experts to gather their predictions regarding AGI. The respondents included AI professionals across North America, Europe, and Asia who had published at two major conferences on AI — the Conference on Neural Information Processing Systems (NIPS) and the Conference on Uncertainty in Artificial Intelligence (UAI).

The survey results revealed a median estimate of AGI realization falling between 2040 and 2050. This means that, on average, experts believed there was a 50% chance that AGI would be achieved within this time frame. However, the results also demonstrated a significant spread in the expert opinions. Some AI researchers predicted AGI could be developed as soon as the 2020s, while others suggested it might not be realized until well into the latter half of the 21st century, if at all.

These divergent estimates reflect the multitude of variables and uncertainties inherent in AGI development. The pace of progress in machine learning algorithms, for example, is unpredictable. Breakthroughs could potentially accelerate the timeline, while unforeseen obstacles could delay it. Similarly, advancements in computational hardware, which provide the physical infrastructure for AI operations, could either hasten or impede progress towards AGI depending on various factors including manufacturing capabilities, energy efficiency, and raw material availability.

Furthermore, the development of AGI is contingent on the availability of high-quality, diverse, and extensive training data. This not only encompasses the sheer volume of data but also the representativeness and inclusivity of this data across different domains of human knowledge and experience. Potential hurdles in data collection, such as privacy concerns and regulatory restrictions, could significantly influence the timeline.

Lastly, we must consider our evolving understanding of human cognition. AGI development is, in part, inspired by and modeled after human intelligence. Therefore, new insights into the workings of the human brain, learning processes, and cognitive development could dramatically shift our approach to creating AGI and, consequently, the estimated timeline.

Given these myriad factors and uncertainties, it is critical to approach any predictions about the emergence of AGI with a healthy degree of skepticism. The timeline for AGI is a moving target, continually subject to change in response to the evolving landscape of technological, scientific, societal, and regulatory developments. This calls for ongoing, dynamic assessment and an openness to adapt strategies as our understanding of AGI progresses.

'But, New York General Group plans to create AGI by 2025.'

We have a technology called "**World System on the Basis of Bidirectional Encoder Representations from Transformers(BERT), Categorical Network(CN) and Point-Voxel Convolutional Neural Network(Point-Voxel CNN)**" It can be applied to omnipotent emulation. Specifically, LLMs such as BERT acquire vast amounts of information from online, categorical network (CN) understand the information through category theory, and PVCNNs represent the information as atomic voxels in a space informed by physics.

Whole-brain emulation has not been feasible due to two main problems. One is that the human brain is a black box with many unexplained parts. The other is that simulating the human brain requires enormous computational resources. We solve them mainly in the following ways. One is that AI continues to automatically acquire unknown knowledge from knowledge from existing consciousness through category theory. The other is to use a quantum computer based on category-theoretic quantum mechanics as a computational resource. We have already succeeded in having LLMs process category-theoretic quantum mechanics and in having an image-generating AI generate detailed images of the brain. With our breakthrough, we expect to complete AGI as early as 2025.