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Pioneering power: the impact of artificial intelligence on international power

Pioneering Power: The Impact of Artificial Intelligence on International Power

A Tiered Analysis

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"[Artificial Intelligence] comes with colossal opportunities, but also threats that are difficult to predict. Whoever becomes the leader in this sphere will become the ruler of the world."

Russian President Vladimir Putin[1]

[1] Russia Today, "'Whoever Leads in AI Will Rule the World': Putin to Russian Children on Knowledge Day."

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3. Abstract

The rise of artificial intelligence (AI) generates profound implications for international power dynamics. With relevant benefits and risks, this is a critical point in time to analyze the role of AI within the theoretical discipline and practical application of international affairs. With proper integration, AI has the potential to strengthen existing dimensions of international power. Understanding the prerequisites of an AI ecosystem (*technological infrastructure*, *human capital*, *educational system*, *resources*, and *drive*), this thesis analyzes the competency of five nations (The United States, the People's Republic of China, India, the Republic of Korea, and Japan) to foster the development of a national AI ecosystem. The nations are ranked in a tiered methodology to understand relative power positions within the international system. Currently, the United States and the People's Republic of China are ranked in Tier 1, and India, the Republic of Korea, and Japan are ranked in Tier 3.

The tiered methodology and individual analyses suggest the introduction of AI into the international system will entrench current power dynamics. First-mover advantage will sustain the global positions of already influential powers, like the United States and the People's Republic of China, founded on early adoption, innovative environments, and economic dominance. While second and late movers will undoubtedly benefit from AI, the application and development of AI in these nations will likely address national challenges before innovative applications or international input. In terms of international power dynamics, AI will widen the power gap between central and peripheral nations of the international system by supplying dominant nations with large gains while only maintaining the power of status quo countries.

Keywords: artificial intelligence (AI), international power, AI ecosystem, mover advantage, diffusion, technological adoption, innovation

4. Introduction

International power dynamics have ebbed and flowed since the creation of nations, shaped by a range of factors that include military capabilities, economic status, and technological progress. The emergence of advanced computational learning systems that have capabilities beyond automation and can perform an array of tasks may alter these dynamics. AI technology introduces a new dimension to traditional power dynamics and world stage influence for nations affluent in resources and capable of harnessing and molding this technology for their benefit.

AI technology applies analytical techniques to large amounts of data and predicts outcomes with that analysis, in a manner similar to human intelligence. AI programs vary from applications present in everyday life, like Siri or Waze, to the ChatGPT bot that produces texts based on various prompts, to data analytics models that collect and discern suggested pathways from aggregated data. As an emerging technology, the benefits and risks of AI are in the nascent stages of being understood. AI exploration, in terms of the types of systems, training of systems, and applications of the technology, leaves room for a multitude of unforeseen outcomes.

Recent and unprecedented advancements in AI technology have resulted in transformative change across a variety of sectors, from business to government. Autonomous vehicles, scientific and medical discoveries, and financial models demonstrate how AI is already present and functional in many lives, often without acknowledgment or understanding. The unveiling of products like ChatGPT, along with consequential feedback from large technology companies, has prompted discussions on the future and impact of AI.

Despite the uptick in these commercial conversations over the past few years, there is a gap in these exchanges when it comes to the role of AI as a technology in the field of international relations. For the academics of international affairs, AI will mix traditional domains of land, air, sea, space, and cyber, and bring about change in economics, diplomacy, and information. These developments will highlight divergences in guiding ideologies and theories, thereby challenging structures built to model our world. For practitioners, diplomats, presidents, and civilians, there are profound implications around the distribution and exercise of power among nations. Security considerations, diplomatic communications, market structures, and other elements of the international system will metamorphize with this new technology, just as past technologies have altered dynamics before. Nuclear weapons, a product of the bipolarity between the United States (U.S.) and the Soviet Union, have come to characterize the Cold War era. Satellite technology has enhanced communication, increased intelligence, surveillance, and reconnaissance of nations, and demonstrated highly technical scientific bases. As nations invest in AI research and development, integrate systems to achieve elements of national strategy, and influence the rules of the AI road, competitive and comparative advantages will shift. Diffusion of AI technologies and systems will influence power differentials and advantages, both reaped or unachieved, shaping international relationships between the powerful and the powerless.

AI history is at a defining point, as theoreticians and practitioners begin to analyze how AI will alter current power dynamics and hypothesize how AI will shape the future of international affairs. Since AI is an emergent technology, there are empirical data collection challenges, so this paper aims to provide insight and a framework for the future and continuous analysis of AI in the international system, with power as the discriminator. The result is a tiered analysis of potential for an AI ecosystem, based on a qualitative equation. The equation breaks down the components needed by a nation to develop an AI ecosystem that can capitalize on existing elements of power. This framework has utility for both a singular isolated evaluation of one country's AI ecosystem potential *and* a relative comparative analysis between multiple nations. Supported by a comprehensive review of literature on AI and power as they relate to international relations and supported with empirical evidence, this thesis aims to explicate how AI will shape and redefine international power relations for the next two to ten years.

5. Background

The history of AI begins with Alan Turing, a British mathematician often referred to as the forefather of contemporary computer science. In 1940, Turing's Bombe machine cracked the German Enigma, a machine that could create 159 quintillion combinations of code (that's a million-million-millions or a billion-billions or 10^{18}), by sifting through large amounts of numbers, much larger amounts than the human brain can process or remember.[2]

In 1950, Turing questioned the thinking capability of machines, introducing the concept of the "Imitation Game" to technological theory. The imitation game refers to a machine's ability to mimic human behavior in a manner that is equal to, or indiscernible from, human intelligence.[3] After Turing's paper, science fiction ran wild with theories about intelligent computers taking over the world. The fear-mongering of these tactics, often business strategies to sell more movies, comics, or games, has drastically impacted the public perception of what AI is, how AI is defined, and what AI is capable of.

AI is present in most of the world's everyday lives and functions. In some sense, it is entirely less revolutionary than it is marketed to be, as many members of the globe have engaged with AI without realizing it. These programs can include apps that analyze traffic patterns to deliver you to your destination with efficiency and speed, home security systems that recognize the difference between a trespasser and a family pet, or Apple's Siri function. Each of these

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[2] Kanaan, *T-Minus AI*.
[3] Turing, "Computing Machinery and Intelligence."

examples has a specific skill set that allows for the program to complete a specific function. These types of AI programs are "... very strong, efficient, and quite capable at [their] purposed job. [They are] incompetent at anything beyond it."[4]

More advanced AI systems, like OpenAI's ChatGPT, have expanded the public perception of what AI is and how AI is used, beyond traffic navigation or talk-to-text transcription.[5] These types of programs appear near par with human intelligence. For example, ChatGPT mimics qualitative analytical skills that go beyond the processing of data through programs. ChatGPT indeed has multiple skill sets and uses these analytical abilities to accomplish multiple tasks, making the service more applicable to a variety of needs than the Waze mapping system, for example.[6] Yet comparing computer analytical capabilities to human intelligence can lead academics to the science fiction trap. Released AI programs like ChatGPT have risky generative capabilities that make mistakes in outcomes. More trial and error are needed, which means more time is necessary to develop AI before placing the technology on par with human intelligence, creativity, and capabilities.

There is a realm of AI that exists entirely in science fiction, a type of super-intelligent AI that does surpass human capabilities. Yet, just as the communicator from Star Trek or driverless cars from comics seemingly exist today, it is not outside the scope of reality for elements of science fiction to become real. Currently, superintelligence is just imaginative, but the concept of an unbounded technology that could be born from the same innovations that brought us specific types of AI does create apprehensions. The concept of super-intelligent AI has value in the conversation about the future of AI but for this paper will not be included in the AI terminology, as it is outside of the current capability of established and planned systems.

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[4] Kanaan, *T-Minus AI*, pp.130.
[5] ChatGPT refers to GPT 3.5 and GPT 4.
[6] Bubeck et al, "Sparks of Artificial General Intelligence: Early experiments with GPT-4."

That said, the reason why super-intelligent AI is pertinent to this specific conversation is because of its potential. Along with a valid fear of the unknown, the concept of super-intelligent AI brings technology towards the technological singularity, a concept similar to a breaking point. Technological singularity refers to a hypothetical moment in time when technological innovation experiences unprecedented growth resulting in unmanageable and irreversible technology that has implications for human existence.[7] Again, somewhat of a science fiction theory, but relevant enough because of the current advances in AI which have raised questions about application, regulation, and governance within influential nations such as the U.S., People's Republic of China (China), the Russian Federation (Russia), and countries within the European Union.[8]

Why does technology, and AI specifically, strike the nerve of fear? How does AI differ from past technological innovations that have altered the human experience, like the printing press, nuclear weapons, or the internet? To answer these questions, refer back to Alan Turing's imitation game concept. Again, the imitation game refers to a machine's ability to mimic human behavior in ways indiscernible from actual human behavior. It is this behavioral element, the "intelligent" aspect of AI, that discerns AI systems from computing systems, like MacBooks or supercomputers. To complete this "intelligence" feat, scientists made programs that mimic neurological patterns that allow humans to form thoughts. With this type of decision-making, machines can use the thought functions of the human brain to analyze and synthesize large amounts of data, beyond the abilities of a human. These abilities include the rate of operations completed in a set amount of time, memory storage, and speed of search, to name a few. These analytical capabilities that extend beyond human abilities are not equivalent to consciousness.

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[7] Logan and Braga, "AI and the Singularity: A Fallacy or a Great Opportunity?"
[8] Ipsos, "Global Opinions and Expectations about Artificial Intelligence"; Myers, "5 Charts That Show What People Around the World Think About AI."

Instead, they demonstrate how scientists use an understanding of brain functions to create new systems of analysis, in the form of technology.

Revolutionary technologies and impacts, both positive and negative, are tales as old as time itself. The printing press constitutes one of those revolutionary inventions that altered international relations beyond its intentions. The printing press allowed for the dissemination of information at a new speed and reach than ever seen before in human history. Chinese woodblock painting (c. 700) and Korean metal movable type (c.1250) contributed heavily to information sharing on the Asian continent, and the printing press (1436) is seen as an enabler of Europe's renaissance and scientific revolution. Groundbreaking technologies have intended purposes yet often generate unintended consequences. The printing press, intended to speed up the process of bookmaking, resulted in unintended consequences like the Protestant Reformation, which altered winners and losers while initiating permanent changes and cultural shifts.[9]

The ability of technology to alter international relations is evident in the invention, arms race, and use of the atomic bomb. The invention of nuclear weapons resulted in increased secrecy and distrust both nationally and internationally and demonstrated both the ability and inability of governments to form nuclear innovation sectors. Countries disguised their nuclear arms strategies and productions from adversaries to maintain strategic advantages and protect national security. One result of mobilizing economies and moving around money to build up huge nuclear arsenals was the nuclear arms race. The eventual use of atomic weapons by the U.S. in Hiroshima and Nagasaki altered the essence of international warfare forever. The arms race, mainly between the U.S. and the Soviet Union but also involving other actors like the United Kingdom, France, and China, stoked fear about proliferation, questioned the magnitude of possible destruction, and sparked international conversations about rules and regulation.

[9] Dewar, "The Information Age and the Printing Press: Looking Backward to See Ahead."

Warfare theory that defined this era such as deterrence, zero-sum, and coercion, evolved from the nature of trench warfare during World War 1. Unintended consequences include environmental degradation and the creation of international organizations to regulate atomic weapons and atomic energy. To date, nuclear weapons impact international relations: for example, Russia moved nuclear weapons into Belarus in 2023, during the invasion of Ukraine, possibly to deter North Atlantic Treaty Organization (NATO) combat in Ukraine.[10]

Historically, nuclear weapons have been a coercive and deterrent tool used by international governments. Yet other inventions, like the internet, have become tools used by civilians, in addition to governments. The internet was born from the need of government researchers to communicate and store large amounts of digital information throughout different connected networks. Widespread computer connectivity occurred in 1983, and the public accessed the World Wide Web in 1993. The low barrier to entry to the internet, meaning the zero or low-cost use, as well as ease of use, allows for a wide user audience. Since the 1990s, the internet has altered diplomacy, ushering in a new age of digital diplomacy where the internet is used to achieve diplomatic goals, created a new domain for warfare with the increased reliance on cyberspace, and developed international interconnectedness. Far from its original intention to create databases and data-sharing pipelines for government researchers, the internet has produced a multitude of unintended consequences that have impacted international relations, including but not limited to changing the social behavior of humans, allowing platforms to non-state actors, and the erosion of social trust.

These examples show how technology and innovation have drastically altered international affairs, often with unintended consequences that have more impact than the intended uses. AI will bring about newfound developments in international relations and surely

[10] McGlinchey, "Nuclear Weapons and International Relations."

produce many unintended consequences; one issue is that we, as people of the world, are too in the moment and realistically very far away from the benefits of hindsight, to know what any of those specific consequences will be. Therefore, like the printing press, nuclear weapons, and the internet, AI will surely impact international power dynamics. The printing press allowed governments to disseminate institutionalized and written laws. Scholars address the profound religious and political changes brought about by works produced on printing presses, often referring to the printing press as an agent, a tool, for change.[11] Nuclear weapons have shaped power competition since 1945, constituting powers that possess nuclear weapons in prominent international roles in the international system. Contemporarily, nuclear weapons arguably are a prominent reinforcement of U.S. international power. The internet allowed for a new era of government propaganda, provided access to wider audiences, and gave a new platform to non-state actors. Just as scholars before have studied the impact of innovation and technology on international affairs, this study will explore the impact of AI on international relations.

We will wait to see how AI serves or does not serve as an agent of change in international relations, how it will or will not be harnessed by governments for specific purposes and intentions, and if it will or will not be capitalized upon by non-state actors as a new resource for their goals. There is scientific potential for AI uses in military inventions, diplomatic decision-making, information warfare, environmental policy, and more. Now is the time to hypothesize, research, and parse through these interactions, to generate ideas about what is to come. Because it will come. Therefore, this paper aims to analyze existing power components needed to harness AI for the purpose of bolstering international power.

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[11] Helmers, Lamal, and Cumby, "Introduction: The Printing Press as an Agent of Power."

6. Literature Review

a. Artificial Intelligence

The literature on AI is enormous. The thematic content of this body can be narrowed by topic from the scientific application to the relevance and use of AI in international relations. The following sections, *AI: Common Scientific Understandings*, *Definitional Description*, and *The Relevance and Use in International Relations*, provide a basic scientific understanding of AI and then an analysis of the topic within the context of international affairs.

1. Artificial Intelligence: Common Scientific Understandings

David Poole and Alan Mackworth, academics at the University of British Columbia who have worked extensively with the Canadian government on the development of AI systems, offer a foundational understanding of the scientific process behind AI in *Artificial Intelligence: Foundations of Computational Agents*. Stuart Russell, an academic with associations to the Universities of Oxford and Stanford and the World Economic Forum Council on AI, and Peter Norvig, former Director of Research and Search Quality at Google, address necessary insights into the scientific industry and roots of AI in *Artificial Intelligence: A Modern Approach*. These texts are used for a foundational understanding of what AI is in the following paragraph.

The field of AI thrives because of computer science and cognitive science. AI is a type of technology that runs on machine learning (ML), the ability of the program to recognize patterns in new data and improve from this analysis for future circumstances. ML is the component of AI that allows for the system to learn. Natural language processing (NLP) is how the system can turn computer language (code) into human language. Some types of AI systems will use ML for analysis and NLP to communicate this analysis. AI is the agent that acts to produce a specific end result, and ML and NLP are a few of the skills used to achieve that end result. With contemporary and advanced programming, AI attempts to be both a rational and intelligent agent to achieve the best-purposed outcome in a given situation.[12]

2. *Artificial Intelligence: Definitional Description*

After analyzing nine primary sources on AI, to be discussed in the following section, a definition for this paper has been developed using a range of perspectives from science to social science. In the confines of this thesis and with concern to the realm of international relations, AI is a technology that applies certain analytical applications and techniques to large amounts of data and then predicts outcomes with that analysis. To borrow from author Michael Kanaan, AI can be broken down into three components: concept, application, and technique.[13]

1. Concept: AI is the concept of a machine completing a task thought to need human brain functions. The conceptualization includes all types of programs that mimic these functions, from text, to visuals, to decision-making.
2. Application: Different applications are used in varying types of AI. ML applications compute a statistical analysis of data via algorithms and learn from this analysis for future inputs and outputs. NLP applications turn code into human language. Large language model (LLM) applications generate data analysis in understandable human language.
3. Technique: AI applications employ techniques, such as mimicking neural networks. This technique copies the highly complex human brain network of neurons, which fire to process information. For instance, deep learning is a specific ML technique modeled after neural networks to mathematically replicate human processing capabilities.

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[12] Poole and Mackworth, "Artificial Intelligence: Foundations of Computational Agents"; Russell and Norvig, *Artificial Intelligence: A Modern Approach.*
[13] Gourley, "Michael Kanaan, Author of T-Minus AI Discusses Artificial Intelligence and Global Power."

Generally speaking, AI is a broad term for an artificial technological process that models human brain functions to generate factual information. Currently, AI concepts can be split into three categories: narrow AI, general AI, and super AI.

1. Narrow AI: is integrated into our everyday lives. These systems include personal finance services, facial recognition, voice dictation, maps, and more. Narrow AI is created with a single specific purpose and cannot function outside the realm of this environment.[14] For example, Waze mapping service cannot generate voice-to-text transcription.
2. General AI (AGI): is an emergent application. AGI can achieve multiple purposes, mimicking the human ability to multitask. AGI is built upon massive computational power, so it has better long-term memory and can analyze information more rapidly than a human.[15] OpenAI's ChatGPT is one example of AGI.[16] ChatGPT can summarize a long text on a whim because it can process the information in an instant, while a human would need to read the entire text before attempting to summarize. ChatGPT can also generate a vacation outline on the Coast of Brava in Spain for two weeks under $2000. These examples show how AGI can address a wide range of questions and tasks concurrently.
3. Super AI (ASI): is currently hypothetical. ASI is the ability of AI to think for itself, beyond the cognitive skills and limitations of humans.[17]

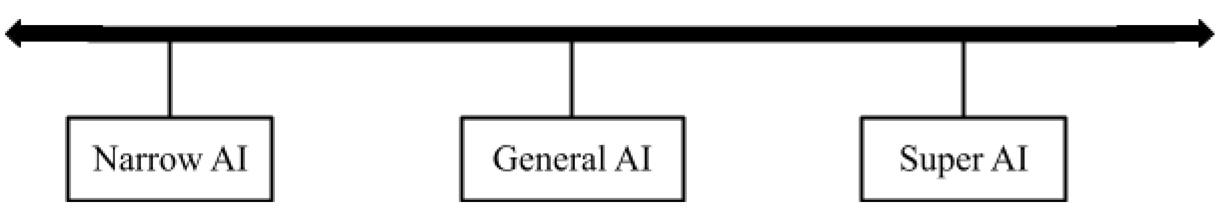

Figure 1: The AI Spectrum

[14] Poole and Mackworth, "Artificial Intelligence: Foundations of Computational Agents"; Kanaan, *T-Minus AI*; Horowitz, "Artificial Intelligence, International Competition, and Balance of Power"; Horowitz, "Do Emerging Military Technologies Matter for International Politics?"
[15] SCSP, "Generative AI: The Future of Innovation Power"; Horowitz, "Artificial Intelligence, International Competition, and Balance of Power"; Kanaan, *T-Minus AI*.
[16] Bubeck et al, "Sparks of Artificial General Intelligence: Early experiments with GPT-4."
[17] Horowitz, "Artificial Intelligence, International Competition, and Balance of Power"; Kanaan, *T-Minus AI*.

3. *Artificial Intelligence: The Relevance and Use in International Relations*

AI literature intersecting with global politics has surged in recent years. Literature in this section was published within the last six years to remain relevant to AI's fast-paced evolution.

Michael Kanaan, the current Military Deputy Chief Information and Cyber Assurance Officer at the Department of Defense Chief Digital and Artificial Intelligence Office, writes about the realities of AI in everyday life, military pursuits, and with concern to the balance of power in *T-Minus AI*: *Humanity's Countdown to Artificial Intelligence and the New Pursuit of Global Power*. This is a very accessible text that introduces the history of AI, describes the current status of the technology, and then addresses geopolitical factors. Kanaan argues that access to data is a key element of successful AI systems. Therefore, AI developed in various nations will operate on asymmetric information, as all countries or companies will not have access to the same data on which they train AI systems. Asymmetric information often reveals power imbalances, miscommunications, strategic advantages, distrust, and more. Kanaan concludes with critical analyses of China's expanding sphere of technological influence, Russia's disruptive AI capabilities, and the role of democratic ideals in a world with AI.[18]

The Special Competitive Studies Project (SCSP) on "Generative AI: The Future of Innovation Power" offers another critical perspective. SCSP is a non-partisan, private U.S. think tank, dedicated to bolstering the long-term competitiveness of the U.S. in a world with AI and other emergent technologies. SCSP defines many of AI's limitations and vulnerabilities, including reflected human bias and hallucinations where information sounds correct in the given context but is not fact. SCSP lists factors that a country needs to develop sound AI, including compute power (the ability to process information at varying speeds for a specific task), private-public partnerships, talent pools with educational support, resources, and a top-down

[18] Kanaan, *T-Minus AI*.

leadership structure. These needs are transitioned to a list of recommendations for the U.S. to harness the powers of AI to sustain its competitive advantage, including out-innovating competitors, setting the rule of the road, and framing AGI global leadership as a national security priority. These recommendations address the fast AI growth within China, which the SCSP sees as the primary threat to global U.S. leadership on AI. China has access to vast amounts of data, due to population size and an authoritarian regime that allows government collection of citizen data, including a global reach via apps like TikTok. Despite this competitive edge in access to data, the regime type historically stifles innovation and limits data sharing, not to mention China's demographic challenges, debt, and lack of compute in the form of graphics processing units (GPUs), the circuits in computers.[19] A huge strength of this literature is its organization. Broken into levels of analysis, this work describes AI in various landscapes from great power competition between the U.S. and China, AGI governance, AGI economy, and beyond. This is a very holistic literature on AGI and its implications, specifically in the international sphere.[20]

Authors Granados, Horowitz, Kissinger, and Pavel all expand on the role of AI in international relations from their varying perspectives.

Granados, a former academic at the University of Jorge Tadeo Lozano in Bogotá, Colombia, analyzes AI in "Artificial Intelligence and International System Structure." Granados uses a network science methodology to illustrate the role of AI in international power relations. Network science explains relationships and, in this case, is used to model power relationships between nations before and after the introduction of AI. Countries can have a central role or a peripheral role in the network. Granados hypothesizes that AI will allow peripheral countries to interact with central countries beyond their traditional conforms of labor or capital. He addresses

[19] SCSP, "Generative AI: The Future of Innovation Power," pp. 23-25.
[20] SCSP, "Generative AI: The Future of Innovation Power."

a gap in the current literature on AI and international relations by holistically evaluating power dimensions instead of focusing on specific power dimensions. In this analysis, Granados notes how asymmetry of information in the creation of AI systems means not all actors will use or develop AI in the same manner. This is relevant for expectations and potential uses of AI.

Granados uses various types of data to stand for different power dimensions. Gross domestic product (GDP) is an indicator of economic power, military expenditure represents military power, and patent evolution and publications stand for human capital power. These metrics explain what is needed to develop sound AI, indicating nations with positive AI potential. After he analyzes AI and the international system, Granados offers three takeaways:

1. Few nations have the means to develop sound AI capabilities. Without dynamic scientific and technological environments, peripheral countries may fall deeper into the periphery of the international system.
2. AI interacts with power dimensions (economic, military, cultural, etc.) and changes these power dimensions (importance, relevance, etc.).
3. AI has deepened and will continue to deepen the technological gap that separates central nations from peripheral nations. This statement affirms the hypothesis that AI will offer means for peripheral countries to interact with central countries but will not provide peripheral countries with ways to challenge central countries. In simple terms, for Granados, AI is not a magical solution for smaller countries in the international system to challenge more powerful countries.[21]

Adding to Granados' analysis of AI and the international system, Rand Corporation questions the same in "AI and Geopolitics: How Might AI Affect the Rise and Fall of Nations?" The authors argue that AI will impact the power of nations depending on how these countries

[21] Granados, "Artificial Intelligence and International System Structure."

harness and integrate the technology *and* how they manage the risks posed by AI, such as exacerbation of inequality or job loss. The authors posit that the U.S. is in a good position to sustain its role in the world, with a free market and profit-driven incentives, but must counter the rise of adversaries in AI, such as China. A key omission is the necessity of public-private partnerships in the development of AI. The term geotechnopolitics is introduced to describe the role AI will play in international politics that are impacted by geographical factors. While this term offers insight, the involvement of geography may be irrelevant to the technology of AI, which many scholars, these included, consider to be borderless.[22]

In "Artificial Intelligence, International Competition, and the Balance of Power," Horowitz examines the impacts of AI on national security. Horowitz likens this age of AI to industrial revolutions prior and Cold War arms and space races, stating that emergent technologies shape the balance of power, often through military and economic results. Horwitz discusses heavy investments in AI made by China and Russia and how these investments attempt to harness first-mover advantage, even though the centrally planned economies of both countries have traditionally limited innovation. Additionally, he mentions that capital-rich countries with smaller populations have larger incentives to adopt and apply AI into everyday life.[23]

Two years later, Horowitz returns to the role of AI in military technologies, with "Do Emerging Military Technologies Matter for International Politics?" With a focus on cyber and nuclear capabilities, there are key takeaways for the role of AI in national strategies. Incentives to develop AI include a lower barrier to entry than other technologies, potential solutions to demographic challenges and dwindling workforces, and cheaper alternatives to human labor. Horowitz also hypothesizes about military-AI capabilities, although there is a key limitation

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[22] Pavel et al, "AI and Geopolitics: How Might AI Affect the Rise and Fall of Nations?"
[23] Horowitz, "Artificial Intelligence, International Competition, and Balance of Power."

when accessing data on new military technologies for national security reasons, a critical obstacle to the analysis of understanding the impact of AI in military power.[24]

In "How the Enlightenment Ends," Henry Kissinger wrote that as a general purpose technology, AI lacks the guiding principles that are inherent to specific technologies. Whereas specific technologies are created for a purpose and have innate guidelines for use (a tractor is used for moving agricultural resources, it cannot be used to type a school paper), AI lacks both purpose and direction: it can be used for a large range of tasks. The current human role in the development and application of contemporary AI systems is what determines both purpose and direction. Kissinger's perspective can be described as advocating for augmented intelligence, or the use of AI to enhance the human decision-making processes rather than replace the human in decision-making processes. Consequently, Kissinger challenged the term 'artificial,' stating that the connotation of something fake detracts from the potential of AI: "Ultimately, the term *artificial intelligence* may be a misnomer."[25]

The examined literature yields key questions about AI's role in the international system:

1. Is imitation cross-cultural?[26]
    a. For example, if a system is trained on a Chinese database in Mandarin, what is the utility of the system for a Brazilian who speaks Portuguese?
2. How will AI be used to achieve national objectives?[27]
3. How do technology and innovation transform international power factors? What international power factors will remain relevant?[28]

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[24] Horowitz, "Do Emerging Military Technologies Matter for International Politics?"
[25] Kissinger, "How the Enlightenment Ends."
[26] Kanaan, *T-Minus AI.*
[27] SCSP, "Generative AI: The Future of Innovation Power."
[28] Granados, "Artificial Intelligence and International System Structure."

   a. International power factors include economic strength, military capability, political and ideological influence, cultural relevance, geopolitical position, resource security, and more.

4. At what speed does AI diffuse from country to country? Will rapid diffusion of AI limit first-mover advantage?[29]
5. Why does literature only address narrow AI applications, when AGI is on the brink?[30]
6. Who is going to use AI capabilities and why?[31]
7. What are the incentives to develop a specific emergent technology?[32]
8. Who could control the development of AI? How will AI affect geopolitics?[33]

These questions prompt discussions around the benefits of implementing and strategically using AI systems as a means to achieve elements of national strategy. No country exists in a vacuum and many play active roles on the world stage, meaning that relationships between countries play a key role in who will use AI and how. To that end, it is necessary to review mover advantage, an economic term used in innovation literature, and diffusion.

b. Mover Advantage and Diffusion

As AI evolves, and as AGI advances, AI as a whole is understood to be a general purpose technology (GPT). A GPT is a technology that can be applied to a wide range of industries, with public and private sector purposes. GPTs generally have low fixed costs and low barriers to entry.[34] For example, ChatGPT can be used by a financial analyst to crunch numbers, by a

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[29] Horowitz, "Artificial Intelligence, International Competition, and Balance of Power."
[30] Horowitz, "Do Emerging Military Technologies Matter for International Politics?"
[31] Ibid.
[32] Horowitz, "Do Emerging Military Technologies Matter for International Politics?"
[33] Pavel et al, "AI and Geopolitics: How Might AI Affect the Rise and Fall of Nations?"
[34] Poole and Mackworth, "Artificial Intelligence: Foundations of Computational Agents"; SCSP, "Generative AI: The Future of Innovation Power"; Horowitz, "Artificial Intelligence, International Competition, and Balance of

scientist to write code, by a student to create an outline for a paper, or by a friend to figure out the best restaurants in the neighborhood. On the contrary, a specific purpose technology is invented for one purpose: a nuclear weapon has the purpose of delivering a nuclear weapon to a specific location to produce an intense explosion.

GPTs have proved revolutionary in international relations in the past. The printing press of the 15th century allowed for information about a wide range of topics to be disseminated to large audiences and was much faster and cheaper than hand copies. The steam engine of the 1700s and the electric motor of the 1800s allowed for different methods of transportation and machinery to develop. The internet of the 1990s and the semiconductors of contemporary times have allowed for widespread communication for various means and the growth of electronic devices. With these examples, it is evident that nations have competed to innovate technologies faster than their counterparts to gain competitive advantages across time, based on different resources, applications, and ways of development.[35] Nations that develop technologies early in the product cycle, in high investment environments where producers can harness consumer feedback to finetune the product, are called first movers in innovation and economic literature. Nations that receive products later in the product cycle, where producers have access to cheaper labor and can produce the product often more efficiently and more rapidly, are called second movers. First-mover advantage refers to the incentives (often economic, but can be normative, social, political, etc.) that first movers reap when they develop useful technology before second movers gain access to the market, resources, and skills needed to start developing the technology themselves.[36]

Power"; Granados, "Artificial Intelligence and International System Structure"; Drezner, "Technological change and international relations."

[35] SCSP, "Generative AI: The Future of Innovation Power"; Horowitz, "Artificial Intelligence, International Competition, and Balance of Power"; Kissinger, "How the Enlightenment Ends."

[36] SCSP, "Generative AI: The Future of Innovation Power"; Horowitz, "Artificial Intelligence, International Competition, and Balance of Power."

Diffusion and the speed of diffusion play a critical role in first-mover advantage.[37] Literature mentions barriers to entry when positing ideas of diffusion and the role of technology in society. Barriers to entry are challenges that limit the number of competitors who can enter an industry or field, such as cost, regulation, or access to knowledgeable people. For example, the space industry has high barriers to entry, because it costs a lot to develop and build spacecrafts with command and control systems, and highly knowledgeable individuals are needed to craft effective technologies. Governments and wealthy individuals often dominate this industry because of the high barriers to entry. On the other hand, the service sector has low barriers to entry, with very little government regulation, potential for product differentiation, and is accessible to small businesses and individuals due to lower costs.

Technologies also have barriers to entry, similar to industry. Whereas nuclear weapons need niche command and control capabilities, substantial funding, scientific research, development, and understanding, AI has lower barriers to entry. This is not to say AI has no barriers to entry: there are certainly costs, the need for highly specialized individuals, a digital ecosystem, and large amounts of data. Good AI, that is efficient and direct with its purpose is hard to develop and harder yet to stabilize in the face of rapid modernization. When compared to other technologies critical to economic success or national security, AI has significantly fewer barriers to entry. The private sector plays a critical role in the initial development of new AI technologies, and going forward, private-public partnerships have the potential to lower barriers to entry, as governments work with industry or support private sector development with grants.[38]

Evaluating barriers to entry and diffusion are critical elements to understanding how AI can disrupt the current international system and has the potential to alter the current balance of

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[37] SCSP, “Generative AI: The Future of Innovation Power”; Granados, "Artificial Intelligence and International System Structure"; Horowitz, “Do Emerging Military Technologies Matter for International Politics?”
[38] SCSP, “Generative AI: The Future of Innovation Power.”

power. With the revival of great power competition between a waning U.S. republic and an increasingly aggressive China, AI plays a pivotal role in the future of the international system. Before analyzing the impact of AI on international affairs, it is critical to understand what power is, who has power, and how power comes to be, in the international system.

c. Power

The idea of power in international relations has been discussed since the very emergence of the academic study and has been a dynamic element of the reality of international relations long before, as demonstrated in 16th century Machiavellian and 20th century Morgenthau theory.[39] A common understanding across various definitions of power is that power is a relational concept where two or more entities interact. Power is not something an actor can possess in isolation since it is not static property but a dynamic relation.

In 1957, Robert Dahl wrote the most foundational definition of power in international relations, in "The Concept of Power." Dahl's power principles are the baseline for many other arguments that conceive different definitions or aspects of power in an international context. The Dahlian definition of power goes as so: Actor A has power over Actor B, to the extent that A can get B to do something that B would otherwise not do.[40] Power is represented through interactions and therefore is a social phenomenon.

Dahlian power has four identifiable elements: source, means, scope, and extent.[41]

1. *Source*: all resources that can be used by Actor A to affect the behavior of Actor B.
    a. Examples: opportunities [war potential], acts [votes], objects [materials]
2. *Means*: all instruments that use sources of Actor A to alter the behavior of Actor B.

[39] Baldwin, "Power and International Relations: A Conceptual Approach."
[40] Dahl, "The Concept of Power."
[41] Dahl, "The Concept of Power"; Baldwin, "Power and International Relations: A Conceptual Approach."

   a. Examples: threat [of war potential], promise [of a vote], exercise [of charm]

3. *Scope*: the range of responses of Actor B to Actor A's sources and means.

   a. Examples: answers [yes/no], reactions [positive or negative]

4. *Extent*: reported in conjunction with means and scope, as a probability statement

   a. Example: chances are 9 out of 10 [extent], that if the President promises [means] judgeships [source] to five key senators, the Senate will not [scope] override the Presidential veto

The Dahlian power relation names three properties that must be held to have a power dynamic: time lag, connection, and potential of negative power.[42]

1. *Time lag*: Actor A's attempt to change Actor B's behavior must occur before Actor B's response.
2. *Connection*: Actors A and B must be connected to have a power relation.[43]
3. *Potential of negative power*: The absence of power, where Actors A and B are independent of one another and therefore not connected, or opposite power, when Actor A's actions make Actor B do the opposite of Actor A's intentions.

Finally, Dahl discusses power comparability factors. Power is often defined in relative terms, with phrases like "more power than," "less power than," or "equal power to." Differences in power comparability harken back to the four identifiable elements of power, so differences in the source, means, scope or extent of power. It is not possible to understand Actor A's potential for power without analyzing Actor A's source, means, scope and extent in terms of Actor B.[44]

While Dahl's definition is a keystone of the meaning and role of power in international relations, serving as the baseline for the realist framework, Dahl offers a caveat to his lines of

[42] Dahl, "The Concept of Power"; Baldwin, "Power and International Relations: A Conceptual Approach."
[43] Dahl leaves connection undefined on purpose, meaning that connections should be defined in successive studies.
[44] Baldwin, "Power and International Relations: A Conceptual Approach."

reasoning. This caveat states that the theoretical or formal definition of power explained above may diverge from the operational or practical definition used in studies or witnessed in reality.[45] If power theory is posited as a one-size-fits-all answer, with hard and fast definitions, the theory becomes inefficient for study because it limits the scope and understanding of power. Therefore, Dahl asserts that individual studies may have, arguably should have, "operational criteria" that alter the "pure" meaning of power.[46] To adhere to this advice, it is necessary to examine alternative conceptions of power to get a holistic understanding of the roles and definitions of power in international relations, before deciding what understanding of power is most effective to analyze the effects of AI on international power.

Michael Barnett and Robert Duvall introduce multiple additional conceptions of power in "Power in International Politics." This interpretation acknowledges the Dahlian definition of power and its longevity and effectiveness in international relations. Barnett and Duvall agree that power is a social relation, one that critically shapes how actors can construct their circumstances. However, as Barnett and Duvall point out, Dahlian power is often connected to realism in theoretical discussions of international relations. Realism relies on an emphasis on power to explain international phenomena, and more specifically, an emphasis on the source of power (military might, diplomatic ties, etc.) to dictate who has power potential.[47] Other relevant theories of international relations, like liberalism or constructivism focus on other criteria, such as ideas or international organizations, to explain international phenomena. Therefore, Barnett and Duvall argue that the Dahlian conception of power is not inclusive to the host of

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[45] Dahl, "The Concept of Power," pp. 202.

[46] Ibid, pp. 214.

[47] Barnett and Duvall, "Power in International Politics"; Baldwin, "Power and International Relations: A Conceptual Approach"; Morgenthau and Thompson, *Politics among nations: the struggle for power and peace*; Sprout and Sprout, *Foundations of National Power: Readings on World Politics and American Security*.

international relations theories used in the discipline. This literature advocates for expanded conceptions of power that can be used alongside a multitude of international relations theories.

The authors develop a conceptual framework of four specific power concepts:

1. *Compulsory power (power over)*: direct type of control over another (Dahlian in nature). The intentionality of Actor A is irrelevant: if Actor B alters its course of action due to a specific move by Actor A, compulsory power is evident.
2. *Institutional power (power over)*: indirect control of another actor from a distance through a proxy actor or international organization. Actor A tries to influence a change in Actor B's behavior through intermediate means.
3. *Structural power (power to)*: direct constitution of power where Actor A attributes some form of power directly to Actor B.
4. *Productive power (power to)*: indirect constitution of an actor where Actor A uses intermediate means like a proxy to give power to Actor B. While similar to structural power, productive power is socially diffuse and a less intentional exercise of power.

		Relational specificity	
		Direct	Diffuse
Power works through	Interactions of specific actors	Compulsory	Institutional
	Social relations of constitution	Structural	Productive

Figure 2: Barnett and Duvall's Taxonomy of Power[48]

The relevant categories of power *over* and power *to* that are developed by Barnett and Duvall allow for alternative conceptions of power besides one that is inherently conflictive, like the Dahlian definition. A key difference between the traditional Dahlian definition and the

[48] Barnett and Duvall, "Power in International Politics," pp. 48.

Barnett-Duvall definition is that Dahl's relies on the idea of power *over*, a domineering type of power, while Barnett-Duvall expands the definition to include both power *over* and power *to*, allowing for the inclusion of multiple conceptions of power. Diffuse types of power, institutional and productive, may be absent of clear conflict but are certainly not absent of power. This literature expands the bellicose understanding of power to include non-conflictive forms, which is increasingly important in a world that is moving away from traditional conflict. This is not to say the international system has successfully moved away from traditional conceptions of war or that war does not exist. The position is that power conceptions beyond those of traditional conflict are necessary in a world that allows for new forms of interaction.

Beyond power in international relations, there is literature exploring power within technology and international affairs, with a particular focus on AI's influence in this context. The realist approach to understanding the role of technology in international relations treats new technologies as something powers must harness or suffer the risks of falling to the new technology used by other actors. Daniel Drezner counters this in "Technological Change and International Relations," where he argues that technology and AI are tools that distribute existing dimensions of power. Drezner says technology and international relations have a reciprocal relationship, meaning technology can change international relations, while international relations can affect the pace of technological change. For example, Drezner says that the polarity of the international sphere is a key way in which international relations affects technology: under unipolarity, the rate of technological innovation slows as the hegemon sees "little incentive to invest in disruptive innovations" but under multipolarity, meaning a mix of security and insecurity among states, innovation spurs as a way to maintain security.[49] Technology can offer an avenue to challenge the hegemon. Drezner also notes how regime type affects the relationship

[49] Drezner, "Technological change and international relations."

between technology and international relations, as authoritarian regimes are often apprehensive about the inception of disruptive innovations with the potential to change the status quo or give more power to civilians.

Not all innovations spur the same interest, receive the same magnitude of investment or public-private focus, so Drezner delineates the following four categories of technology.

	Public sector dominance	*Private sector dominance*
High fixed costs	**Prestige tech**	**Strategic tech**
Low fixed costs	**Public tech**	**General purpose tech**

Figure 3: Drezner's Technological Categories[50]

Prestige technology, like manned space exploration or nuclear weapons, are technologies that have large fixed costs and limited private sector applications. States are the actors incentivized to resource and develop these technologies, to benefit their nation with the perception of having these technologies in their various arsenals. Public technology, like streetlights and public health developments, are technologies that have low fixed costs but minimal private sector interest, because these goods are nonrival and nonexcludable, so the gains rarely come in the form of profit. Strategic technology, like civilian aircrafts or 5G networks, have large fixed costs but significant civilian usages, so gains have economic value in the private sector. General purpose technology (GPT), like drones or the steam engine, have low fixed costs and a wide range of applications. While these GPTs are often developed first by the public sector, private sector use ramps up after the technology is integrated into daily life, driving future innovative private

[50] Drezner, "Technological change and international relations," pp. 292.

production. According to Drezner, "...the development of artificial intelligence could eventually fall under this [GPT] category as well."[51]

This paper will focus on general purpose technology (GPT), because since Drezner's 2019 publication, AI has come to be understood within this category.[52] Due to low fixed costs, low barriers to entry, and private sector incentives, GPT diffuses much more quickly than strategic, prestige, or public technology. As new GPTs emerge into the international sphere, there are often economic effects and social disruptions. Technology can increase productivity, reduce poverty, and induce other net positive effects, but can also create new threats, generate social upheaval, and other net negative effects. Technology can redistribute power from one player to another. As GPTs have emerged, governments who innovate first and quickly tend to advocate for norms that will sustain their advantage, but it is difficult for these norms to proliferate and be effective, due to the low-cost entry of GPT. For example, the low-cost entry to the internet coupled with widespread and global access has allowed for non-state actors to use this GPT and resulted in little to no international internet regulations. Some authoritarian regimes, like China, have successfully regulated the internet within their sphere of influence. Drezner's position goes to show how technology has changed international relations, by producing new winners and losers in international outcomes, and how international relations have changed technology, by pacing development, creating norms, and building organizational oversight.

In Horowitz's "Artificial Intelligence, International Competition, and the Balance of Power," he calls AI an enabling technology, in a similar vein to how Drezner addresses AI as a GPT. Enabler or general purpose, the base-level technology of AI has multiple uses that can be

[51] Drezner, "Technological change and international relations."
[52] Drezner, "Technological change and international relations"; SCSP, "Generative AI: The Future of Innovation Power"; Horowitz, "Artificial Intelligence, International Competition, and Balance of Power"; Granados, "Artificial Intelligence and International System Structure."

focused to address specific issues when directed by the user. Horowitz calls AI the ultimate enabler because of its potential in a diverse range of fields, comparing AI to electricity or the engine to show its multiple uses in multiple projects. With analogies to the aircraft carrier and printing press, Horowitz references how these technologies have shaped outcomes in international relations in terms of his adoption capacity theory.[53]

Adoption capacity theory says that there are relative financial and organizational requirements to adopt military innovations that influence the diffusion of that innovation and the impact of that innovation on the balance of power. *Financial requirements* can include hardware costs and private or public sector development while *organizational requirements* can include social openness to the innovation or flexibility of the private sector to develop the innovation. Adoption capacity impacts the rate of diffusion of the technology, from first movers (those who invest heavily and create innovations first) and second movers (those who adopt technologies after they have been parsed out and are cheaper to manufacture). It is necessary to understand the role of the innovation in each context to analyze how it will be used and diffused. To expand this, the political context, regime type, market structure, and financial standing of a country will impact how a nation uses AI technology.

Granados questions the role of AI within the international system in "Artificial Intelligence and International System Structure." Granados references prior literature that addresses how technology alters specific power dimensions, like military strength, commodities and capital, or labor, arguing that narrowing studies to specific power dimensions leaves out the big-picture implications.[54] Analyzing aspects of power in isolation, outside of the complexities of

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[53] Horowitz, "Artificial Intelligence, International Competition, and Balance of Power"; SCSP, "Generative AI: The Future of Innovation Power."
[54] Horowitz, "Artificial Intelligence, International Competition, and Balance of Power"; Horowitz, "Do Emerging Military Technologies Matter for International Politics?"

the international system, is a fallacy. Granados hammers this point home by saying there is hard power (economic, military, financial) and soft power (diplomatic, cultural). There are different means to exert this power (coercion, deterrence, etc.). The different types and means result in a lot of complex interactions and lots of combinations for the use of different power dimensions. Another complication is that the mutualistic relationship between technology and the user means not all actors will use or develop powerful technologies in the same way, making an isolated understanding even less useful for realistic hypotheses.[55] Granados utilizes key vocabulary that is important when discussing the advantages and diffusion of AI. *Central nations* refer to countries that have many relations with other nations, are economic powerhouses, shape the rules of the international system, and therefore interact with many other countries. *Peripheral nations* are those which have specific relations and follow the status quo international system. Central nations, like the U.S. and China, have multiple power dimensions that allow them to compete for more relations with peripheral countries. Technology impacts the way both central and peripheral nations compete with power dimensions and for new power dimensions, thereby altering the international system.

To understand the role of AI and the way this emergent technology will affect power dimensions, Granados outlines some needs to develop useful AI. A computer science ecosystem, meaning computational power and design as well as cultural acceptance of AI, is necessary to harness AI. Whereas some other emergent technologies have diffused extremely quickly in the past because they were cheap to create and easy to get used to socially, AI poses challenges. While cost is not a huge component when compared to other profound technologies like nuclear weapons, AI is extremely complex to stabilize and it modernizes very quickly, outpacing stabilizing efforts in many cases. This is why a scientific ecosystem is necessary to support AI in

[55] Granados, "Artificial Intelligence and International System Structure."

addressing national needs. When modeling these effects, Granados uses the current central nations of the international system (the U.S., China, etc.) to show how power dimensions, such as the ability to invest excess funds into these technologies or military innovation, result in a first-mover advantage for these countries. They benefit from developing the technologies, honing the process, and trying to set the rules for the game. On the reverse, “several countries that do not have a dynamic process of science, technology, and knowledge development could fall to a deeper peripheral position.”[56] To summarize Granados’ research and position, countries that develop an AI ecosystem by harnessing their power dimensions such as the ability to mobilize the private sector, economic and military power, and cultural influence, will maintain and even consolidate their international power. Even with the fast diffusion of AI, the difficulty in achieving a sound and consistently effective AI ecosystem will bolster the powerful against the powerless.

7. Methodology

The methodology used to analyze the selected data for this thesis is heavily inspired by studies published by the International Institute for Strategic Studies (IISS), “Cyber Capability and National Power: A Net Assessment” and the Belfer Center at Harvard University, “National Cyber Power Index 2022.”[57] Both of these studies have contributed to the development of national cyber power indexes and rankings, and have been cited extensively by governments and academics alike to advise cyber policy decisions. A tiered analysis allows for the systematic assessment of a complex situation, by breaking the problem into multiple levels of analysis. This is a useful way to understand intricate situations because each tier provides a detailed

[56] Granados, "Artificial Intelligence and International System Structure."
[57] IISS, “Cyber Capability and National Power: A Net Assessment”; Voo, Hermani, and Cassidy, “National Cyber Power Index 2022.”

examination of the specific subject matter at hand, and then compounds these components for a holistic analysis.

There are AI indexes available for public consumption: Tortoise Media, a British news outlet, regularly updates its Global AI Index; Stanford University's Institute for Human Centered Artificial Intelligence published its own AI Index alongside public data; various think tanks examine sector-specific AI development.[58]

Despite the few public AI indexes, there is yet to be an AI index that analyzes the national role of AI holistically. Tortoise Media's Global AI Index makes tremendous headway into this unexamined aspect, with a focus on investment, implementation, and innovation rankings for 62 nations taking part in the "global AI race." These rankings are determined based on scale, global output, capacity within the population, or economic uses of AI. As it relates to this thesis, Tortoise Media's Global AI Index examines a nation's capacity to develop AI very thoroughly but fails to apply what this means on a national scale. This analysis primarily focuses on private sector development across time, forgoing a government level of examination, a factor that is necessary to investigate when researching the impact of AI on international power dynamics. Stanford's AI Index analyzes technical aspects of AI development, the diversity of candidates developing AI, and educational initiatives about AI, as they relate to specific nations, but fails to examine all the categories holistically and relatively. Additional resources tend to focus on one element or one outcome of AI applications.

This methodology holistically examines AI as it relates to national power. After extensive reading on what power is, how to define power, and what critical components are needed to be a powerful nation, as well as an understanding of AI and the need to develop sound systems, a new

[58] Cesareo and White, "The Global AI Index"; Stanford University Institute for Human-Centered AI, "The AI Index 2023 Annual Report."

AI power index has developed. Due to the scope of this thesis, it is not possible to analyze the power dimensions bolstered by AI in all nations. Therefore, this analysis can be considered a snapshot in time as it relates to the five selected nations' AI statuses, and how these nations are or are not harnessing their AI abilities to support elements of national power.

a. Scope of research

The scope of this analysis is limited to five nations: The U.S., China, India, the Republic of Korea (South Korea), and Japan. This is due to the constraints of an honors thesis, both time and page limit. The scope of the data analyzed is limited by quite a few factors, including but not limited to the availability of public information, the infancy of AI as an emergent technology, and the unknown potential of AI when integrated into a nation's national strategy in terms of regime type, infrastructure, resources and more. Additionally, this analysis should be understood as a relative comparison of the five selected nations, while the criteria used to evaluate the nations can be applied to a wider range of countries: it is due to the innate constraints of this thesis that the analysis cannot be extended to evaluate all countries in the international system.

AI is an emergent and rapidly evolving technology with unknown potential. Therefore, this analysis could remain relevant for the next five years, as the technology is further refined for better accuracy and applied in manners that alter international power within economic, social, political, and national security matters. Narrow AI functions and AGI functions are considered the relevant topics when referring to "AI," as noted in the definition section. ASI is omitted from this analysis and speculative sections, as the potential for ASI is currently hypothetical.

To measure the effectiveness of AI in achieving national goals and supporting the power status of a nation, AI ecosystem probability is determined within the context of national power dimensions from literature on power and international relations and an analysis of why a country develops and integrates AI systems. This is supported by the current publicly available data and an evaluation of the individual potential of nations to harness AI effectively and efficiently.

b. Data collection

Data on AI metrics is sourced from the Organization for Economic Co-operation and Development (OECD), an international organization that prioritizes democratic and open market based solutions to a variety of international challenges, including but not limited to social, economic, and environmental issues. With 38 member countries and additional key partners, the OECD maintains ranging databases that inform statistically sound policy recommendations to member countries and partners.[59] The OECD AI Policy Observatory (OECD.AI) project "combines resources from across the OECD, partners and stakeholder groups to create a one-stop-shop for AI policymakers." The OECD.AI Network of Experts brings together AI experts from policy to programming, to assess risks, measure national AI abilities, and inform policymakers via consistent blog publications. OECD.AI also developed AI Principles, the first intergovernmental standards for AI, which provided a basis for the G20 AI Principles, which member countries have accepted.[60] The organization maintains a database of AI policies from around 70 countries, which goes beyond the 38 member countries.

Supplemental data is sourced from the governments of the five selected countries which have all published national AI strategies for further qualitative investigation, and the World Bank, for population and GDP metrics to support the quantitative investigation.

[59] OECD, "Who We Are."
[60] OECD, "The Context - OECD.AI."

8. Research

This analysis will investigate a country's aptitude to innovate and benefit from AI, based on the qualifications needed to develop and integrate AI systems into the national strategies of a nation and the presence or absence of traditional dimensions of power. The methodology section explains the utility and application of a tiered analysis. Existing literature described in the literature review has explained the concept of power as it relates to this investigation, including dimensions of power that are critical to the development of AI and dimensions of power that have the potential to be disrupted or supported by AI. The tiered analysis aims to categorize nations on their ability to develop and benefit from AI while allowing for relative bilateral analyses to understand why some nations succeed and why others fall behind.

To begin, the following qualitative equation, understood as a framework for this analysis, underscores five critical components to develop an AI ecosystem at a national level of analysis. An AI ecosystem is defined as a nation's ability to leverage existing elements of power to secure the advantageous application of AI to a variety of sectors, projects, and national interests. The qualitative equation that follows defines an AI ecosystem:

AI Ecosystem = **Technological Infrastructure** + **Human Capital** + **Educational System** + **Resources** + **Drive**

To dissect the equation, the components of an AI ecosystem can be described, acknowledging the evolving nature of AI that makes these characteristics non-exhaustive:

AI Ecosystem Components	**Specific Elements**
Technological Infrastructure	Internet access, digital economy infrastructure, cybersecurity preparedness Ability to harness and integrate AI, flexibility of the technological base[61] Compute, regime type, public-private partnerships[62] Economy structure[63]
Human Capital	Population[64] Talent pools[65]
Educational System	Publications, patent evolution[66] Leadership structure, educational support[67]
Resources	GDP[68] Access to data[69] Economic structure[70]
Drive (meaning urgency, reason, necessity of developing AI)	Demographic trends[71] Setting the rule of the road, global leadership, out-innovating[72] Risk management, economic incentives[73] Military innovation[74]

[61] Pavel et al, "AI and Geopolitics: How Might AI Affect the Rise and Fall of Nations?"
[62] SCSP, "Generative AI: The Future of Innovation Power."
[63] SCSP, "Generative AI: The Future of Innovation Power"; Pavel et al, "AI and Geopolitics: How Might AI Affect the Rise and Fall of Nations?"
[64] Horowitz, "Artificial Intelligence, International Competition, and Balance of Power"; Horowitz, "Do Emerging Military Technologies Matter for International Politics?"
[65] SCSP, "Generative AI: The Future of Innovation Power."
[66] Granados, "Artificial Intelligence and International System Structure."
[67] SCSP, "Generative AI: The Future of Innovation Power."
[68] Granados, "Artificial Intelligence and International System Structure"; Horowitz, "Artificial Intelligence, International Competition, and Balance of Power."
[69] SCSP, "Generative AI: The Future of Innovation Power"; Kanaan, *T-Minus AI*.
[70] SCSP, "Generative AI: The Future of Innovation Power"; Pavel et al, "AI and Geopolitics: How Might AI Affect the Rise and Fall of Nations?"
[71] Horowitz, "Artificial Intelligence, International Competition, and Balance of Power"; Horowitz, "Do Emerging Military Technologies Matter for International Politics?"
[72] SCSP, "Generative AI: The Future of Innovation Power."
[73] Pavel et al, "AI and Geopolitics: How Might AI Affect the Rise and Fall of Nations?"
[74] Granados, "Artificial Intelligence and International System Structure."

For this analysis, the five factors will be weighted equally. However, some components indeed necessitate others: for example, it is impossible to have technological infrastructure without resources, most importantly without financial resources. An educational environment is irrelevant if human capital is not present, as who will engage with the educational system if a country has no one to train or attend school? The scope of this analysis limits a deep dive into the mutual relationship of some components, so for this thesis, the factors will be held equal. In the summary section of each country's analysis and tier evaluation, the relevance of factors to that country will be discussed in an attempt to fill the addressed gaps in the study.

The following tiered categories provide a qualitative ranking system to analyze the strength of a country's current AI ecosystem. As it is possible to identify national strengths and weaknesses within these rankings, relative bilateral conclusions are welcome. Relative analyses are useful when attempting to understand lessons learned, as one country may develop AI systems in a manner that would be effective policy in another country if they have similar AI ecosystem potential.

Tier	Definition
Tier 1	Dominating the AI landscape on the world stage, potential to be the leader in global AI. Leads in the five categories needed to develop an AI ecosystem.
Tier 2	Keen followers of the hegemon(s) in the AI landscape, often have potential to enter Tier 1 with a few key elements. Key actors in the international AI landscape. May sustain critical partnerships with Tier 1 countries.
Tier 3	Driven by necessity, these countries often lack the resources/infrastructure/etc., needed to develop and integrate sound AI systems into the nation's functions. Some may lack both drive and resources. Despite the low barrier to entry, these nations will remain on the periphery of the international AI ecosystem and obtain AI products last in the product cycles.

Country Selection

This thesis will analyze the current AI ecosystems in five countries. The countries were selected on:

1. Population statistics including crude birth rate, populations aged 65+, and total population growth over time
2. GDP metrics

Population statistics are relevant to AI for two primary reasons. First, demographic challenges are significant incentives to develop AI, to increase productivity, supplement a declining workforce, increase economic output, and more. Second, AI requires a scientific base and knowledge pools found within educated populations. GDP metrics were considered, as technological investments, restructuring economies to develop an AI ecosystem, and getting a foot into the global AI race will take money, among other resources. Future analysis could compare the varying impacts of monetary resources against the urgency to develop AI that comes from demographic challenges, but for this analysis, demographic factors and GDP are considered equally relevant to the country selection criteria. The countries selected are the U.S., China, India, South Korea, and Japan. Figures 4 through 13, located in the appendix, contain the specific quantitative demographic and GDP metrics for each country. Metrics begin in 2000 and conclude in 2022 or 2023, due to data availability. This is to maintain consistency with the AI data available, which begins in 2000 and will be elaborated upon later in this section.

The U.S. was selected because it is the number one economy in the world, a position the nation has held since the final years of the 19th century.[75] Despite the high performance in GDP and productivity metrics, it is important to note the steady debt the U.S. has accrued over time, with the federal debt reaching $33.2 trillion through the fiscal year 2023.[76] Relatively sustained population metrics of a large population, even in the face of a declining crude birth rate and increasing population aged 65+, means the U.S. has access to resources, in terms of money and people, needed to build an AI ecosystem.

China was selected because it is the number two economy in the world and has been since 2010. While China has a growing population, growth has slowed over the past six years, and the crude birth rate is declining while the population aged 65+ is increasing. This means that China has the monetary resources to engage in an AI ecosystem but may face demographic

[75] The Economist, “America’s Economic Outperformance is a Marvel to Behold”; Bolt and Luiten van Zanden, “Maddison Project Database, Version 2020.”
[76] U.S. GAO, “Financial Audit: Bureau of the Fiscal Service's FY 2023 and FY 2022 Schedules of Federal Debt.”

challenges when doing so. On the other hand, the demographic challenges are an incentive to develop and integrate AI systems in the first place.

India was selected because it is the number six economy in the world and has risen from number 13 to number six over the past 22 years. Additionally, India has a wealth of population metrics, as the total population increases, the crude birth rate declines on par with the world average, and the population aged 65+ increases, primarily because of the total population growth rate, and at a low rate when compared to aged 65+ growth rates of China and South Korea.

South Korea was selected for its economic strength and population metrics. South Korea has experienced extremely slow population growth over the past 22 years, with negative growth since 2020. The total population is also relatively small when compared to the populations of the U.S. and China. The population aged 65+ has more than doubled over the past 22 years and the crude birth rate is the lowest of the five countries analyzed here. Therefore, South Korea has extreme population incentives to build an AI ecosystem.

Japan was selected because it is the number four economy in the world, a position it fell into in 2023, after sustaining positions two and three since the 1950s.[77] The population metrics of Japan provide huge incentives to develop an AI ecosystem, as Japan has experienced a negative rate of population growth since 2010. The total population has declined over the past 22 years, the crude birth rate is in decline, and the population aged 65+ is increasing.

The chart below highlights the abilities of the U.S., China, India, South Korea, and Japan to develop an AI ecosystem. As described in the methodology section, data has been accumulated primarily from the OECD.AI and World Bank databases to support conclusions drawn about the presence of technological infrastructure, human capital, educational

[77] Kageyama, "Japan slips into a recession and loses its spot as the world's third-largest economy."

environment, and financial resources.[78] The presence of drive, the reason behind AI development and integration ranging from necessity to strategy, is supported by the national AI strategies of each country, executive actions, and other national-level agendas. The "total" section is a holistic evaluation of a country's potential to develop an AI ecosystem that provides utility to the country and the "tier" section allows for relative comparisons between nations.

Nation	Presence of technological infrastructure	Presence of human capital	Presence of educational environment	Presence of financial resources	Presence of drive	Total	Tier
U.S.	✓	✓	✓	✓	✓	5/5	Tier 1
China	✓	Present but potentially not for long	✓	✓	✓	4.5/5	Tier 1
India		✓		✓	✓	3/5	Tier 3
South Korea	Absent but strong initiative to develop			✓	✓	2.5/5	Tier 3
Japan	Absent but strong initiative to develop			✓	✓	2.5/5	Tier 3

The sections below are individual analyses of the selected countries. The summary paragraph generalizes the current presence or absence of the components needed for the AI ecosystem and explains why the country is in the tier it is. Additionally, the final part of the section addresses the potential for movement between tiers.

[78] OECD, "Trends and Data"; World Bank, "Data."

The U.S.: Tier 1

Score: 5/5 components

Summary: The U.S. has a strong presence of all five components needed to develop an AI ecosystem. The strong technological infrastructure explained within executive actions and global rankings is already mobilized to support AI development and integration. The U.S. is the third most populous country in the world, with relatively maintained metrics across the past 22 years, suggesting continuity of current population trends if immigration metrics are sustained. According to the OECD, approximately half of the U.S. population has tertiary education.[79] With the highest quality academic research publications, seen by citation statistics, and large quantities of publications, there is an educational environment to support AI development. As the number one economy in the world, and due to the longevity of this position, there are financial resources in the U.S. to build an AI ecosystem. Large-scale executive action, from executive orders to national strategies, indicates the current centralized development of an AI ecosystem that can mesh with other elements of U.S. national strategy.

1. Technological Infrastructure

Looking at the global top AI startups and investment in these companies from 2012-2020, the top three AI startups in the U.S. raised significantly more funding in eight years relative to funding raised in the other analyzed countries, with the second and third ranked AI startups in the world based in the U.S. Additionally, the U.S. leads the world in compute startups with the top three compute startups in the world located in the U.S. (as a reminder, compute is processing power). The U.S. is ranked first on the Cybersecurity Index of the International Telecommunication Union (ITU), the Information and Communication Technology (ICT) agency of the United

[79] OECD, "Population with tertiary education."

Nations (UN), with a score of 100 out of 100.[80] The U.S. is widely considered an early adopter of AI, meaning one of the first nations to heavily invest in AI, develop a national strategy, and display an intention to be a global leader in AI. Early adoption of technology often comes hand in hand with first-mover advantage (reminder: first-mover advantage is the incentives of developing technology first; usually economic gains, but also the ability to shape the rules of the road for the technology and gain a competitive edge in development). Finally, executive actions across administrations have expressed confidence in the existing technological infrastructure of the U.S. to support an AI ecosystem.

2. Human Capital

The sheer size of the U.S. population is a strength. The U.S. population grew by roughly 18% from 2000 to 2022, primarily through immigration.[81] While the population aged 65+ grew 64%, this metric is less than the growth rate of the world's population aged 65+, which is 84% between 2000 and 2022. Finally, the U.S. crude birth rate, which was 36% below the world average in 2000 is 35% below the world average in 2022, meaning the crude U.S. birth rate, although declining in absolute terms, has maintained its position relative to the crude birth rate of the world. All of these factors suggest a very strong presence of human capital in the U.S.

3. Educational Environment

From 2000 to 2018, the U.S. led the world in high-impact research publications. In 2000, the U.S. published 10,450 high-impact AI publications compared to China's 1237: in 2018, the U.S. published 45,055 high-impact AI publications compared to China's 42,406. The U.S. led China by a significant margin in the realm of high-impact citations, maintaining a lead gap from 2000 to 2016 of approximately 650,000 high-impact citations. These metrics display that the U.S. has

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[80] ITU, "Global Cybersecurity Index 2020."
[81] U.S. Census Bureau, "U.S. Population Trends Return to Pre-Pandemic Norms as More States Gain Population."

consistently published the most influential works on the topic of AI when compared to the other four selected countries. Influential, or high-impact/quality works, are determined quantitatively by OpenAlex, the source of the citation data. A quality score is determined with the following equation; Quality score = # Citations / [(upcoming year) – (year of publication)] and then ranked low (score≤0.828), medium (0.828<score≤0.946), or high-quality (score>0.946).[82] The consistent issuing of AI publications across the past 22 years along with the sustained relevance and quality of these publications suggest the U.S. has a strong educational environment to develop an AI ecosystem.

4. Resources

The U.S. has sustained its place as the number one economy in the world from 2000 to 2022. GDP per capita is significantly higher than the four other countries analyzed, in 2000 and 2022, and the GDP per capita growth rate was just below the GDP per capita growth rate of the world. With a GDP of $25.44 trillion U.S. Dollars (USD) in 2022, the financial resources of the U.S. will support the growth of an AI ecosystem.

5. Drive

As seen through executive action, the U.S. has positioned itself to be a global leader in AI, AI norms, and responsible AI development. Additionally, research and development in AI have received high-priority directions. Former President Trump signed Executive Order (E.O.) 13859 “Maintaining American Leadership in Artificial Intelligence,” known as the American AI Initiative in 2019, and E.O. 13960 “Promoting the Use of Trustworthy Artificial Intelligence in the Federal Government” in 2020.[83] These executive orders prioritized AI investment,

[82] OECD.AI, “OpenAlex counting of publications: quality measure.”
[83] U.S., Executive Office of the President [Donald Trump], Executive Order 13859: Maintaining American Leadership in Artificial Intelligence; U.S. Executive Office of the President [Donald Trump], Executive Order 13960: Promoting the Use of Trustworthy Artificial Intelligence in the Federal Government.

established AI research institutes, generated AI standards, and focused on international AI partnerships. These pathways were codified in the National Artificial Intelligence Initiative Act of 2020, and the National Artificial Intelligence Office was established in accordance in 2021. President Biden has furthered these national AI efforts, with E.O 14110 on the "Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence," risk management frameworks, and the National AI Research & Development Strategic Plan.[84] Overall, the executive actions taken by the U.S., with a strong forward lens in terms of investment, development, and shaping the rules of the road, demonstrate a strong drive for an AI ecosystem.

China: Tier 1

Score: 4.5/5 components

Summary: Overall, China has a strong presence in the five components needed to develop an AI ecosystem. The current presence of human capital appears to be tenuous in the near future, cumulating to 0.5/1 points for the ranking. While China has the world's second-largest population (the largest population before 2022) and therefore currently has the human capital needed for an AI ecosystem, the country faces a demographic challenge that places the presence of human capital at risk, the legacy of the One Child Policy. Demographic crises may require AI resources diverted from research and development towards automation, as the workforce and productivity decline, which sustains Chinese power dimensions but does not add to international power. In contrast, economic strength and a regime type that allows for government-directed spending, coupled with the fast growth of the educational environment, are evident. This is shown through the growth rates of academic research publications; from 2000 to 2020, the Chinese academic research publication growth rate was 8,832.58% compared to 402.8% in the

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[84] The White House [Joseph Biden], "Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence"; Select Committee on AI of the National Science and Technology Council, "National Artificial Intelligence Research and Development Strategic Plan 2023 Update."

U.S. Additional support for an AI ecosystem can emerge from diversifying AI investment across various industries, which is essential to fostering a comprehensive AI ecosystem. With the incentive to develop AI from the demographic challenges that China faces along with executive action highlighting how China intends to shape the rules of the road, drive is present.

1. Technological Infrastructure

Looking at the top AI startups in the world and investment in these companies from 2012-2020, the AI startup that raised the most funding in these eight years, Didi Chuxing, is based in China. The top three Chinese AI startups and investments received fall just behind those of the U.S.-based companies, although are large when compared to the other countries in this analysis. However, China is not present in the top AI compute startups. Diversifying investments in various sectors of AI development is one strategy China can implement to maintain its AI advantage. China is ranked 33 on the ITU's Cybersecurity Index, with a score of 92.53 out of 100.[85] China is considered an early adopter of AI and will likely reap first-mover advantage from these rapid developments. Executive documents from China state goals that range from building the largest data models to train AI to developing intelligent infrastructure systems, which demonstrate confidence in the existing technological infrastructure to support an AI ecosystem.

2. Human Capital

The Chinese population grew by roughly 12% from 2000 to 2022. The population aged 65+ almost doubled, growing roughly 122% in terms of total population, making this metric much higher than the world growth rate, which is 84% between 2000 and 2022. Finally, China's crude birth rate, which was 36% below the world average in 2000 is 47% below the world average in 2022, meaning the crude Chinese birth rate has declined and has declined relative to the crude birth rate of the world. While the sheer size of the Chinese population is a strength and suggests

[85] ITU, "Global Cybersecurity Index 2020."

a presence of human capital right now, the increasing age coupled with declining births suggests an absence of human capital soon.

3. Educational Environment

China is second to the U.S. in the quantity and quality of academic research publications. Not only do the metrics suggest that China has the educational environment to support the development of an AI ecosystem, but also that China is destined to surpass the U.S. in this ability. When compared to the U.S. in 2000, China had significantly fewer publications, and of poorer quality. However, the growth rates of the quantity and quality of publications are huge. For example, in 2000 the U.S. published 10,450 high-quality research publications whereas China published 712; in 2020, the U.S. published 52,543 high-quality research publications while China published 63,600. The consistent growth in the quality and quantity of China's AI publications suggests a new educational environment; this is likely to benefit China, suggesting flexibility and huge potential for further growth. Additionally, Chinese talent pools for AI researchers and scientists have boomed in recent years.[86] Overall, the metrics on AI publications suggest a strong educational environment within China to support an AI ecosystem.

4. Resources

China has jumped from the eighth economy in the world in 2000, to the second in 2022. China's GDP per capita was significantly lower than the U.S., Japan, and South Korea in 2000, but experienced the highest growth rate, making the GDP per capita in 2022 on par with the world average. While the GDP per capita in 2022 is still less than the U.S., Japan, and South Korea, with a GDP of $17.96 trillion USD in 2022, China has significant financial assets to invest in an AI ecosystem.

[86] MacroPolo, "The Global AI Talent Tracker 2.0."

5. Drive

In a similar fashion to the U.S., and arguably in direct contention with U.S. executive initiatives on AI, China is attempting to shape the rule of the road for AI and lead global AI development. The Ministry of Foreign Affairs (MFA) of China has published the "Global AI Governance Initiative," aiming to develop global norms and standards for AI. [87] Additionally, the MFA of China has published two position papers, one on ethical AI governance and another on regulating AI military applications, spurring the assumption that China intends to further ethical AI governance in China and abroad and is developing AI military applications that incentive shaping military AI norms.[88] A critical agenda item is the development of large data banks to develop more holistic and effective AI programs. With the demographic challenge China faces with a declining and aging population, there is an additional incentive to create AI systems that can reduce the need for human workers across industrial sectors and facets of everyday life. Taken together, the executive actions of China as well as the demographic challenge of the future generate many reasons for China to develop an AI ecosystem and shape international perception.

India: Tier 3

Score: 3/5 components

Summary: India poses a unique case for this analysis. India's national AI strategy appears to be the most realistic and actionable strategy of all the countries in this analysis. It identifies strengths and weaknesses, and how to improve upon weaknesses. In terms of technological infrastructure, India currently lacks the technology to support an AI ecosystem, but with aims to harness late-mover advantage and a critical relationship with China in the Brazil, Russia, India,

[87] Ministry of Foreign Affairs of China, "Global AI Governance Initiative."
[88] Ministry of Foreign Affairs of China. "Position Paper of the People's Republic of China on Regulating Military Applications of Artificial Intelligence (AI)"; Ibid, "Position Paper of the People's Republic of China on Strengthening Ethical Governance of Artificial Intelligence (AI)."

China, and South Africa (BRICS) intergovernmental organization, India has potential to develop the technological infrastructure needed. Similarly, the educational environment needed is not present at this moment in time, which the national AI strategy acknowledges and aims to build up. Strong growth rates in publications, both in terms of quality and quantity, support this. Human capital is an interesting component: with the largest population in the world, overtaking China in 2022, and a very young population at that, India has the potential for a wealth of human capital. It is necessary to note the role of the caste system when discussing Indian human capital, specifically when investigating the percentage of educated Indians, something that may hinder the development and integration of AI into Indian society. While India's GDP is large and supports the resources needed for an AI ecosystem, GDP per capita is very low, questioning the equality of the AI ecosystem. Drive is evident in the realistic and applicable national AI strategy by capitalizing on late-mover advantage for cheaper and more reliable AI systems.

1. Technological Infrastructure

Looking at the top AI startups and investment in these companies from 2012-2020, India stands in the middle on AI startups and very low on compute startups. India is ranked 10 on the ITU's Cybersecurity Index, with a score of 97.5 out of 100.[89] In India's "National Strategy for Artificial Intelligence," the document acknowledges that India will not be a global leader in AI development but instead should aim to harness late-mover advantage, that can deliver cheaper and more refined AI technologies to meet India's needs. The primary aim is long-term competitiveness via strong foundations and an ability to integrate AI into everyday life to maximize social good, as opposed to shaping the rules of the road or dominating international competitiveness.[90] While India may not have the technological infrastructure at this moment in

[89] ITU, "Global Cybersecurity Index 2020."
[90] NITI Aayog, "National Strategy for Artificial Intelligence."

time to support an AI ecosystem, the National Strategy policy suggestions and India's cybersecurity environment strength suggest that India is trending towards the technological infrastructure needed in the future, especially when taking into account India's relationship with AI powerhouse China and BRICS. In 2023, BRICS established an AI study group, to track AI development in the member countries, monitor norms creation, and incubate innovation. Within this intergovernmental organization framework, India will benefit from a strategic partnership with AI leader China.[91]

2. Human Capital

The Indian population grew by roughly 34% from 2000 to 2022. While the population aged 65+ more than doubled, growing 105% between 2000 and 2022, the percentage of the population aged 65+ was 4.4% in 2000 and was only 6.8% in 2022. To compare, the percentage of the U.S. population aged 65+ was 12.3% in 2000 and 17.1% in 2022. So relatively speaking, while the jump appears large, the percentage of the Indian population aged 65+ is very low. Finally, the Indian crude birth rate, which was 22.7% above the world average in 2000 is exactly on par with the world average in 2022, meaning the crude Indian birth rate, although declining in absolute terms, has equalized over time with the world average. All of these factors suggest a strong presence of human capital in India, with a young and large population.

3. Educational Environment

In terms of quantity and quality of publications, India was in the worst position in 2000. While the 2020 metrics are still relatively low compared to China and the U.S., the growth rates of publications and quality of publications are comparable to those of China. India is currently contributing higher quality AI publications to the world than South Korea or Japan. India exports quality AI researchers and has improved retention of these individuals throughout the last three

[91] BRICS Information Portal, "BRICS Nations to Establish a Study Group to Track AI."

years.[92] It is also important to note that in India's "National Strategy for Artificial Intelligence," one of the five policy areas is education. However, low retention rates, poor learning outcomes, and low adoption of existing technologies are current obstacles to the presence of an educational environment that can support an AI ecosystem. OECD ranks India fourth to last in its tertiary education ranking, although these metrics indicate that younger populations are increasingly more educated than populations aged 55+.[93] The overall numbers suggest that India does not have an educational environment to support an AI ecosystem, but that if India sustains its current trajectory, the possibility of a supportive education environment could become a reality.

4. Resources

The Indian economy has grown from the thirteenth largest economy in 2000 to the fifth largest in 2022. GDP per capita has experienced a very large growth rate, significantly higher than the world GDP per capita growth rate, although the numerical values of GDP per capita are significantly lower than the four other countries in this analysis. China, which has the fourth lowest GDP per capita in this analysis at $12,720.2 USD, is still significantly higher than India's GDP per capita of $2,410.9 USD, both in 2022. With a GDP of $3.42 trillion USD in 2022, India does have the total financial resources to support the creation of an AI ecosystem.

5. Drive

India's international AI presence differs slightly from the other four countries in this analysis. The "National Strategy for Artificial Intelligence" was developed by the National Institution for Transforming India (NITI Aayog), a policy think tank within the Indian government directed to catalyze the economy when established in 2015. Despite this technical difference, the National Strategy functions as executive action. A critical element of this National Strategy is that it

[92] MacroPolo, "The Global AI Talent Tracker 2.0."
[93] OECD, "Population with tertiary education."

evaluates where the private sector will be most efficient in developing AI to further India's foreign and domestic policy goals, and where the government will be most effective. For example, the agricultural sector of India has fewer profit incentives for private-sector AI applications, so the government should take the lead in effective AI implementation in this industry. India's National AI Strategy aims to harness late-mover advantage, like cheaper product development and better flushed out technology, to support research and development sectors to improve international competitiveness. Holistically, this National Strategy appears to be the most realistic and intentional of the five strategies examined, demonstrating a strong Indian drive to build an AI ecosystem.

South Korea: Tier 3

Score: 2.5/5 components

Summary: The South Korean national AI strategy notes strengths and areas for growth, leaning back on the country's reputation as innovative, seen in the technically sound information and communications technology (ICT) sector. The current technological infrastructure in South Korea does not support an AI ecosystem, but factors suggest the country is very close to developing the needed infrastructure, especially ahead of Japan. Similarly, the educational environment needed to sustain an AI ecosystem is absent, but the national AI strategy lays out ways to counter this. Growth rates in publications suggest a positive trend in the educational environment. However, South Korea has the smallest total population out of all the analyzed countries and a crude birth rate that does not sustain the aging population, meaning a deficit in human capital. While this is an incentive for AI development, it is also a hindrance; resources may be diverted to automation instead of research and development, and without sufficient human capital the success of the potential educational environment is limited. South Korea finds strengths in its large GDP per capita and GDP in general and possesses the drive needed to develop an AI ecosystem evident in executive action and ICT reputation.

1. Technological Infrastructure

In the South Korean "National Strategy for Artificial Intelligence," there is an acknowledgment that South Korea sits squarely between first movers and late movers, in terms of advantage. Manufacturing, e-government, and ICT infrastructure are the noted areas of expertise where South Korea believes it can harness second-mover advantage and lead the middle section of global AI adopters.[94] This is supported by the South Korean ranking of fourth on the ITU's Cybersecurity Index, with a score of 98.52 out of 100.[95] Challenges are found in the top AI startups and investments in these companies from 2012-2020, as South Korea is behind the other countries in this analysis, in terms of company rank and investment. The third Indian AI startup raised similar funds to the first South Korean AI startup. However, a leg up may be found in AI compute startups, where funding exceeds that of Japan and India, as enforced by the National Strategy. One element of the strategy is "AI Infrastructure Enhancement" with the noted challenge being access to data and the high costs associated with needed compute resources. Overall, South Korea does not have the technological infrastructure to support an AI ecosystem, but it is extremely close to obtaining the needed components via vigorous strategizing.

2. Human Capital

The South Korean population grew roughly 9.8% from 2000 to 2022. The population aged 65+ more than doubled in this range, growing roughly 169%, making this metric significantly higher than the world growth rate, which is 84%. Finally, the South Korean crude birth rate, which was 36% below the world average in 2000 is 70.1% below the world average in 2022, meaning the

[94] The Government of the Republic of Korea, "National Strategy for Artificial Intelligence."
[95] ITU, "Global Cybersecurity Index 2020."

crude South Korean birth rate has declined and has declined relative to the crude birth rate of the world. In the Group of 20 (G20), South Korea has the lowest crude birth rate in 2022. South Korea faces an extreme deficit of human capital, with a relatively small population when compared to other nations and a large aging population without a birth rate to replace.

3. Educational Environment

South Korea was in the second weakest position to develop an AI ecosystem in 2000, with the second lowest quantity and quality metrics of AI publications. By 2022, South Korea has demonstrated strong growth in both categories as shown by high growth rates, but the overall numbers are still low when compared to the other countries in the study. While the OECD ranks South Korea first in world tertiary education rankings, the South Korean government took the position that their current educational environment was not sufficient to meet their AI development needs, focusing heavily on future education innovation development and implementation.[96] The metrics suggest South Korea has large potential to develop an educational environment that can support an AI ecosystem with relevant investment and prioritization, but currently does not possess the educational environment to support an AI ecosystem.

4. Resources

The South Korean economy has fallen one spot in the world economy rankings, from the 12th largest economy in 2000 to the 13th largest in 2022. However, GDP per capita has experienced a growth rate above the world GDP per capita growth rate. With a GDP of $1.67 trillion USD in 2022 and a solidly high GDP per capita when compared to the other four nations in this study, South Korea has financial resources to support an AI ecosystem.

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[96] OECD, "Population with tertiary education"; The Government of the Republic of Korea, "National Strategy for Artificial Intelligence," pp. 30 - 33; MacroPolo, "The Global AI Talent Tracker 2.0."

5. Drive

South Korea has published executive action on AI and plans to support its international reputation as a leader in ICT with AI developments. Ranked first in Bloomberg's Innovation Index from 2013-2016 and only falling to Germany for second place in 2020, South Korea has led global economic and research and development innovation, boasting fast internet speed and information technology (IT) firm's headquarters and hubs, among other factors.[97] South Korea's "National Strategy for Artificial Intelligence," published in 2019, focuses on innovation, investment, and the demographic challenge that South Korea faces. Similarly to Japan, a critical demographic crisis creates a primary incentive for AI development to replace critical workforces that will soon diminish. While this agenda is less focused on shaping the actions of other nations in terms of AI, the executive direction and support of the technological reputation of South Korea demonstrates the drive to develop an AI ecosystem.

Japan: Tier 3

Score: 2.5/5 components

Summary: Japan is an interesting case study in this analysis, because quite a few of its components, whether present or absent, affect the status of other components, in terms of the five needed to develop an AI ecosystem. Japan's national AI strategy explains how the current technological infrastructure cannot support an AI ecosystem but outlines ways to improve this, suggesting that Japan has the potential to develop adequate technological infrastructure shortly. Japan faces a critical demographic crisis, with a declining population. Additionally, the current educational environment is not sufficient to support an AI ecosystem. While Japan has the financial resources to better this situation, the extreme absence of human capital is evident in the only negative total population growth rate in this study (-1.35%, compared to 29.4% growth rate

[97] Jamrisko and Lu, "Germany Breaks Korea's Six-Year Streak as Most Innovative Nation."

for the world) and birth growth rate lower than the world average (-30.5% compared to -22.44% for the world), raises questions about who will be trained or educated if the educational environment does arise. On the contrary, the demographic crisis is a massive incentive to develop AI, although to support automation, not for research and development that may strengthen international power. The economic success of Japan may aid in some of the lacking components, but without people, Japan may come to rely on AI for economic success and increased productivity, instead of shaping global AI development. Executive action notes that Japan is aware of the components it lacks and the nuances of its situation, meaning drive is present.

1. Technological Infrastructure

Japan is ranked seventh on the ITU's Cybersecurity Index, with a score of 97.82 out of 100.[98] Looking at the top AI startups and investment in these companies from 2012-2020, Japan lags behind the other countries in this analysis in funds raised and diversified investment. Japanese AI startups raised the least amount of funds when compared to the other countries. The top Japanese AI startup raised less funds than the third AI startup in South Korea. Japan's "AI Strategy 2022" acknowledges that AI needs infrastructure, including high-speed communication networks and access to large-scale data storage, two aspects that Japan lacks.[99] These needs are addressed by data infrastructure development initiatives that began over the past six years. Since this initiative is ongoing as outlined in the strategy and accounting for the metrics stated, Japan does not currently have the technological infrastructure necessary to support an AI ecosystem, although it seems on a good trajectory to build what is needed.

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[98] ITU, "Global Cybersecurity Index 2020."

[99] Government of Japan. "AI Strategy 2022 - tentative translation."

2. Human Capital

The Japanese population declined by roughly 1.4% from 2000 to 2022. The population aged 65+ grew roughly 66%, making this metric lower than the world growth rate, which is 84% between 2000 and 2022. Despite the numerical value, 17.8% of Japan's population was aged 65+ in 2000, and almost 30% of the population was aged 65+ in 2022. For comparison, 17.1% of the U.S. population was aged 65+ in 2022, making the numbers relatively the same but 22 years apart. Finally, the Japanese crude birth rate, which was 54% below the world average in 2000 is 58% below the world average in 2022, meaning the crude Japanese birth rate has declined and has declined relative to the crude birth rate of the world. In the G20, only South Korea has a lower crude birth rate average from 2000 to 2022 when compared to Japan. Japan is experiencing a severe drought of human capital, with a declining population that was originally relatively small when compared to other nations, without a crude birth rate to sustain the large aging population.

3. Educational Environment

Japan displayed an adequate educational environment in 2000 but faded out of contention by 2022. When the 2000 Japanese metrics are compared to the other selected countries, Japan seemed in a good position for future growth, far behind the U.S. but issuing more AI publications than China and higher quality publications. While Japan has continued to issue AI publications and contribute high-quality publications, growth rates are very small when compared to the other selected countries. Additionally, Japan is not present on MacroPolo's "Global AI Talent Tracker." However, positive factors include the OECD's tertiary education ranking of Japan, the third highest in the world, and concrete quantitative goals within Japan's "AI Strategy 2022," such as producing 500,000 university and technical college graduates with entry-level mathematics, data science, and AI understanding, regardless of concentration.[100]

[100] OECD, "Population with tertiary education"; Government of Japan. "AI Strategy 2022 - tentative translation."

While these factors suggest Japan has the means and drive to develop an educational environment that can support an AI ecosystem, when understood in relation to the other nations in this study, the current educational environment in Japan would not support the development of an AI ecosystem.

4. Resources

Japan has sustained a high position among the world's largest economies, ranking fourth in 2000 and third in 2022. Unlike the four other nations in this study, Japan has experienced growth and losses across the last 22 years, making the growth trajectory non-linear. Japanese GDP per capita was the highest out of all five nations in 2000, and although significantly lower than the U.S. in 2022, is the second-highest GDP per capita out of the selected countries. Despite this fact, the GDP per capita growth rate was negative, suggesting that the Japanese economy may be slowing down at this exact point in time. The National Strategy acknowledges a lag in Japanese adoption of AI and how this could potentially threaten Japanese economic development. However, with a GDP of $4.26 trillion USD in 2022 and a high GDP per capita, Japan has the financial resources to support an AI ecosystem.

5. Drive

The reasoning behind AI development in Japan is multifaceted but can be divided into two categories: necessity and innovation. Japan is facing an extreme demographic crisis, with a declining population that is aging without a birth rate sufficient to sustain the population. Japan needs AI and automation to replace human capital elements that are not present and are not projected to be present in the future. This need for AI to replace human elements is a critical catalyst behind AI development and a reason why Japan has effectively implemented AI systems. In terms of innovation, the executive branch of the Japanese government, the Cabinet

Office, has published the Society 5.0 plan for a future society based on science and technology. Society 5.0 is described as a human-centric society that thrives, economically and socially, in physical *and* cyber spaces. Society 5.0 addresses the demographic challenge Japan faces and how AI can aid in some of these challenges. This plan also highlights industrial competitiveness with AI. AI is a critical element of analysis in the transition from Society 4.0 to 5.0, with AI positioned as the middleman between humans and information from cyberspace.[101] There are potential fallacies in this executive plan, like a human-centric aim even within the digital world, but the concept behind Society 5.0 demonstrates that the Japanese government is aware of the potential AI holds for their nation, demonstrating a drive to develop an AI ecosystem.

Potential for movement to a new tier

The potential for movement to a new tier is relevant for many reasons as countries can determine what elements to develop in order to increase their potential for success when building an AI ecosystem. Diffusion, networks of diffusion, and mover advantage are all important to discuss when noting which countries have the potential to move to a new tier. [102]

Ⅰ. China: While scientific trends place China squarely in AI global leadership contention, the potential economic impact of the demographic challenge and lack of AI compute power within industry, pose two weaknesses for China maintaining its position in Tier 1.

Ⅱ. South Korea and Japan: Both nations face extreme demographic challenges which are first and foremost hindrances to the development of an AI ecosystem. That said, the demographic impacts on productivity and economic success are strong incentives to develop the AI ecosystem, although South Korea and Japan may have to divert resources based on necessity, as opposed to the U.S. and China which intend to use AI to bolster national power. If the current trajectories of

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[101] Government of Japan Cabinet Office, "Society 5.0."

[102] Loucks et al, "Future in the balance? How Countries are pursuing an AI advantage"; BRICS Information Portal, "BRICS Nations to Establish a Study Group to Track AI."

developing technological infrastructures occur *and* these governments focus on tying these educational environments to developed technological infrastructure, there is potential for movement into tier 2.

9. Results

AI has the potential to alter international power dynamics. As a technology, AI will shape the international system while being shaped by the international system, in a very dynamic process. Using the Dahlian identifiable elements of power in international relations, *source, scope, means, and extent*, along with Barnett and Duvall's power categories of *compulsory, institutional, structural*, and *productive* power, it is possible to forecast how AI will change international power dynamics.

AI is itself a *source* of power, a *means* of power, and a *scope* of power, thereby influencing the *extent* of power. AI is a resource that Actor A can use to affect the behavior of Actor B. AI is an instrument that can use other sources of power, like material resources, from Actor A to affect the behavior of Actor B. AI is a scope of power in that Actor B could harness AI to respond to Actor A's source and means.[103] Therefore, AI increases the potential for:

1. *Power over* types of power
    a. Compulsory power: Actor A can use AI to directly alter the actions of Actor B, by training an AI system to act towards Actor B.
    b. Institutional power: Actor A can exert indirect influence over the actions of Actor B with AI, whether that be through setting the rules of the road for AI or controlling data used to train systems.

[103] Dahl, "The Concept of Power."

2. P*ower to* types of power
    a. Structural power: Actor A can use AI to directly attribute elements of power to Actor B, like gifting AI systems or allowing access to data banks.
    b. Productive power: Actor A can indirectly attribute elements of power to Actor B through AI, via globally used AI programs.

Nations that harness AI to portray *power over* other nations while using AI to aid in *power to* relations, whether that be in solidifying their existing power dimensions or helping allies and partners, will prove to be powerful AI actors. Therefore, AI increases a nation's ability to exert *power over* another and to give dimensions of *power to* another.[104]

Power to is relevant when discussing the diffusion of AI systems, which is a critical element of understanding the mover advantage of this emergent technology. The tiered AI ecosystem probability rankings place the U.S. and China in Tier 1, and India, South Korea, and Japan in Tier 3, which is relevant to understanding AI and international power right now. That withstanding, the *power to* element of AI is a key understanding for the future of AI, power, and international relations. As noted, different international relationships, partnerships, adversarial structures, and international organization involvement will influence how AI diffuses globally.

The U.S. and China have the resources to develop AI systems and have developed integration plans, influencing the future perception and uses of AI, thereby harnessing first-mover advantage. Gains, while not to be known for some time, may be economic, political, and normative. The national strategies of both nations specifically intend to shape the rules of the road for AI. In a hypothetical situation, the first-mover normative advantage could hinder gains made by second and late movers, intentionally limiting the use, integration, or application of AI

[104] Barnett and Duvall, "Power in International Politics."

systems in these second and late-mover nations, with the purpose of exploiting first-mover advantage in the U.S. and China.

Second movers, to be determined but possibly including South Korea and Japan, will integrate AI systems that have been refined over time and therefore are more accurate in their purpose and involve less risk, but may lose out on some of the economic, political, and normative gains of first movers. Specifically, South Korea and Japan may use AI to support their human capital droughts or to regain economic and normative strength lost on the world stage, while the U.S. and China make influential strides ahead. Late movers, like self-determined India, will inherit AI systems with proven effectiveness in harnessing existing elements of national power, but not before the first movers sustain large leaps and the second movers regain competitive advantages. This is not to say that late movers will not benefit from AI: they surely will, whether that be in automation that aids human capital drought, increased productivity and efficiency that aids economic growth, or the future development of critical military innovations with AI. When more nations harness AI to aid their existing elements of power, hard (military, economic) or soft (diplomatic, cultural), those with existing power will jump ahead of those that do not harness those dimensions of power, incentivizing the adoption and integration of AI systems and speeding up diffusion. The argument is that mover advantage will diminish as AI quickly diffuses through international partnerships and alliances, as systems become more efficient and effective, and as AI becomes more widespread based on the low barriers to entry.

Central nations in the international system will maintain their centrality via first-mover advantage, applying AI to existing and strong elements of power to reinforce these power dimensions. The outcomes of peripheral nations will vary. Those peripheral nations with key relationships to central nations, for example, India and China due to their participation in BRICS, may be able to reap second-mover advantages to bolster specific existing elements of power and make strides on the world stage. However, these strides will not be enough to shake up the existing international order. Peripheral nations that severely lack components of the AI ecosystem or lack key economic and technical relationships with central nations, will fall deeper into the periphery of the international system.[105]

10. Conclusion

AI has the potential to alter international power dynamics, by increasing both the ability of nations to exert *power over* other nations and aid their allies and partners by giving *power to* other nations. As a relatively new technology, with few normative guidelines and unknown benefits and drawbacks, the impact of AI on international relations cannot be underestimated.

The purpose of this paper is to evaluate a range of nations on their existing elements of power and the necessary components in the development of an AI ecosystem, to produce a tiered evaluation. The tiered ranking outcomes position nations relative to one another, while allowing for isolated evaluation of a nation's competency to develop and integrate an AI ecosystem. Understanding why nations are in Tier 1 or Tier 3 can identify areas for improvement or critical vulnerabilities in the AI ecosystem. The roles of diffusion and mover advantage are explanatory factors in the tiered ranks and aid in the explanation of why AI will exacerbate existing power differentials.

Future analysis could determine the role of mover advantage in sustaining comparative advantage in AI, whether that be in technological development or setting the rules of the road. As an emergent technology, this analysis is in no way intended to be read as exhaustive: this is just the beginning of understanding the role of AI in international affairs. The schema of the AI

[105] Granados, "Artificial Intelligence and International System Structure."

ecosystem and tiered analysis is a useful method for further study on the impacts of AI on international power dynamics. In future study and research, it would be beneficial to further parse out the five components of the AI ecosystem. When more data becomes available, which is contingent on research, time, and sensitivity of discoveries, this hypothetical analysis can be better supported by empirical metrics. A critical gap in this analysis is the application and integration of AI to support military power, whether that be in command and control rooms or the justification behind militaristic decisions. Due to the classification of this material, this information may not be publicly available for some time, which affects the totality of understanding AI in the international system. Therefore, hypotheticals, hypotheses, and comparisons to technological situations in the past are useful strategies to address these gaps.

11. Figures

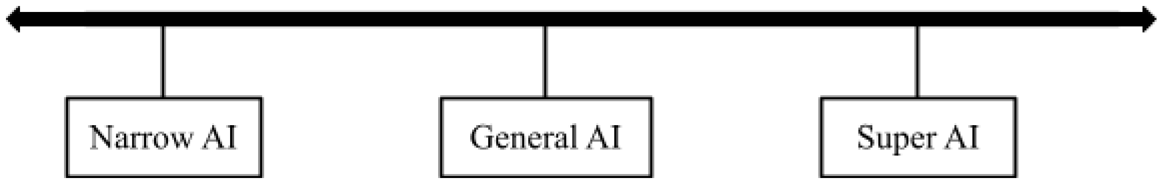
1. 

Figure 1: The AI Spectrum

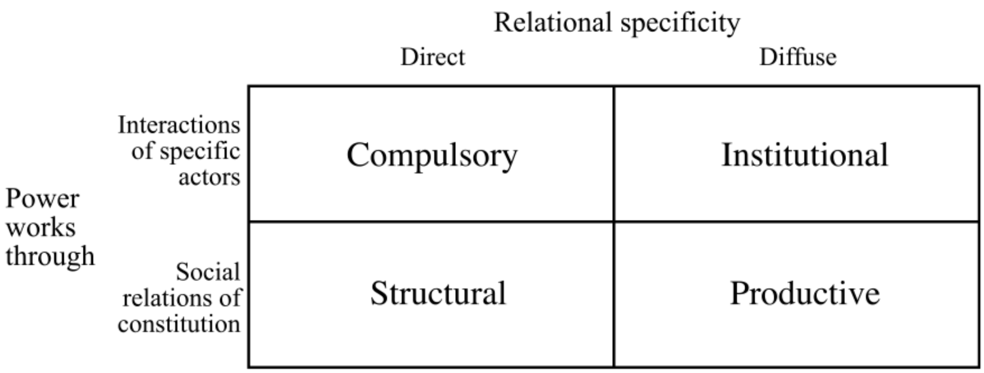
2. 

Figure 2: Barnett and Duvall's Taxonomy of Power[106]

3.

	Public sector dominance	*Private sector dominance*
High fixed costs	**Prestige tech**	**Strategic tech**
Low fixed costs	**Public tech**	**General purpose tech**

Figure 3: Drezner's Technological Categories[107]

[106] Barnett and Duvall, "Power in International Politics," pp. 48.
[107] Drezner, "Technological change and international relations," pp. 292.

4. Figure 4: World Metrics (Population, crude birth rate, population 65+, GDP)

Year	Population Total[108]	Crude Birth Rate (Per 1,000 people)[109]	Population 65+[110]	GDP (Current USD $, in Trillions (T))[111]
2000	6144321462	21.8417245	423103283	33.90
2001	6226348086	21.5513509	434244243	33.69
2002	6308140970	21.2414985	445817722	34.98
2003	6389462496	20.9577167	457355201	39.22
2004	6470924346	20.7885499	468711289	44.20
2005	6552700448	20.6113133	480077594	47.86
2006	6635110367	20.4410125	491448431	51.86
2007	6717567584	20.4043796	502135081	58.45
2008	6801440971	20.3411884	512300645	64.23
2009	6885663352	20.1633037	522628368	60.89
2010	6969985525	20.0045311	533318780	66.71
2011	7054044372	20.1191346	545600682	73.97
2012	7141386257	20.2340955	560966278	75.61
2013	7229303088	19.7280882	578111274	77.71
2014	7317040295	19.6429823	596947700	79.84
2015	7403850164	19.1128427	617444939	75.28
2016	7490415449	19.1738942	639319478	76.52
2017	7576441961	18.7000992	662621137	81.48
2018	7660371127	18.1788072	686904072	86.54
2019	7741774583	17.8176966	711989606	87.78
2020	7820205606	17.2266113	737072656	85.27
2021	7888305693	16.9386559	758641414	97.15
2022	7950946801	N/A	779605295	100.88
Percentage Growth from 2000 to 2021 = (Present-Past)/(Past)	29.40%	-22.44%	84.26%	197.58%

108 World Bank Data, "Population, total."
109 World Bank Data, "Birth rate, crude."
110 World Bank Data, "Population ages 65 and above, total."
111 World Bank Data, "GDP (Current US$)."

5. Figure 5: U.S. Metrics (Population, crude birth rate, population 65+, GDP)

Year	Population Total[112]	Crude Birth Rate (Per 1,000 people)[113]	Population 65+[114]	GDP (Current USD $, in Trillions (T))[115]
2000	282162411	14.4	34755721	10.25
2001	284968955	14.1	35042477	10.58
2002	287625193	14	35341824	10.93
2003	290107933	14.1	35619261	11.46
2004	292805298	14	36028870	12.22
2005	295516599	14	36526333	13.04
2006	298379912	14.3	37064967	13.82
2007	301231207	14.3	37677408	14.47
2008	304093966	14	38531316	14.77
2009	306771529	13.5	39439341	14.48
2010	309327143	13	40299692	15.05
2011	311583481	12.7	41347761	15.60
2012	313877662	12.6	42638513	16.25
2013	316059947	12.4	43904126	16.84
2014	318386329	12.5	45005701	17.55
2015	320738994	12.4	45954694	18.21
2016	323071755	12.2	47402094	18.70
2017	325122128	11.8	48983844	19.48T
2018	326838199	11.6	50325557	20.53
2019	328329953	11.4	51849212	21.38
2020	331511512	10.9	53782439	21.06
2021	332031554	11	55379196	23.32
2022	333287557	N/A	57085895	25.44
Percentage Growth from 2000 to 2021 = (Present-Past)/(Past)	18.12%	-23.61%	64.25%	148.20%

112 World Bank Data, "Population, total."
113 World Bank Data, "Birth rate, crude."
114 World Bank Data, "Population ages 65 and above, total."
115 World Bank Data, "GDP (Current US$)."

6. Figure 6: China Metrics (Population, crude birth rate, population 65+, GDP)

Year	Population Total[116]	Crude Birth Rate (Per 1,000 people)[117]	Population 65+[118]	GDP (Current USD $, in Trillions (T))[119]
2000	1262645000	14.03	87382979	1.21
2001	1271850000	13.38	90569395	1.34
2002	1280400000	12.86	93692315	1.47
2003	1288400000	12.41	96660764	1.66
2004	1296075000	12.29	99361609	1.96
2005	1303720000	12.4	102021532	2.29
2006	1311020000	12.09	104839668	2.75
2007	1317885000	12.1	107525766	3.55
2008	1324655000	12.14	109993150	4.59
2009	1331260000	11.95	112495225	5.10
2010	1337705000	11.9	115264009	6.09
2011	1345035000	13.27	118580277	7.55
2012	1354190000	14.57	122544762	8.53
2013	1363240000	13.03	127059111	9.57
2014	1371860000	13.83	132153818	10.48
2015	1379860000	11.99	138262713	11.06
2016	1387790000	13.57	145118407	11.23
2017	1396215000	12.64	152834660	12.31
2018	1402760000	10.86	161037596	13.89
2019	1407745000	10.41	169240734	14.28
2020	1411100000	8.52	177774074	14.69
2021	1412360000	7.52	185721855	17.82
2022	1412175000	N/A	193783391	17.96
Percentage Growth from 2000 to 2021 = (Present-Past)/(Past)	11.84%	-46.40%	121.76%	1,384.30%

116 World Bank Data, "Population, total."
117 World Bank Data, "Birth rate, crude."
118 World Bank Data, "Population ages 65 and above, total."
119 World Bank Data, "GDP (Current US$)."

7. Figure 7: India Metrics (Population, crude birth rate, population 65+, GDP)

Year	Population Total[120]	Crude Birth Rate (Per 1,000 people)[121]	Population 65+[122]	GDP (Current USD $, in Trillions (T))[123]
2000	1059633675	27.001	47616579	0.4684T
2001	1078970907	26.728	49113495	0.4854T
2002	1098313039	26.082	50676067	0.5149
2003	1117415123	25.375	52269470	0.6077
2004	1136264583	24.728	53832505	0.7092
2005	1154638713	23.94	55342330	0.8204
2006	1172373788	23.22	56817102	0.9403
2007	1189691809	22.713	58275189	1.22
2008	1206734806	22.276	59741552	1.2
2009	1223640160	21.934	61251588	1.34
2010	1240613620	21.438	62849330	1.68
2011	1257621191	20.945	64583831	1.82
2012	1274487215	20.421	66495584	1.83
2013	1291132063	19.935	68634509	1.86
2014	1307246509	19.049	71341897	2.04
2015	1322866505	18.765	74613573	2.10
2016	1338636340	18.514	78116348	2.29
2017	1354195680	17.911	81804197	2.65
2018	1369003306	17.651	85618417	2.70
2019	1383112050	17.049	89515357	2.84
2020	1396387127	16.572	93171419	2.67
2021	1407563842	16.419	95749032	3.15
2022	1417173173	N/A	97734540	3.42
Percentage Growth from 2000 to 2021 = (Present-Past)/(Past)	33.74%	-39.19%	105.25%	630.15%

120 World Bank Data, "Population, total."
121 World Bank Data, "Birth rate, crude."
122 World Bank Data, "Population ages 65 and above, total."
123 World Bank Data, "GDP (Current US$)."

8. Figure 8: Korea Metrics (Population, crude birth rate, population 65+, GDP)

Year	Population Total[124]	Crude Birth Rate (Per 1,000 people)[125]	Population 65+[126]	GDP(Current USD $, in Trillions (T))[127]
2000	47008111	13.5	3353550	0.5762
2001	47370164	11.7	3548716	0.5477
2002	47644736	10.3	3749902	0.6273
2003	47892330	10.2	3956369	0.7027
2004	48082519	9.8	4164400	0.7932
2005	48184561	9	4363900	0.9349
2006	48438292	9.2	4589185	1.05
2007	48683638	10.1	4825056	1.17
2008	49054708	9.4	5053487	1.05
2009	49307835	9	5259533	0.9439
2010	49554112	9.4	5473792	1.14
2011	49936638	9.4	5691117	1.25
2012	50199853	9.6	5891279	1.28
2013	50428893	8.6	6110977	1.37
2014	50746659	8.6	6361571	1.48
2015	51014947	8.6	6610311	1.47
2016	51217803	7.9	6844554	1.5
2017	51361911	7	7125615	1.62
2018	51585058	6.4	7455735	1.73
2019	51764822	5.9	7798729	1.65
2020	51836239	5.3	8205194	1.64
2021	51744876	5.1	8615918	1.82
2022	51628117	N/A	9030344	1.67
Percentage Growth from 2000 to 2021 = (Present-Past)/(Past)	9.8%	-62.22%	169.28%	189.83%

124 World Bank Data, "Population, total."
125 World Bank Data, "Birth rate, crude."
126 World Bank Data, "Population ages 65 and above, total."
127 World Bank Data, "GDP (Current US$)."

9. Figure 9: Japan Metrics (Population, crude birth rate, population 65+, GDP)

Year	Population Total[128]	Crude Birth Rate (Per 1,000 people)[129]	Population 65+[130]	GDP (Current USD $, in Trillions (T))[131]
2000	126843000	9.5	22584255	4.97
2001	127149000	9.3	23420079	4.37
2002	127445000	9.2	24245889	4.18
2003	127718000	8.9	24992848	4.52
2004	127761000	8.8	25630222	4.89
2005	127773000	8.4	26326876	4.83
2006	127854000	8.7	27178297	4.6
2007	128001000	8.6	28084356	4.58
2008	128063000	8.7	28918875	5.11
2009	128047000	8.5	29663227	5.29
2010	128070000	8.5	30225206	5.76
2011	127833000	8.3	30651515	6.23
2012	127629000	8.2	31457297	6.27
2013	127445000	8.2	32602328	5.21
2014	127276000	8	33762485	4.9
2015	127141000	8	34745347	4.44
2016	127076000	7.8	35512557	5.00
2017	126972000	7.6	36141302	4.93
2018	126811000	7.4	36650477	5.04
2019	126633000	7	37077906	5.12
2020	126261000	6.8	37352017	5.06
2021	125681593	6.6	37436889	5.03
2022	125124989	N/A	37443104	4.26
Percentage Growth from 2000 to 2021 = (Present-Past)/(Past)	-1.35%	-30.5%	65.79%	-14.29%

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[128] World Bank Data, "Population, total."
[129] World Bank Data, "Birth rate, crude."
[130] World Bank Data, "Population ages 65 and above, total."
[131] World Bank Data, "GDP (Current US$)."

10. Figure 10: Population Total Metrics[132]

Year	World	U.S.	China	India	Korea	Japan
2000	6144321462	282162411	1262645000	1059633675	47008111	126843000
2001	6226348086	284968955	1271850000	1078970907	47370164	127149000
2002	6308140970	287625193	1280400000	1098313039	47644736	127445000
2003	6389462496	290107933	1288400000	1117415123	47892330	127718000
2004	6470924346	292805298	1296075000	1136264583	48082519	127761000
2005	6552700448	295516599	1303720000	1154638713	48184561	127773000
2006	6635110367	298379912	1311020000	1172373788	48438292	127854000
2007	6717567584	301231207	1317885000	1189691809	48683638	128001000
2008	6801440971	304093966	1324655000	1206734806	49054708	128063000
2009	6885663352	306771529	1331260000	1223640160	49307835	128047000
2010	6969985525	309327143	1337705000	1240613620	49554112	128070000
2011	7054044372	311583481	1345035000	1257621191	49936638	127833000
2012	7141386257	313877662	1354190000	1274487215	50199853	127629000
2013	7229303088	316059947	1363240000	1291132063	50428893	127445000
2014	7317040295	318386329	1371860000	1307246509	50746659	127276000
2015	7403850164	320738994	1379860000	1322866505	51014947	127141000
2016	7490415449	323071755	1387790000	1338636340	51217803	127076000
2017	7576441961	325122128	1396215000	1354195680	51361911	126972000
2018	7660371127	326838199	1402760000	1369003306	51585058	126811000
2019	7741774583	328329953	1407745000	1383112050	51764822	126633000
2020	7820205606	331511512	1411100000	1396387127	51836239	126261000
2021	7888305693	332031554	1412360000	1407563842	51744876	125681593
2022	7950946801	333287557	1412175000	1417173173	51628117	125124989
Percentage Growth from 2000 to 2022 = (Present-Past)/(Past)	29.40%	18.12%	11.84%	33.74%	9.8%	-1.35%

[132] World Bank Data, "Population, total."

11. Figure 11: Crude Birth Rate (Per 1,000 people) Metrics[133]

Year	World	U.S.	China	India	Korea	Japan
2000	21.84	14.4	14.03	27.00	13.5	9.5
2001	21.55	14.1	13.38	26.73	11.7	9.3
2002	21.24	14	12.86	26.08	10.3	9.2
2003	20.96	14.1	12.41	25.38	10.2	8.9
2004	20.79	14	12.29	24.73	9.8	8.8
2005	20.61	14	12.4	23.94	9	8.4
2006	20.44	14.3	12.09	23.22	9.2	8.7
2007	20.41	14.3	12.1	22.71	10.1	8.6
2008	20.34	14	12.14	22.28	9.4	8.7
2009	20.16	13.5	11.95	21.93	9	8.5
2010	20.01	13	11.9	21.44	9.4	8.5
2011	20.12	12.7	13.27	20.95	9.4	8.3
2012	20.23	12.6	14.57	20.42	9.6	8.2
2013	19.73	12.4	13.03	19.94	8.6	8.2
2014	19.6	12.5	13.83	19.05	8.6	8
2015	19.11	12.4	11.99	18.77	8.6	8
2016	19.17	12.2	13.57	18.51	7.9	7.8
2017	18.70	11.8	12.64	17.91	7	7.6
2018	18.18	11.6	10.86	17.65	6.4	7.4
2019	17.82	11.4	10.41	17.05	5.9	7
2020	17.23	10.9	8.52	16.57	5.3	6.8
2021	16.94	11	7.52	16.42	5.1	6.6
2022	N/A	N/A	N/A	N/A	N/A	N/A
Percentage Growth from 2000 to 2021 = (Present-Past)/ (Past)	-22.44%	-23.61%	-46.40%	-39.19%	-62.22%	-30.5%

133 World Bank Data, "Birth rate, crude."

12. Figure 12: Population Age 65+[134]

Year	World	U.S.	China	India	Korea	Japan
2000	423103283	34755721	87382979	47616579	3353550	22584255
2001	434244243	35042477	90569395	49113495	3548716	23420079
2002	445817722	35341824	93692315	50676067	3749902	24245889
2003	457355201	35619261	96660764	52269470	3956369	24992848
2004	468711289	36028870	99361609	53832505	4164400	25630222
2005	480077594	36526333	102021532	55342330	4363900	26326876
2006	491448431	37064967	104839668	56817102	4589185	27178297
2007	502135081	37677408	107525766	58275189	4825056	28084356
2008	512300645	38531316	109993150	59741552	5053487	28918875
2009	522628368	39439341	112495225	61251588	5259533	29663227
2010	533318780	40299692	115264009	62849330	5473792	30225206
2011	545600682	41347761	118580277	64583831	5691117	30651515
2012	560966278	42638513	122544762	66495584	5891279	31457297
2013	578111274	43904126	127059111	68634509	6110977	32602328
2014	596947700	45005701	132153818	71341897	6361571	33762485
2015	617444939	45954694	138262713	74613573	6610311	34745347
2016	639319478	47402094	145118407	78116348	6844554	35512557
2017	662621137	48983844	152834660	81804197	7125615	36141302
2018	686904072	50325557	161037596	85618417	7455735	36650477
2019	711989606	51849212	169240734	89515357	7798729	37077906
2020	737072656	53782439	177774074	93171419	8205194	37352017
2021	758641414	55379196	185721855	95749032	8615918	37436889
2022	779605295	57085895	193783391	97734540	9030344	37443104
Percentage Growth from 2000 to 2021 = (Present-Past)/(Past)	84.26%	64.25%	121.76%	105.25%	169.28%	65.79%

[134] World Bank Data, "Population ages 65 and above, total."

13. Figure 13: Gross Domestic Product (Current USD $) Metrics[135]

Year	World (In Trillions (T))	U.S. (In Trillions (T))	China (In Trillions (T))	India (In Trillions (T))	Korea (In Trillions (T))	Japan (In Trillions (T))
2000	33.90	10.25	1.21	0.4684	0.5762	4.97
2001	33.69	10.58	1.34	0.4854	0.5477	4.37
2002	34.98	10.93	1.47	0.5149	0.6273	4.18
2003	39.22	11.46	1.66	0.6077	0.7027	4.52
2004	44.20	12.22	1.96	0.7092	0.7932	4.89
2005	47.86	13.04	2.29	0.8204	0.9349	4.83
2006	51.86	13.82	2.75	0.9403	1.05	4.6
2007	58.45	14.47	3.55	1.22	1.17	4.58
2008	64.23	14.77	4.59	1.2	1.05	5.11
2009	60.89	14.48	5.10	1.34	0.9439	5.29
2010	66.71	15.05	6.09	1.68	1.14	5.76
2011	73.97	15.60	7.55	1.82	1.25	6.23
2012	75.61	16.25	8.53	1.83	1.28	6.27
2013	77.71	16.84	9.57	1.86	1.37	5.21
2014	79.84	17.55	10.48	2.04	1.48	4.9
2015	75.28	18.21	11.06	2.10	1.47	4.44
2016	76.52	18.70	11.23	2.29	1.5	5.00
2017	81.48	19.48	12.31	2.65	1.62	4.93
2018	86.54	20.53	13.89	2.70	1.73	5.04
2019	87.78	21.38	14.28	2.84	1.65	5.12
2020	85.27	21.06	14.69	2.67	1.64	5.06
2021	97.15	23.32	17.82	3.15	1.82	5.03
2022	100.88	25.44	17.96	3.42	1.67	4.26
Percentage Growth from 2000 to 2021 = (Present-Past)/ (Past)	197.58%	148.20%	1,384.30%	630.15%	189.83%	-14.29%

[135] World Bank Data, "GDP (Current US$)."

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