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Emerging National Artificial Intelligence Innovation Systems in Canada and China: Strategic Governance and Institutional Evolution

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Issue 2020-01| Volume 16
www.spaces-online.com

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Please quote as Frost, R Blair (2020): Emerging National Artificial Intelligence Innovation Systems in Canada and China: Strategic Governance and Institutional Evolution. SPACES online, Vol.16, Issue 2020-01. Toronto and Heidelberg: www.spaces-online.com.

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Keywords Artificial intelligence, innovation, technological innovation, national innovation systems, national competitiveness, institutional change, governance, regulation, strategy

JEL codes O33 (Technological Change: Choices and Consequences, Diffusion Processes), O38 (Government Policy), O43 (Institutions and Growth), O51 (US, Canada), O53 (Asia including Middle East), O57 (Comparative Studies of Countries)

Abstract

Artificial intelligence (AI) is proving to be a powerful general-purpose technology with the potential to transform national economies. Innovations in AI technologies are accelerating the pace of innovation more generally across a variety of economic sectors and application areas. The strategic governance of AI innovation is becoming increasingly essential to the competitiveness of firms, industries, and nations, yet little work has been done to study the economic geographies and institutions in which AI innovation is embedded. This paper corrects that gap by integrating sectoral, technological, territorial, and institutional approaches into a comparative study of AI innovation systems in Canada and China. While AI innovation in Canada is governed through a middling approach of promoting strategic co-creation between sectors, China favors a top-down approach of aligning AI innovation activities to long-term national planning goals. The strengths and weaknesses inherent to these differing AI strategies are discussed with a focus on issues of governance structures, ethics and regulation, and global leadership. Opportunities for strengthening each nation's AI strategy and deepening coordination between them are considered. Directions for future research in AI innovation and AI strategy are suggested.

Editors: Harald Bathelt, Johannes Glückler
Managing Editor: Sebastian Henn
ISSN: 1612-8974

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1 AI Governance: A New Frontier in International Competition

Artificial intelligence (AI) is a general-purpose technology that enables machines to autonomously *"perform many tasks that require human intelligence"* (Rossi 2019: p. 127). Recent advances in algorithmic techniques, computational power, and data availability have greatly improved and proliferated new innovations in AI technology across a vast range of application areas, including process automation, decision support, computer vision, digital assistance, cybersecurity, healthcare, education, law enforcement, and national defense. With such broad applicability and transformative potential across seemingly every economic sector, AI innovations are opening a new frontier in national strategy and international competition.

Within that strategic context, AI governance has recently emerged as an interdisciplinary area of research which seeks to understand *"the institutions and contexts in which AI is built and used"* (Dafoe 2017: p. 5). In practice, governing AI has quickly come to be seen as a strategic necessity by a multitude of state and industry actors. Between March 2017 and November 2018, eighteen countries adopted national AI strategies, marking *"the first time that governments around the world almost simultaneously released national plans to develop the same technology"* (Dutton 2018: p. 4). AI governance is often premised on the enormous promise and peril of AI innovation within particular economic geographies and institutional settings (OECD 2019; European Commission 2019a; 2019b; National Security Commission on Artificial Intelligence 2019; Cihon 2019; Dafoe 2018; Cath 2018). Despite the crucial influences of economic geographies, institutions, and innovation dynamics in the governance of AI, these influences have scarcely been studied. One significant exception is a small handful of recent exploratory studies presented during an agenda-setting conference organized by the US National Bureau of Economic Research (Cockburn et al. 2019; Agrawal et al. 2019; Trajtenberg 2019). These studies provide timely insights into the politics and economics of AI innovation that are highly valuable for both researchers and practitioners of AI governance. Still, greater attention to issues of economic geography, institutional governance, and comparative advantage in specific national AI strategies is needed to address several of the research areas outlined in Dafoe's (2017) seminal AI governance research agenda, such as international political economy, international security, and institutional mechanisms for AI governance.

This paper corrects that research gap by presenting a comparative study of the innovation dynamics underlying the national AI strategies of Canada and China. Canada and China present multilayered contrasts in their approaches to AI governance, making their national AI strategies especially well-suited for comparative analysis. In a study of AI advantage sampling 1,900 business executives across seven countries, Loucks et al. (2019) describe Canada and China in contrast with one another, characterizing Canadian AI innovation as *"taking a*

cautious approach" (p. 10), while China is more boldly *"pursuing a strategic imperative"* (p. 11). The comparative (dis)advantages of Canada's and China's national AI strategies raise broader questions of strategic governance: What governance strategies are Canada and China deploying to secure a competitive advantage in AI innovation, and why? How might those strategies enable different competitive advantages over different scales of time? Is it even possible for a middle power like Canada to even maintain a competitive advantage in AI when confronted by a powerful technology-push approach like China's?

I will address those questions by analyzing the innovation systems through which Canada and China are implementing their respective AI strategies. I will first outline a framework for the analysis with reference to relevant theoretical approaches. I will then describe the institutional setting of Canada's AI innovation system and analyze the strategies used to govern AI innovation within that setting. That analysis will be followed by a similar analysis of AI innovation in China. Finally, I will compare the AI innovation goals and governance strategies of both nations, discuss their relative strengths and weaknesses, and suggest opportunities for strengthening each nation's AI strategy and deepening coordination between them.

2 Analyzing AI Innovation Systems

2.1 Theory

In the innovation studies literature, innovation systems are viewed as a *"unifying framework"* for analyzing the mechanisms through which *"innovation results from interactive learning processes between different types of actors"* (Asheim et al. 2016: p. 47). Technological innovation systems as described by Carlsson and Stankiewicz (1991) provide a model for analyzing AI governance as a phenomenon that operates through *AI innovation systems*. Following Carlsson and Stankiewicz's model of technological innovation systems, an AI innovation systems approach can account for how technical innovations in AI—such as more accurate machine learning algorithms, specialized computer hardware, or improved data architectures—result in new AI technologies being diffused across geographies and sectors, where their adoption and embedding in industrial infrastructures can yield second-order innovations. However, this AI innovation systems approach is primarily socio-technical in scope and lacks focus on sectoral and territorial factors, both of which are necessary for analyzing AI innovation within a specific geographic context such as that of Canada or China. A sectoral innovation systems approach such as that of Breschi and Malerba (1997) can augment the AI innovation systems approach, honing analysis in on the economic sectors that are most directly involved in leading the technical innovation of AI, which as a general-purpose technology, enables AI-driven horizontal innovation across many other sectors (Cockburn et al. 2019; Trajtenberg 2019). To add multiple levels of territorial focus to analyzing the AI innovation systems of Canada and China, a sub-national adaptation of the national innovation systems (NIS) approach is required. NIS are *"territorial innovation systems that are capable of shaping their own development path"* (Bathelt and Henn 2017: p. 458) due to the *"increasing specialization [that] takes place as interrelations between production, innovation and institutions at the national level stimulate positive feedback loops"* (p. 463). Many approaches have been suggested to adapt the NIS approach to explaining innovation dynamics at sub-national levels. Regional innovation systems (RIS), for example, originated from discussions of how *"particular regions linked together business networking, technology transfer and vocational training"* (Cooke 1998: p. 3) in order to develop "clusters of competitive advantage in an increasingly globalized economy" (p. 5). Although the RIS is a flexible adaptation of the NIS approach, Balthelt and Henn (2017) note that the RIS approach incorrectly

assumes that sub-national regions exhibit the same self-sustaining organizational dynamics as national systems. Similar flaws in the RIS approach have long been acknowledged by proponents of the approach (Cooke 1998; Bracyzk and Heidenrich 1998). As an alternative approach, Asheim and Herstad (2005) suggest analyzing top-down regional concentrations within national production structures alongside bottom-up regional networkings of NIS activity within specific geographic clusters. This regionalized NIS approach provides greater accuracy in analyzing sub-national dynamics than an RIS approach, simultaneously accounting for the unique institutional dynamics that unfold at national scales as well as the granular structure of national economies.

Despite their differences, these approaches to analyzing innovation systems all acknowledge the central role of institutions in producing innovation across diverse spatial and temporal contexts. Glückler & Bathelt (2017) characterize institutions as entities which organize, regulate, and enact the *"patterned interactions"* (p. 123) through which innovation is produced, making institutions *"fundamental reference points in the analysis of differential spatial and temporal dynamics in the economy"* (p. 122). These institutional dynamics operate on two interdependent spatial scales: a *macro scale* that follows a logic of *"downward causation, where codified normative orders define social incentive structures and thus constrain or guide economic interactions"* (p. 131), and a *micro scale* that follows a logic of *"upward causation,"* where repeated patterns of behavior *"may successively convert into legitimate practice and become an institution"* (p. 132). At the interface of these macro and micro scales, van Wijk et al. (2019) identify a *meso scale* in which associative institutions build and maintain *"interactive spaces"* through which macro- and micro-institutional actors can align their interests and co-create innovation with one another. In the case of the *national AI innovation systems* (NAIIS) of Canada and China, macro scales of AI innovation operate at the level of national governance institutions, micro scales operate at the level of individual firms within each nation, and meso scales operate at the level of sub-national jurisdictions and boundary spanning organizations that aim to align local firm behavior with national behavior.

The institutions at each of these spatial scales are dynamic entities that gradually change according to their contexts. Therefore, to be capable of explaining how the transformative effects of AI innovation influence and are influenced by institutional context, this spatially oriented model of multi-scale institutional behavior must be supplemented with a temporally oriented theory of institutional change. Mahoney and Thelen (2010) theorize institutional change as a phenomenon that exhibits one of four possible modes of change depending on the context and strategic rationale for changing the rules, organization, and behavior of an institution: 1) *Displacement*, a process of replacing of existing rules with new rules; 2) *Layering*, a process of adding of new rules to existing rules, *"thereby changing the ways in which the original rules structure behavior"*; 3) *Drift*, in which *"rules remain formally the same but their impact changes as a result of shifts in external conditions"*; 4) *Conversion*, in which *"rules remain formally the same but are interpreted and enacted in new ways"* (pp. 16–17). Even at the macro scale of national behavior, governing these modes of change is not exclusively within the purview of the state. Integrating studies of national competitiveness and governance strategy from the political economy literature (e.g., Biggart and Guillen 1999; Guillen 2000) with studies from the strategic management literature (e.g., Porter 1990; Chandler 1990), Griffiths and Zammuto (2005) provide a contingency model for institutional governance. They note that depending upon the political-economic context of institutional change, there are up to four possible modes of institutional governance that can be used independently or in combination to pursue national competitive advantage: 1) *State governance*, in which public policies and programs are used to foster long-term economic growth in underperforming industries; 2) *Market governance*, in which market forces are permitted to act with no or minimal state intervention in allocating greater resources to the most profitable firms in a stable industry; 3) *Corporate governance*, in which interfirm behavior within a rapidly growing industry is coordinated through industry-led decision-making and value chain integration; 4) *Joint*

governance, in which the state coordinates with a highly innovative, value-adding industry to facilitate industry decision-making and value chain integration.

The selection of specific modes of institutional change and governance has wide-ranging impacts, both spatially and temporally. Building upon the work of historical institutionalists (e.g., Streeck and Thelen 2005; Richerson and Boyd 2001; North 1990), Lewis and Steinmo (2012) propose an evolutionary theory of institutional change that extends the temporal horizon of the theory of Mahoney and Thelen (2010) into the medium- and long-term. Lewis and Steinmo contend that when modified through governance practices, the processes of institutional change constitute part of a larger process of *institutional evolution*: in the medium- to long-term, the selection, replication, and re-adaptation of particular political values and strategies across diverse institutional contexts adds evolutionary dynamics to the process of institutional change. Observing patterns of institutional change within these higher-order processes of institutional evolution enables a more extensive analysis of AI innovation systems. The processes of and rationales for institutional evolution reveal how actors in each national context can, through the strategic governance of AI innovation systems, direct various processes of institutional change in the short-term and institutional evolution in the medium- to long-term.

By expanding the inherent institutional dynamics of an AI innovation systems approach into a more extensive institutional theory grounded in multiple spatial and temporal scales, the AI innovation systems of Canada and China can be analyzed with attention to how each nation strategically governs the changes and evolutions that produce and are produced by AI innovation. These conceptualizations of technological, sectoral, and territorial innovation systems—alongside conceptualizations of institutional dynamics at multiple spatial and temporal scales—all contribute to a more fulsome approach to analyzing AI innovation systems.

2.2 Methodology

The AI innovation systems of Canada and China were comparatively studied through a multi-phased review and analysis of literature pertaining to AI innovation and AI governance in each nation. To validate the ontology and epistemology of the NAIIS approach, analysis was generally focused on structural and relational aspects of institutions and governance. To achieve a well-rounded comparative analysis across multiple spatial and temporal scales, data collection and analysis was segmented into four phases based on a division of micro- and macro-institutional contexts: Phase one focused on AI innovation in the Canadian micro context, phase two on the Canadian macro context, phase three on the Chinese micro context, and phase four on the Chinese macro context. Each micro and macro context was analyzed with reference to the dynamics of institutional change and governance within that context, as well as with reference to meso scale arrangements and rationales that are causing AI innovation systems to emerge and gradually evolve in each context. A fifth phase of the study involved comparative analysis and synthesis of findings from the first four phases, bringing additional attention to similarities, differences, and opportunities for coordination between the Canadian and Chinese contexts at multiple levels of institutional scale. The findings of the first four phases of the study are presented in Sections 3 and 4. The findings of the fifth phase are presented in Section 5.

3 AI Innovation in Canada

3.1 The Micro Scale: Knowledge Brokers and Layered Standards

In March 2017, Canada became the first country to adopt a national AI strategy (Dutton 2018). Canada's early leadership in AI innovation emerged from one distinct competitive advantage: strong AI research institutions that produced commercially valuable knowledge. Most notably, the Turing Award-winning work of LeCun, Bengio, and Hinton (2015) introduced a new approach for developing *deep learning* algorithms that can cost-efficiently process large volumes of data, an approach that has been widely credited with fueling the global wave of innovation in AI applications that emerged in the mid to late 2010s (Chui et al. 2018; Cockburn et al. 2019; Klinger et al. 2019). Analyzing the citation counts of AI research published at 21 leading scientific conferences from 2017 to 2018, Kiser and Mantha (2019) observe that out of approximately 4,000 researchers worldwide, 45 of the most globally cited AI researchers from 2017 to 2018 were situated in Canada. Compared with 1,095 researchers in the United States, 255 in China, 140 in the United Kingdom, and 80 in Australia, Canada's count of 45 researchers at the end of 2018 is relatively small, yet still large enough to constitute the fifth largest national supply of researchers conducting high-impact research on current issues at the forefront of AI innovation. This provides Canada with an early advantage on the global stage that can be built upon through expanded talent recruitment initiatives. Canada's national AI strategy leverages this early advantage in AI research to add expert knowledge to the burgeoning AI innovation clusters of the Toronto, Montréal, Vancouver, Waterloo, and Ottawa regions, all of which have evolved out of pre-existing clusters of high tech research and commercialization (Henderson and Mantha 2019). A report by the University of Toronto's Government Relations Office (2020) illustrates that Canadian AI firms have greatly benefitted from layering new institutions upon existing institutions of technical research and innovation: From 2010 to 2020, 50,000 new jobs were created at 670 AI-focused tech firms, $3 billion was invested into Canada's AI sector, and Canada produced more AI patents per million people than any other G7 nation or China (p. 2). However, as the report's genesis in a university's government relations office suggests, developing a NAIIS for Canada has required extensive relationship-building between firms, governments, and boundary-spanning *"knowledge brokerage"* institutions (Lenihan 2015) that coordinate the production and consumption of knowledge between micro and macro scales.

Coordination of micro- and macro-institutional behavior within Canada's NAIIS primarily occurs through the *CIFAR Pan-Canadian AI Strategy*, a federally-funded project led by the Canadian Institute for Advanced Research (CIFAR) with the goal of further cultivating Canada's early leadership in AI research in order to strengthen Canada's competitive advantage in AI innovation (Barron et al. 2019). As a knowledge brokerage institution, CIFAR has formed an International Scientific Advisory Committee as well as a National Program Committee, which together, govern AI innovation in Canada through five main program areas: 1) *Research institutes* to support the networking of regional AI clusters, with the Vector Institute established in Toronto, Mila in Montréal, and Amii in Edmonton; 2) *Research chairs*, with 46 leading AI researchers recruited from around the world in the program's first year; 3) *AI training*, provided through the research institutes to students in each respective region; 4) *AI partnerships*, establishing interactive spaces in which industry, government, and academic stakeholders in the NAIIS can align their interests with one another; 5) *AI & Society*, a program intended to *"support inquiry on the social, ethical, legal, and policy implications of artificial intelligence"* (p. 26) through a series of research workshops, policy labs, and publications.

CIFAR's AI & Society program is particularly notable for the emphasis it places on cross-sectoral AI ethics research, which has become an issue of competitive urgency to both government and industry. AI systems that

do not adhere to ethical design principles pose the risk of making unfair, unaccountable, unsustainable, and unsafe decisions (Fjeld et al. 2020; Leslie 2019; Lepri et al. 2018). A strong emphasis on securing competitive advantage through global leadership in AI ethics is central to Canada's national AI strategy (Trudeau 2018, 14:35–15:19), and with interactive spaces such as CIFAR's programs in place to align the federal government's macro-level interests with the micro-level interests of firms, that emphasis has emerged across many Canadian AI institutions. For example, *The Montréal Declaration* was a product of an initiative led by Université de Montréal in partnership with several other institutions, including Mila, the Government of Quebéc, and the Government of Canada, aiming to *"reflect on the transition towards a society in which AI helps to promote the common good"* (Abrassart et al. 2018: p. 5). Meanwhile, *The Toronto Declaration* was developed by a coalition of industry, academic, and non-profit sector partners to advocate for greater observance of human rights law and standards in automated decision-making (Bacciarelli et al. 2018). Backed by a $100 million donation from two Canadian business leaders, the 2019 establishment of the Schwartz Reisman Institute for Technology and Society at the University of Toronto represents another cross-sectoral pursuit of ethical AI innovation, aiming to mobilize interdisciplinary research to *"make sure powerful technologies truly make the world a better place—for everyone"* (Schwartz Reisman Institute 2020). Taken together, these initiatives demonstrate a pattern of institutional change: a "drift" (Mahoney and Thelen 2010) in AI ethics and standards, corrected by the formation and re-organization of institutions as the intensifying social impacts of AI innovation became cause for greater public concern.

Alongside AI ethics initiatives coordinated through interactive spaces, business leaders are creating their own inter-firm and intra-firm approaches for the corporate governance of AI innovation. The cross-sectoral Canadian CIO Strategy Council has developed and recommended the adoption of a standard for managing ethical risk in automated decision systems (2019). Element AI, a Montréal-based firm that develops AI business solutions, has become a particularly prominent voice within Canada's AI innovation system, and its corporate leadership has shown a strong interest in implementing frameworks and maturity models for ethical AI governance (Gagné 2019; Ramakrishnan 2019). Demonstrating the value of Canadian corporate leadership in global AI governance, the CEO of Element AI serves on the European Commission's High-Level Expert Group on Artificial Intelligence as the group's only non-European member, adding a Canadian perspective to the group's *Ethics Guidelines for Trustworthy AI* (2019a) and *Policy and Investment Recommendations for Trustworthy AI* (2019b). The influence of corporate governance and leadership in AI ethics signals another mode of institutional change as conceptualized by Mahony and Thelen (2010): a layering of new rules for AI innovation onto existing institutions in the form of ethical guidelines and standards. In the medium-term, this layering strategy could prove to be an effective method of adapting business and knowledge brokerage institutions to make them more capable of designing AI systems that conform to ethical standards. This strategy would integrate Canada's strengths in AI research and ethics with an endogenous appetite in industry for ethical AI innovation, increasing Canada's competitiveness by positioning Canadian firms as leading authorities on designing AI systems and standards that are sensitive to stakeholder values.

Cross-sectoral design and adoption of AI standards in Canada will be a challenging feat without more intensive support from the federal government. Already, the Canadian NAIIS lacks sufficient support from the federal government in key areas such as incubating and commercializing domestic AI innovation (Davidson 2019), retaining and recruiting enough AI talent to meet industry demand (Kiser and Mantha 2019), and competing with non-Canadian AI firms that have expanded into the Canadian market (Reynolds 2019). Inter-firm corporate governance cannot adequately address those macro challenges. Canada's federal government, however, is

resolutely attempting to address those challenges, but a closer look at the macro scale of AI innovation in Canada will show that there is still much work to be done.

3.2 The Macro Scale: Strategic Conversation and Joint Layering

Canada's national AI strategy relies upon a multi-departmental, inter-governmental, and inter-organizational set of policies and programs—including but not limited to CIFAR's programs—in order to govern Canada's NAIIS. Of the many programs offered by Innovation, Science and Economic Development Canada (ISED), two are especially noteworthy for their impact on the NAIIS: the *innovation superclusters* initiative and the *strategic innovation fund*. ISED's innovation superclusters are a $950 million initiative that incentivizes the private sector to modernize industrial infrastructures by adopting innovative new technologies such as AI. Although each supercluster targets a specific region, these superclusters are formed out of demand-side agglomerations that the federal government seeks to amass through economic intervention, rather than being formed out of supply-side agglomerations as is typical for clusters (McCann and Folta 2009). ISED hopes that its demand-led superclusters will attract more high-skilled talent to Canada, increase business expenditures on R&D, and support new Canadian firms in commercializing and scaling their business offerings (Government of Canada 2018a). ISED also supports Canadian AI firms through its strategic innovation fund, which provides a $250 million pool of funding to Canadian businesses seeking financial support for R&D, commercialization, expansion and growth, investment attraction, and technology development (Government of Canada 2019a). ISED's demand-led programs demonstrate that in Canada's NAIIS, institutional change is met with the strategic application of Mahoney and Thelen's (2010) concept of conversion: economic shifts prompt the federal government to enact new programs and funds through existing institutions such as ISED. Conversion of existing institutions to meet new economic needs can also be observed in the Global Skills Strategy and Global Talent Stream programs of Immigration, Refugees and Citizenship Canada (IRCC), both of which were launched as solutions to the challenges of talent attrition and recruitment encumbering the growth of the Canadian NIS. These programs allow skilled foreign workers to bypass the typical labor market impact assessment and have their work visa processed in two weeks, with Global Talent Stream offering privileged consideration to workers in ICT-related and digital sectors (Government of Canada 2019b; 2019c).

Outside of the strategies being employed by ISED and IRCC, challenges of AI innovation are being tangentially addressed by other strategic initiatives such as the federal data strategy roadmap (Government of Canada 2018b), the workforce innovation projects of Employment and Social Development Canada's Future Skills Centre (2019), and the revitalization of National Defence's cyber strategy (2017). At the provincial level, meso-institutional initiatives such as Québec's Artificial Intelligence Cluster Steering Committee, Invest in Ontario, and Invest in Alberta coordinate value flows from the federal government with the needs of local firms. To support the federal government in managing the growing complexity of Canada's NAIIS across multiple scales, an Advisory Council on Artificial Intelligence has been established to provide policymakers with an integrated view of the NAIIS, enabling them to *"build on Canada's AI strengths, identify opportunities to create economic growth . . . and ensure that AI advancements reflect Canadian values"* (Government of Canada 2019d). This invocation of *"Canadian values"* once again calls attention the critical role of ethical standards in Canadian AI innovation at both the micro and macro scales. The federal government has pursued global leadership in ethical AI governance through two major policy initiatives: the *G7 Charlevoix Common Vision for the Future of Artificial Intelligence* (2018) and the *Directive on Automated Decision-Making* (Government of Canada 2019e). The Charlevoix Common Vision was advanced by the Canadian government during their 2018 G7 presidency and agreed upon at the 2018 G7 summit in Québec, committing the G7 leaders to adhere to a set of twelve shared

principles in their AI policymaking. The Directive, meanwhile, has been lauded as a *"game-changer"* for managing ethical AI adoption in governments (Karanicolas 2020), requiring all AI vendors who wish to work with Canada's federal government to undertake an algorithmic impact assessment which ensures their system complies with specific ethical and technical standards. Independently, the non-partisan Office of the Privacy Commissioner of Canada (OPC) has also launched a call for proposals (2020) seeking views from industry, government, academia, and civil society on how the OPC should regulate data privacy in Canadian AI systems.

Through these policies, programs, and initiatives, Canada manages its national AI strategy through a mode of what Griffiths and Zammuto (2005) conceptualize as joint governance, wherein competitive advantage is derived from federal government's interventions in industry to *"encourage economic and industrial learning . . . in a coordinated fashion with an industry's firms"* (Griffiths and Zammuto 2005: p. 835). By directly intervening in industry value chains through these policies, programs, and initiatives, the federal government shows a willingness to intervene in the NAIIS, so long as its intervention is led by industry demand. At the macro level, it is relatively simple for the federal government to convert programs and activities within the existing institutions of ISED or IRCC to account for economic shifts. However, in aligning macro- with micro-institutional interests, a more complex, layered mode of institutional change becomes apparent once again. As this meso scale, CIFAR's Pan-Canadian AI Strategy functions as a layering mechanism: a boundary-spanning knowledge brokerage appended to the existing institutional arrangement. Through CIFAR's interactive spaces, the federal government can form mutually reflexive relations at the firm level and enact layering according to the AI sector's multilayered demands.

Enacting institutional change through layering is also important to the federal government in their pursuit of ethical AI innovation. For now, the federal government is affording substantial latitude to Canadian AI firms in instituting their own ethical standards and corporate governance of AI innovation, but the Charlevoix Common Vision, the Directive on Automated Decision Making, and the OPC's call for proposals foreshadow a coming wave of AI regulation in Canada. Because Canada's NAIIS is jointly governed at the macro scale, AI regulation will not be an entirely top-down imposition of new rules, but rather, part of a co-created *"layered model for AI governance"* (Gasser and Almeida 2017) in which information asymmetries between actors is reduced, a normative consensus for governance style is sought, and new interactive spaces are opened to reduce the risk of a mismatch between governance needs on the micro and macro levels. This careful, demand-led attention to ensuring stakeholder needs are met throughout the process of institutional change is at the heart of what Loucks et al. (2019) characterize as Canada's *"cautious approach"* to AI innovation. Rather than being guided by grandiose, long-term national planning objectives, Canada takes a modest approach of co-creating strategy, knowledge, and innovation cross-sectorally while cultivating a fluid and adaptable assemblage of strategic options throughout the federal government.

Some observers have rejected this middling strategy of joint governance and layered change, calling for a more rapid, broad, and state-led replacement of institutional and policy norms in Canada's NAIIS (e.g., Hirsh 2018; Munro 2019; Gaon and Stedman 2019). While a stronger macro-institutional push may produce greater economic benefit in the short-term, the ability of such an approach to ensure medium- and long-term gains in national competitiveness is questionable. A strong technology-push may not be well-suited to the endogenous strengths of Canada's NAIIS: research and knowledge brokerage institutions situated within extensive regional and global innovation networks; international leadership in AI ethics and standards in both the public and private sectors; a culturally engrained sensitivity to diverse value systems and pluralistic modes of governance. In China,

however, an historic AI technology-push from the macro scale downward may be essential to achieve the nation's long-term competitive ambitions.

4 AI Innovation in China

4.1 The Macro Scale: Intelligentization and Evolutionary Conversion

In July 2017, the State Council of China published the *New Generation Artificial Intelligence Development Plan* (AIDP), a sprawling plan for the short-, medium-, and long-term governance of Chinese AI innovation. Surrounding the AIDP is a network of other economic development plans that are strategically integrated with the goals of the AIDP. Among these plans, the AIDP has the unique function of mobilizing a *"whole-of-society push"* (Ding 2018: p. 21) for AI innovation, with the ultimate aim of enacting an evolutionary push to *"accelerate the construction of an innovative new-type nation"* (State Council of China 2017: p. 4). Prior to the AIDP, China's technology-push approach to innovation strategy was justly criticized for "supporting the high-tech start-ups rather than raising innovative capabilities in existing firms and traditional industries" (Gu et al. 2016: p. 446). However, the goals of the AIDP signal that China is making a high-stakes gamble that *cognitive technology*—that is, AI in combination with the computational media through which it operates—promises a "*stronger evolutionary potential than any other technology"* (Hayles 2017: p. 34, emphasis in original). The AIDP is peppered with techno-utopian rhetoric, often reading more like science fiction than public policy, but its imagining of AI as an evolutionary force that will *"profoundly change human society and life"* (p. 2), as well as become *"the main driving force for China's industrial upgrading and economic transformation"* (p. 6) may hold merit. Cockburn et al. (2019) identify an evolutionary feedback loop inherent to the innovation systems of general-purpose technologies (GPTs) such as AI, in which AI-driven innovation in one sector *"enhances innovation in the GPT itself, which then induces subsequent demand (and further innovation) in other downstream application sectors"* (p. 6). They go on to explain that *"a reinforcing cycle of innovation between the GPT and a myriad of application sectors can generate a more systemic economy-wide transformation as the rate of innovation increases across all sectors"* (p. 6).

The Chinese government is keenly aware of the evolutionary dynamics of embedding general-purpose cognitive technologies into institutions: the Creemers et al. translation of the AIDP (2017) repeatedly refers to this embedding phenomenon as *intelligentization.* The AIDP seeks to intelligentize seemingly every institution of industry, government, and society as a whole, ultimately *"advancing intelligentization as the center of humanity's sustainable development"* (p. 4). The process of intelligentization is, in the conceptual framing of Mahoney and Thelen (2010), a conversion of existing institutions: it does not remove any established rules of behavior, but rather, enables cognitive technologies to autonomously act within institutional settings, learn from their actions, and in time, adapt to and change their institutional settings. The institutional conversions resulting from intelligentization are reflected in China's approach to governing its NAIIS, which presumes that in the long-term, a confluence of micro-institutional adaptations driven by mass intelligentization will gradually evolve the macro-institutional context of the nation as a whole, bringing about *"the great rejuvenation of the Chinese nation"* (State Council of China 2017: p. 4). This attempt to achieve wide-reaching national institutional evolution through intelligentization is, of course, a high-risk competitive strategy grounded mainly in futurological extrapolation rather than empirical observation. But China is clearly willing to put money on that bet: In the year after launching the AIDP, the central government is estimated to have invested in the range of

11.7 to 39 billion RMB (1.7 to 5.7 billion USD) into R&D for civilian AI applications and 1.8 to 19 billion RMB (263 million to 2.8 billion USD) into R&D for defense applications (Acharya and Arnold 2019).

To understand the impetus for China's daring AI gambit, recall the *"strategic imperative"* that Loucks et al. (2019) observe in Chinese AI governance. China currently faces many severe threats to its long-term competitiveness. Even before the COVID-19 pandemic, escalating economic and diplomatic tensions with the United States prompted the Chinese government to pursue greater technological independence. The Chinese government's anxieties with regard to the threat of foreign tech dependency were amplified in 2018, when the US government prohibited the Chinese telecom firm ZTE from purchasing American-produced microchips, prompting the unwelcome discovery that *"the U.S. Department of Commerce has the capacity to shut down a major Chinese company in a matter of days"* (Băzăvan 2019: p. 6). Alongside the threat of tech dependency, China must also grapple with the demographic time bomb of an aging population requiring greater economic support from a shrinking workforce (Eggleston et al. 2013), impacts of environmental degradation on public health and economic growth (Albert and Xu 2016), and a manufacturing sector that is increasingly having to compete for global export share with other fast-growing national manufacturing sectors, such as those of India and Vietnam (Bellman and Roy 2019; Jamrisko 2019). The AIDP therefore advances AI innovation as the potential panacea for those and other threats, embedding AI applications into vulnerable institutions of healthcare, elder care, environmental management, and manufacturing. By 2025, the AIDP plans to advance Chinese AI technologies to a *"world-leading level"* (p. 6) on par with the United States, and by 2030, the AIDP envisions China becoming *"the world's primary AI innovation center"* (p. 6), a victory that will feed into President Xi Jinping's larger long-term goal of evolving China into a *"cyber superpower"* (as cited in Triolo and Goodrich 2018: p. 3).

The ambitious, economy-wide vision of the AIDP reflects the strongest competitive feature of China's NAIIS: its ability to accelerate nationwide AI adoption by leveraging a powerful central government alongside existing industrial infrastructures and digital innovations. China's existing data infrastructure and permissive data regulations afford the nation a significant advantage in being able to access a large domestic supply of data with which to train machine learning models and deploy new AI applications more quickly and more widely (Roberts et al. 2020; Allen 2019; Ding 2018). Faster and broader AI adoption will accelerate the pace at which institutional changes are made to the nation through widespread intelligentization. This evolutionary strategy—in which all AI innovation is directed towards gradually changing the macro-institutional setting into a planned state—is perhaps the most crucial characteristic of China's NAIIS. Superficially, this appears to be a textbook example of Griffiths and Zammuto's (2005) concept of state governance: policies, programs, and mandates cascade downward from the central government, redirecting institutional behavior towards state-led goals as new rules and funds flow through the economy. Upon closer observation, though, more subtle modes of governance can be seen in China's NAIIS through which the nation-state selectively devolves specific powers to specific sub-national and industry actors.

4.2 The Micro Scale: Multi-Modal Governance and Moral Authority

The AIDP functions as an integrating mechanism between the micro- and macro-institutional scales of China's NAIIS, enabling the central government to pursue evolutionary goals by aligning its top-down push for AI innovation with micro-institutional behaviors. Of the six sections the AIDP is divided into, four outline visions for strategic action: 1) *Administrative Organization & Implementation*, 2) *High-Priority Areas*, 3) *Resource Allocation Mechanisms*, and 4) *Guarantee Measures*. By analyzing the institutional dynamics underpinning those

four categories of strategic action, a more nuanced picture can be drawn of how China's NAIIS aligns macro- and micro-institutional behaviors.

Administrative Organization & Implementation – As described by Triolo and Goodrich (2018), implementation of the AIDP is ordered downward from the Communist Party's Central Committee and the State Council, where the Ministry of Science and Technology (MoST) is assigned with implementing the AIDP through a new AI Plan Implementation Office. Horizontally, MoST is responsible for coordinating the AIDP's implementation with 15 other ministries. Advising MoST is the New Generation AI Strategy Committee, which includes academics and private sector representatives from Alibaba, Baidu, Tencent, iFlytek, and SenseTime, dubbed China's "National Team" for AI. Below the macro scale, the AIDP has cascaded down to provincial and municipal governments, who have started implementing their own localized AI strategies. Beijing, Shanghai, and the Pearl River Delta are emerging as three major regional clusters for AI innovation, with 395 AI firms in Beijing, 210 in Shanghai, and 165 in the Pearl River Delta as of 2019 (Development Solutions Europe Ltd. 2019). Intergovernmental delegation of AIDP tasks primarily operates through a gift economy: the central government offers regional and local funding incentives in return for the local government's "gift" of implementing a large-scale AI project (Sheehan 2018). This approach gives some latitude to sub-national governments in planning and implementing their own AI strategies, but also forms a line of authority in which the actions of sub-national and industrial actors are ultimately subservient to the central government through patronage institutions.

High-Priority Tasks – The AIDP specifies a variety of technical innovations as focal points for implementation. Of particular note is the AIDP's push to strengthen China's domestic supply of AI hardware and software platforms, echoing insights from the 2018 *China AI Development Report* that suggest China is *"still weak on the front of core technologies of AI, such as hardware and algorithm development"* (China Institute for Science and Technology Policy at Tsinghua University 2018: p. 6). Thus, the AIDP calls for the development of new specialized semiconductors that are designed to improve the performance of AI applications, similar in function to Google's Tensor Processing Unit (TPU). China's dependence on a foreign supply of semiconductors is widely seen as a critical vulnerability to both its national competitiveness and national security, including by President Xi (Allen 2019). The vulnerability is so severe that from 2014 to 2018, China established and invested $65 billion USD in a national fund to support the growth of their domestic semiconductor industry (p. 19). However, rather than focusing on building a domestic supply of general-purpose semiconductors, the AIDP focuses on building a domestic supply of TPU-style chips, which are more simple to manufacture than general-purpose semiconductors and can take advantage of China's domestic electronics supply chain to produce the chips at low cost (Allen 2019: p. 18). This is an efficient institutional strategy, as *"the cutting edge of AI technology increasingly depends on custom computer chips"* (p. 16), and China can convert or layer upon its existing industrial infrastructures and institutions to rapidly produce TPU-style chips at scale.

China's disadvantage in algorithms and software dampens China's greatest strength: China is extremely capable of implementing new AI applications across many sectors, but those applications are mostly developed using Google and Microsoft programming frameworks (Allen 2019: p. 12). At the level of municipal institutions, however, China's advantage in the permissive data supply needed to train its machine learning models becomes highly visible: Baidu has received permission from the municipal government of Beijing to test its self-driving cars on Beijing's streets; Alibaba has started intelligentizing Hangzhou's traffic management system; Tencent has deployed its AI applications in medical clinics and laboratories across the country (Băzăvan 2019). Despite those strengths, the sudden imposition of stricter data regulations through China's new Cybersecurity Law could slow domestic AI innovation by placing new restrictions on cross-border data transfer (Triolo and Goodrich

2018). Sudden changes to regulatory institutions reveal a systemic weakness of the state governance of China's NAIIS: if an institutional change outside of the strategic plan causes a significant disruption to the plan, the NAIIS must be systematically re-directed from the top down to adapt to the change. If it is not, planned timelines and resource allocations could be put at risk. To mitigate that risk by making the NAIIS more institutionally flexible, the AIDP includes resource allocation mechanisms which devolve some powers of governance to actors below the macro scale.

Resource Allocation Mechanisms – The AIDP simultaneously plans to *"give play to the advantages of the socialist system to concentrate forces"* (p. 5) as well as *"give full play to the role of market mechanisms to mobilize departments, local, business and social forces"* (p. 23). China's NAIIS thereby evades socialist or capitalist essentialisms, governing AI innovation through pragmatism and contingency rather than a steadfast ideology. Băzăvan (2019) observes that in governing technological innovation, China's central government acts as principal executer and manager for *"priority areas that exceed the capacity of the private sector,"* market coordinator and business partner for technology sectors where *"the market alone is not capable to upgrade the technology to the level and in the time expected,"* and *"distant observer in those technology sectors that develop organically . . . as long as this spurs new technologies"* (p. 2). These three contingent roles—principal executer, business partner, and distant observer—resonate with the modes of state, joint, and market governance as described by Griffiths and Zammuto (2005). Alternation between these modes has been vital to the emergence of China's NAIIS. The central government initially left Chinese AI firms to innovate and grow the market for AI technologies on their own. But, with the global proliferation of AI as a uniquely powerful general-purpose technology and the ascendance of MoST's "National Team" of private sector champions, the central government shifted its role to principal executer. In that capacity, the government identified priority areas of the AI sector for state-led economic development and enacted institutional evolution and strategic governance of the NAIIS through the AIDP (Triolo and Goodrich 2018). With a national AI strategy in place, a mode of joint governance is now practiced in which the central government more often plays the role of business partner by making investments in startups through strategic funds, encouraging international flows of venture capital, and facilitating inter-firm decision-making rather than actively managing the AI sector from the top down (Ding 2018). At the micro scale, China's NAIIS emerged through a multi-modal governance process that is, to some extent, more pluralistic than the relatively authoritarian dynamics of the macro scale. Nonetheless, joint governance at the micro scale always remains highly influenced by and deeply beholden to a strong, state-led push from above.

G*uarantee Measures* – The AIDP uses a variety of risk mitigating measures to "guarantee" its successful implementation, including the development of AI laws and regulations, the establishment of new standard-setting institutions, and the implementation of monitoring systems for AI security and performance evaluation. The AIDP suggests that China should aim to become a global leader in developing laws, regulations, and ethical norms for AI innovation, a goal which the Standardization Administration (Ding and Triolo 2018) and the Beijing Academy of Artificial Intelligence (2019) have pursued through their AI ethics and standards initiatives. Roberts et al. (2020) describe how Chinese culture is producing an approach to an AI ethics that differs from that of the Global North, placing *"greater emphasis on social responsibility and group and community relations, with relatively less focus on individualistic rights"* (p. 10). Roberts et al. go on to note that individualistic rights such as the right to privacy are interpreted differently in China, where *"high levels of trust in the government and frequent private sector leaks and misuses* [of personal data]*"* are seen as granting legitimacy to the central government's authoritarian institutions of regulation, surveillance, and moral governance (p. 12). As a consequence, the central government exercises greater moral authority in deciding how AI ethics should be

interpreted and implemented throughout the nation. Governance in China's NAIIS hinges upon such lines of moral authority being drawn and maintained from the macro to micro scale through institutions such as gifting, delegation, performance evaluation, and digital ethics (Roberts et al. 2020). This strategy is an excellent cultural fit for China's domestic AI governance. However, in the realm of global AI governance, China must establish the moral authority to lead the world on issues of AI governance and AI ethics through alternative institutional mechanisms. Patronage, performance monitoring, and devolving powers will have relatively limited utility in shaping the behaviors of international institutions, where authority is more distributed amongst a multipolar set of actors.

5 Discussion and Conclusion

Having identified key features of institutional change, governance, and strategy in Canada's NAIIS and China's NAIIS, some discussion of their similarities, differences, strengths, and weaknesses is in order. Table 1 compares the modes of change, modes of governance, and strategic goals exhibited by each NAIIS. The most crucial differences can be found in the strategic goals of each nation. In the long-term, China seeks cyber superpower status and nationwide transformation by intelligentizing its institutions, while Canada has no clearly discernable long-term evolutionary goal for its NAIIS. In the medium-term, China's most pressing goal is to develop an AI sector with a domestic supply of hardware, software, and talent that is on par with that of the United States. Meanwhile, as a smaller economy than China, Canada aims for more moderate growth in its domestic AI market and talent pool, while also aiming to attain greater social outcomes through ethical AI innovation as well as greater global authority in shaping AI ethics and standards.

Modes of change and governance in each NAIIS are influenced by each nation's pursuit of these differing goals. Canada's NAIIS is loosely systematized, consisting of institutions that have been arranged simultaneously from the bottom up and top down in a middling strategy of building national consensus on AI governance through knowledge brokerage, co-innovation, and value co-creation. Canada's NAIIS more closely resembles a fluid assemblage of institutions, actors, and strategies than it does a strategically unified, functionally integrated system. In the absence of decisive long-term planning for the NAIIS, this continually deliberative, adaptive style of *transactive planning* may prove more valuable in allowing the NAIIS to adapt to unforeseen economic shifts and emerging opportunities (Brews and Purohit 2007). Conversely, China's NAIIS evolves through a relatively rigid style of *rational planning*, making it less adaptable than China's NAIIS, but more capable of maintaining stability and control over the course the AIDP's complex and prolonged implementation process (Brews and Purohit 2007). Although China's NAIIS shares some of the pluralistic qualities of joint governance that exist in Canada's NAIIS, joint governance in China is organized through authority-affirming institutions (e.g., patronage, delegation, performance evaluation), while in Canada, joint governance is organized in interactive spaces through which the federal government seeks legitimacy in its approach to governing AI. Again, this difference has significant implications for planning and institutional evolution: China seeks to align micro-institutional behaviors to its macro-institutional plan, while Canada facilitates the bottom-up development of micro-institutional plans to which the federal government can align its macro-institutional behavior.

Table 1: Overview of Key Features of Modes of Change, Modes of Governance, and Strategic Goals in Canada's and China's NAIIS

		Canada	**China**
Modes of change (Mahony and Thelen 2010)	*Displacement*	- Not significant, though some observers call for quicker introduction of new policies and standards.	- Not significant, early AI governance institutions are still emerging.
	Layering	- New institutions integrate strategic interests, AI ethics, and standards through interactive spaces.	- New organizations and industrial behaviors added to existing institutions to enhance AI innovation capabilities.
	Drift	- Absence of AI ethics and standards prior to layering.	- Institutions of AI sector developed with minimal state involvement prior to AIDP.
	Conversion	- Existing government institutions offer new or modified programs to support AI innovation.	- Institutions of AI sector modified after introduction of AIDP; national institutions strategically transformed through intelligentization.
Modes of governance (Griffiths and Zammuto 2005)	*State*	- Limited, mostly through strategic innovation and talent programs of ISED and IRCC.	- Extensive state direction of long-term goals through AIDP.
	Market	- Not significant, AI sector received early state support and AI market has not yet stabilized.	- Growth of early AI market and emergence of AI sector's *"national champions"* occurred with minimal state intervention.
	Corporate	- Inter-firm collaboration on AI adoption and standardization.	- Inter-firm collaboration on AI adoption and standardization.
	Joint	- Legitimacy-seeking; extensive co-creation of innovation, knowledge, and national strategy through interactive spaces.	- Authority-affirming; state selectively serves as business partner and market coordinator to AI sector.
Strategic goals	*Short-term*	- Maintain early advantages in AI research and high-impact talent.	- Begin nationwide implementation of AIDP, develop associated AI applications and institutions.
	Medium-term	- Grow domestic AI market and talent pool; global leadership in AI ethics and increased social outcomes through ethical AI innovation.	- AI sector on par with United States; greater independence in AI hardware, software, and talent.
	Long-term	- Unspecified.	- Transformation of society and economy through intelligentization cyber superpower status.

CIFAR's *Pan-Canadian AI Strategy* and China's AIDP are emblematic of the core differences in how Canada and China strategically govern their respective NAIIS. CIFAR's strategy relies on joint governance of the NAIIS between governments and sectors. Alongside other governmental initiatives, the strategy establishes interactive spaces which facilitate sectoral and sub-national actors in adding new layers of rules and organization onto existing institutions of AI innovation. Although this approach makes Canada's NAIIS adaptable to exogenous institutional changes, Canada could benefit from some features of the Chinese model by integrating more systematic practices of inter-ministerial collaboration and top-down data regulation into Canada's overall AI strategy (Robbins 2019). In China, a slightly different approach to institutional change and governance is being taken: China's AI sector was once left alone to evolve through institutional drift, but in reaction to the global upsurge in AI innovation, the central government shifted the sector out of drift mode, pushing it *"from riding a wave to full steam ahead"* (Triolo and Goodrich 2018: p. 1). With the launch of the AIDP, the central government began enacting change to the AI sector by converting its existing institutions to function in accordance with the AIDP's long-term planning. As part of this gradual conversion, governance of the NAIIS transitioned quite seamlessly from market to state to joint modes as the NAIIS and its economic needs evolved. This systematic transition through multiple modes of governance demonstrates that China's central government has extraordinary power to reshape patterns of behavior and organization within both macro- and micro-institutional contexts; such far-reaching power is not exercised by the federal government in Canada's NAIIS.

The international contexts in which the two nations operate are substantially different, presenting each nation with a unique set of opportunities and threats. While China aims to safeguard national security and long-term economic stability in competing with the United States for the mantle of cyber superpower, Canada has the relative luxury of only having to *"walk the tightrope of escalating competition between these two powers* [the United States and China]*"* (Robbins 2019: p. 16), rather than having to aggressively compete with either. To be sure, walking that diplomatic tightrope will be a perilous challenge for Canada, particularly within the heightened tensions of pandemic politics. However, with a highly competitive strategy for recruiting international tech talent (Samuels 2019), as well as its relatively comfortable embeddedness in international supply chains of hardware and software, Canada is not faced with as critical a threat to its domestic supply of technology and talent as China is. Because AI innovation is not as decisive to Canada's national security and economic stability as it is to China's, Canada has greater room to focus its resources on achieving global leadership in AI ethics. Advocates of Canadian AI ethics initiatives have suggested that Canada build upon its existing institutions of AI ethics to attain distinctive competitive advantages: world-leading research on the social science and ethics of AI (van der Linden et al. 2020), a domestic AI sector and talent pool with extensive expertise in designing ethical AI systems (McLaughlin and Quan 2019), and a well-regulated AI sector that strongly safeguards the security, privacy, rights, and well-being of consumers (Gaon and Stedman 2019). Although China has recently made great advances in developing principles and standards for AI ethics (Roberts et al. 2020), China's paternalistic attitude toward data privacy may result in increased cyber vulnerabilities (Triolo and Goodrich 2018) and gradual exclusion from international initiatives on AI ethics and standards (Ding 2018; Asia Pacific Foundation of Canada 2019). Meanwhile, Canada is emerging as a global leader in this area through several initiatives at multiple institutional scales, all of which are aimed at democratically legitimizing a national approach to AI regulation (Villeneuve et al. 2019). Porter's (1990) perspective on anticipatory regulation suggests that Canada's deliberative, legitimacy-seeking approach to AI regulation could, in the medium-term, place Canada in a uniquely competitive position: *"When tough regulations anticipate standards that will spread internationally, they give a nation's companies a head start in developing products and services that will be valuable elsewhere"* (p. 88). Effective anticipatory regulation would further strengthen Canada's position as a global authority on ethical AI innovation.

Robbins (2019) argues that on matters of global AI governance, Canada should act as a *"rule-taker"* rather than a *"rule-maker"* (p. 14), but that strategy conflicts with Kassab's (2014) astute characterization of Canada as a *"quintessential middle power"* whose *"comparative advantage and backbone of power is its legitimacy as a force for good."* Therefore, a quintessentially Canadian strategy for leading global AI governance would see Canada acting not as rule-taker nor rule-maker, but rather, as *rule-mediator*. In such a role, Canada could leverage the deliberative spirit of its joint-governed NAIIS to facilitate and intermediate in the deliberations of other nations that wish to develop their NAIIS with regard for their own local values, ethics, and institutional norms. A report by the Asia Pacific Foundation of Canada (2019) suggests that as a rule-mediator, Canada can coordinate with China on AI governance: *"there is an opportunity for Canada to play the role of a middle power in finding pragmatic areas of collaboration with China . . . eschewing more sensitive topics such as social surveillance or military applications, and addressing non-political yet critical aspects of AI regulation focused on safety"* (p. 17). More broadly, *"Canada is in a position to play a positive role on the international stage as a mediator. It has strong AI researchers and institutions as an asset and the credibility that China, the United States, and European countries lack vis-à-vis each other"* (p. 37). In the medium-term, such a strategy would afford Canada enormous political capital in the arena of global AI governance, but in the long-term, how could such political capital be spent to further advance Canada's competitive position? Here, Canada should look to the AIDP: although a top-down governance push is uniquely compatible with the political culture of China (Gu et al. 2016), and in many ways, wholly incompatible with that of Canada, China's long-term evolutionary vision for AI innovation may still be adaptable to the Canadian context. This will require Canada to develop a clear long-term plan for using its NAIIS to push the nation toward a planned future state by systematically—and ethically—embedding AI into its institutions. This could be achieved through Canada's existing approach of governing AI innovation from the middle out. Canada already has the institutions needed to architect and legitimize a comprehensive, long-term plan for evolving its NAIIS in deliberation with knowledge brokerages, sub-national governments, and industry leaders.

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