Centre for International
Governance Innovation

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The Knowledge-based and Data-driven Economy

Quantifying the Impacts of Trade Agreements

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About the Author

Senior Fellow Dan Ciuriak joined CIGI's Global Economy Program in April 2016, focusing on the innovation and trade research theme.

At CIGI, Dan is exploring the interface between Canada's domestic innovation and international trade and investment, including the development of better metrics to assess the impact of Canada's trade agreements on innovation outcomes.

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Previously, he was deputy chief economist at Canada's Department of Foreign Affairs and International Trade (DFAIT) (now Global Affairs Canada), with responsibility for economic analysis in support of trade negotiations and trade litigation, and served as contributing editor of DFAIT's Trade Policy Research series (2001–2007 and 2010 editions). He has also held several other positions at DFAIT, including as deputy to the chair of the Asia-Pacific Economic Cooperation Economic Committee and as finance counsellor at Canada's embassy in Germany.

About the Global Economy Program

Addressing limitations in the ways nations tackle shared economic challenges, the Global Economy Program at CIGI strives to inform and guide policy debates through world-leading research and sustained stakeholder engagement.

With experts from academia, national agencies, international institutions and the private sector, the Global Economy Program supports research in the following areas: management of severe sovereign debt crises; central banking and international financial regulation; China's role in the global economy; governance and policies of the Bretton Woods institutions; the Group of Twenty; global, plurilateral and regional trade agreements; and financing sustainable development. Each year, the Global Economy Program hosts, co-hosts and participates in many events worldwide, working with trusted international partners, which allows the program to disseminate policy recommendations to an international audience of policy makers.

Through its research, collaboration and publications, the Global Economy Program informs decision makers, fosters dialogue and debate on policy-relevant ideas and strengthens multilateral responses to the most pressing international governance issues.

Acronyms and Abbreviations

AI	artificial intelligence
CETA	Canada-EU Comprehensive Economic and Trade Agreement
CGE	computable general equilibrium
CPTPP	Comprehensive and Progressive Agreement for Trans-Pacific Partnership
DCFTAs	deep and comprehensive free trade agreements
FDI	foreign direct investment
FTAs	free trade agreements
GNP	gross national product
GTAP	Global Trade Analysis Project
IP	intellectual property
IT	information technology
NAFTA	North American Free Trade Agreement
OECD	Organisation for Economic Co-operation and Development
R&D	research and development
S&P	Standard and Poor's
TPP	Trans-Pacific Partnership
USITC	United States International Trade Commission
USTR	Office of the United States Trade Representative

Executive Summary

Intellectual property (IP) and data constitute the essential capital stocks of the knowledge-based and data-driven economy. These intangible capital stocks are not, however, represented in the workhorse models used to assess the impact of international trade agreements. As a result, it is not possible — using conventional tools — to evaluate the impact of treaty obligations in respect of IP protection, e-commerce and data; foreign direct investment (FDI) in the knowledge-based sectors; and competition. Canada has recently implemented the Canada-EU Comprehensive Economic and Trade Agreement (CETA), is engaged in renegotiating the North American Free Trade Agreement (NAFTA) and the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), and is in exploratory talks with China. The parties to these treaties dominate the knowledge-based and data-driven economy, yet none of these treaties or negotiations has been evaluated for its impact on Canada's knowledge-based and data-driven economy, nor is it possible to show the treaties' value in these areas of the twenty-first-century economy for the partner economies. This represents a serious gap in Canada's ability to form evidence-based trade policy and to negotiate effectively. These considerations establish a prima facie case for urgent development of a quantitative framework to assess Canadian trade policies in terms of how they affect the knowledge-based and data-driven economy. This paper develops this argument.

Introduction

A pervasive theme of contemporary economic commentary is that accelerated technological change has transformed the way goods and services are produced, with profound implications for who captures the returns to economic activity, which business models succeed and which fail, the structure of industry, the competitive balance between societies, and indeed how societies function. Building on the knowledge-based economy foundations established in the last several decades of rapid technological development, further profound changes are anticipated from the next big thing: the digital transformation, which has been termed the "fourth industrial revolution" (Schwab 2016). This is ushering in what might be labelled the data-driven economy, based on data and artificial intelligence (AI).[1]

In the knowledge-based economy, an economy's growth is conditional on the dynamism of its innovation activity, which generates the knowledge capital on which the knowledge-based economy trades and the IP that is instrumental in its monetization.

Similar considerations apply a fortiori to data and the data-driven economy. AI places extreme demands on data and computing resources (Gualtieri, Lo Giudice and Purcell 2017). Firms recognize that positioning to capture or access data is critical to their ability to develop the AI capabilities to compete in a rapidly evolving market.

The automotive sector provides a good example of the transformation that the data-driven economy is moving forward. At stake is which firm or segment will dominate the emergent "mobility services" sector built around self-driving cars. The contestants come from the automotive manufacturing side (for example, General Motors subsidiary Cruise Automation and Elon Musk's Tesla); from internet services (for example, Google spinoff Waymo and China's Baidu — the latter is making its AI software for self-driving cars available for free in return for the data the software generates [Feng and Yang 2017]); from the ride-share business (for example, firms such as Uber and Lyft, which built their business models on proprietary data collected from the use of their platforms); and from the rental fleet business (for example, companies such as Enterprise and Hertz, which are lobbying to ensure they get access to the data generated by their fleets[2]). These same kinds of dynamics can be anticipated in other areas being transformed by the Internet of Things, which the Office of the United States Trade Representative (USTR) (2017) estimates will comprise, by 2024, some 27 billion devices (including cars, refrigerators, tractors and even buildings)

1 The Organisation for Economic Co-operation and Development's (OECD's) analysis on the role of data in promoting innovation, growth and well-being in what it labelled the data-driven economy started in 2011; see www.oecd.org/sti/ieconomy/data-driven-innovation.htm.

2 See, for example, Enterprise Holdings' Submission to the Canadian Senate Standing Committee on Transport & Communication (Enterprise Holdings 2017).

continuously generating and transmitting data that, if accessible, provides the recipient firms with a foothold in the data-driven economy.

The nature of the knowledge-based and data-driven economy presents strategic problems for states as well as firms. A striking structural feature of this economy is increasing industrial concentration due in good measure to the emergence of "superstar" firms across a wide swathe of industries (Autor et al. 2017).[3] Importantly, this skewing of market share is global and operates across countries, as well as within industries. In his seminal study on superstar economics, Rosen (1981) observed — and studies of returns to modern superstar companies have confirmed — that the superstars capture not only market share, but also a vastly disproportionate share of rents. This sounds a public policy alert: for a state to prosper, it must capture rents, as well as pay them.

A number of explanations, all highly relevant to innovation, trade and competition policy, have been advanced in the literature as to why the knowledge-based and data-driven economy generates this "winner takes most" (Autor et al. 2017) structure:

- → Firms establish leading positions on the strength of strong patent-protected innovation or superior efficiency (ibid.).
- → Control over data and networks confers market power, providing new capabilities for firms to hinder entry and extract rent from customers (Productivity Commission 2016).[4]
- → Firms leverage globalization to exploit network externalities and economies of scale (Fels 2017; Shivakumar 2017).
- → Investments in intangible assets involve larger up-front fixed costs and scale more readily (Haskel and Westlake 2017; Frick 2017).
- → Firms that attain a leading position use market power to erect barriers to entry to protect their position, including by lobbying and by taking over potential future rivals through acquisitions (Solomon 2016; Frick 2017; Van Reenan and Patterson 2017).[5]

These factors are mutually complementary and make a compelling case that the behaviour of the economy is qualitatively different than in the earlier industrial age (Haskel and Westlake 2017).

Canada is entering into international treaties that potentially affect its ability to prosper in this rapidly evolving technological and commercial landscape, yet it is doing so without the benefit of a quantitative framework for assessing the value to itself or to its partners of the commitments in areas pertinent to the knowledge-based and data-driven economy, such as IP protection, e-commerce and data, FDI and competition — all factors identified in the list above.

At present, quantitative assessments of the impact of trade agreements are, for the most part, limited to the commitments in traditional areas, such as tariffs, non-tariff measures affecting services, and border facilitation. To the extent that IP and data provisions are taken into account, the treatment is limited to imputation of trade cost reductions in traditional trade flows. To paraphrase Robert Solow's famous remark that the information technology revolution could be seen "everywhere except in the productivity statistics" (Solow 1987), the knowledge-based and data-driven economy can be seen everywhere except in the trade models.

This is an important gap in our analytical capability on several counts:

3 The notion of superstar firms was first put forward by Sherwin Rosen (1981), who showed that in markets where a quality advantage obtained (implying imperfect substitution across suppliers) was coupled with effectively zero marginal costs of serving an additional customer, a small number of suppliers would dominate the market and command most of the returns — i.e., "winner takes all (or most)." This framing of the issue seems prescient, as it was advanced prior to the internet and digital economy age when this possibility became ubiquitous.

4 Google and Facebook, two of the pre-eminent superstar firms, are built almost entirely on data. But consider how Amazon, another leading contender to become the first trillion-dollar market-capitalized company, describes the pervasive role of AI in its operations: "At Amazon, we've been investing deeply in artificial intelligence for over 20 years, and many of the capabilities customers experience are driven by machine learning. Amazon.com's recommendations engine is driven by machine learning (ML), as are the paths that optimize robotic picking routes in our fulfillment centers. Our supply chain, forecasting, and capacity planning are also informed by ML algorithms. Alexa is fueled by Natural Language Understanding and Automated Speech Recognition deep learning; as is our drone initiative, Prime Air, and the computer vision technology in our new retail experience, Amazon Go." See https://aws.amazon.com/amazon-ai/.

5 CBC News (2017) reports that "Amazon lobbied government 99 times last year, Google had 37 meetings, Netflix 16." John Van Reenan and Christina Patterson (2017) write: "large firms are lobbying to protect their advantage, skewing the political system. Microsoft became a near-monopolist in operating systems, and then strove to keep entrants like Netscape out of the market. Even when superstars fail to deter competitors, they can often just buy up the new threat, as Facebook has with Instagram and WhatsApp."

- First and foremost, the inability to quantify how modern deep and comprehensive free trade agreements (DCFTAs) like the Trans-Pacific Partnership (TPP) impact the knowledge-based and data-driven economy could materially impact the assessment of their net benefits (see, for example, Dade et al., 2017, 7). This is of particular concern in a dynamic context at the dawn of the data-driven economy era.

- Second, the knowledge-based and data-driven economy-relevant measures have been among the most controversial in the public policy debate, both because the optimality for Canada of some of the measures is disputed (see, for example, Blit 2017; Geist 2017), and because strengthened IP implies international rent transfers, which are not "win-win" propositions. Quantification would help ground the debate by confronting arguments with empirical evidence.

- Third, filling this gap would strengthen Canada's hand at the negotiating table and in public outreach in the United States in the context of the renegotiation of NAFTA. For example, as Friedbert Pflüger (2017) observes, Europe's digital trade deficit with the United States in 2014 has been estimated at US$68 billion, a very significant offset to Germany's goods trade surplus with the United States, which has come under fire from the administration of Donald Trump. Canada could likely make a similar claim, if it had the numbers.

Premised on these arguments, this paper proceeds as follows. The following section sketches out the basic elements of a quantitative framework and a possible approach to quantification. The third section sets out some of the specific issues that a quantitative framework would need to address in order to inform Canadian policy in the knowledge-based and data-driven economy world.

Trade Agreements and the Knowledge-based and Data-driven Economy

The Silence of the Models

Modern DCFTAs have pervasive economy-wide impacts through measures affecting the following:

- trade in goods (including tariffs, non-tariff barriers and border costs);

- trade in services (cross-border market access, foreign affiliate sales through market presence, and movement of personnel);

- investment (including *ex ante* national treatment, post-entry investment protection, restrictions on technology transfer requirements and other forms of knowledge spillovers);

- innovation (including expansion of IP protection and the enforcement of IP laws);

- e-commerce and the digital/digitally enabled economy (including restrictions on data localization requirements and the free flow of data across borders to enable the "cloud" business model); and

- industrial policy (liberalization of procurement and incorporation of competition measures, especially in respect of state-owned corporations).

Agreements cover all or virtually all sectors of the economy (consistent with the World Trade Organization requirement that all free trade agreements [FTAs] cover "substantially all" trade) and often cover many countries at the same time (as in the TPP and NAFTA).

Only dynamic, multi-sector, multi-region computable general equilibrium (CGE) models have sufficient structural features to integrate the various shocks generated by a modern DCFTA. Accordingly, they serve as the workhorse tool for quantifying the impacts of such agreements. Examples of their deployment include government joint studies assessing the prospective value of FTAs, such as the Canada-Japan and Canada-EU joint studies; assessments of trade agreements under negotiation or concluded, such as the various studies on the TPP (for example, Kawasaki 2016; Petri and Plummer 2016; World Bank 2016; United States International Trade Commission [USITC] 2016; and Ciuriak, Dadkhah and Xiao 2016); and event studies, such as the various assessments of the economic consequences of Brexit (see, *inter alia*, Latorre, Olekseyuk and Yonezawa 2017; Jafari and Britz 2017; and Ciuriak, Dadkhah and Xiao 2017).[6]

However, the established framework for CGE modelling, which is built on the Global Trade Analysis Project (GTAP) database, is badly out of date. Designed for the nationally integrated industrial/agricultural economy of the pre-1980s, it is not well suited to capture the critical features of the modern economy. Moreover, the mainstream efforts to improve CGE models and data focus on traditional elements — updating estimates of tariffs and non-tariff measures; improving the treatment of the dynamic impacts of FTAs, including by incorporating firm-level heterogeneity; improving treatment of global value chains; and refining the treatment of rules of origin and utilization of preferences.

Importantly, the model databases are silent on the knowledge-based and data-driven economy. Missing are the basic building blocks of an innovation module, namely: stocks of knowledge capital; research and development (R&D) investment (which adds to these stocks); flows of royalties; and indices of IP protection (which enhances the value of these stocks and flows, but also creates stumbling blocks to follow-on innovation). IP-intensive sectors singled out for special treatment in DCFTAs, such as software, media content and pharmaceuticals, are not separately represented as sectors in the GTAP database (although the next-generation version of the database will break out basic pharmaceutical products and include 10 new services sectors). If anything, data and the firms built on data are even less visible in the GTAP framework than IP.

To date, as noted, attempts to account for the impact of trade agreements on the knowledge-based and data-driven economy have treated the relevant measures as reducing trade costs for conventional goods and services. For example, Peter A. Petri, Michael G. Plummer and Fan Zhai (2011) assign a trade-cost reduction across sectors to the TPP's IP and e-commerce chapters based on how extensive the treatment of each subject is in terms of length of text. Similarly, the USITC (2016) develops estimates of the cost reductions for cross-border services trade across industries that are due to the TPP's data provisions requiring the free flow of data across borders and prohibiting data localization requirements.

The key missing element in the framework is arguably intangible capital, which includes IP and data, the essential capital stocks of the knowledge-based and data-driven economy. This suggests the point of departure to assess the impact of trade agreements on the knowledge-based and data-driven economy is to introduce intangible capital into the quantitative framework.

Introducing Intangible Capital into the Quantitative Framework

In broad-brush terms, the key distinction between the era of the knowledge-based and data-driven economy and the earlier industrial era rests on the nature of the essential capital stock of each era.

In the industrial era, economic growth was based on the mechanization of production; the essential capital stock was powered machinery and equipment. Economic policy, not surprisingly, focused on incentivizing domestic capital investment and attracting foreign capital by making an economy an attractive place to do business. For small economies such as Canada, which could not achieve sufficient scale producing for domestic markets alone, economic policy also focused on ensuring access to global markets.

In the era of the knowledge-based economy, the essential capital stock became IP. Protection of IP is essential to its monetization and, not surprisingly, this became the centrepiece of economic policy in the leading knowledge-based economies, as underscored by former US President Barack Obama's statement on the TPP: "America's greatest asset is IP....We're going to aggressively protect our intellectual property. IP is the cornerstone of innovation. It is essential to our prosperity and it will only become more so in this century....That's why the U.S. Trade Representative is using the full arsenal of tools available to crack down on practices that blatantly harm our businesses, and

6 For a discussion of the degree of confidence in CGE estimates, see Hertel et al. (2003). For a discussion of the types of different features of CGE models used for analyzing DCFTAs, see Narayanan, Ciuriak and Singh (2015). For a discussion of differences in estimates of a given trade agreement derived using different CGE models and different approaches to quantifying the policy elements in a trade agreement, see the discussion of modelling results for the TPP in Ciuriak (2016).

that includes negotiating proper IP protections and enforcing our existing agreements, and moving forward on new agreements" (Obama 2010).

In the era of the data-driven economy, the essential capital stock is data. AI — the industrial version of learning — is trained by data. Not surprisingly, economic policy in the leading data-driven economies emphasizes unfettered access to data. Given the extreme data requirements to implement firm-level AI strategies (Gualtieri, Lo Giudice and Purcell 2017), this means access to data on a global scale. Hence, the TPP e-commerce chapter insisted on the free flow of data across borders and banned requirements to localize data storage.

IP and data are two components of firms' intangible capital assets (see Box 1 for definitions and historical background on the rising share of intangible capital).

Given that conventional measures of intangible capital accumulation during the era of the data-driven economy do not include the value of data, it can be inferred that the actual accumulation of intangible capital has been substantially greater than would be inferred from applying the perpetual inventory method based on investment and depreciation flows. By the same token, while it is precarious to estimate the share of the total existing private sector capital stock that is comprised of intangible capital, it seems fair to conclude that, in the leading knowledge-based and data-driven economies, intangible capital now dominates, based on the strength of the sustained excess of intangible investment, the steep rise in the contribution of data to enterprise value and the creative destruction in the traditional economy, which is writing down the value of physical capital stocks (see, for example, the "retail apocalypse" of 2017, as traditional bricks-and-mortar retail succumbed to the bricks-and-clicks data-driven model of Amazon [Thompson 2017]).

The distinction between tangible and intangible capital provides a point of departure for developing a quantitative framework for the knowledge-based and data-driven economy. The essentials of the approach are as follows:

- CGE models currently include capital stock by region and sector based on replacement cost. In dynamic CGE frameworks, this stock changes through standard capital accumulation models of new investment less depreciation.
- Tobin's Q, which has been used to measure the value of a firm's intangible assets, relates market capitalization (the market value of a company's assets as measured by its outstanding equity and debt) to the value of its physical capital stock (as measured by the replacement cost of the company's assets at book value). The share of intangible assets in total enterprise value varies highly across industries, ranging from very low in oil and gas to very high in internet, pharmaceuticals, biotechnology, software and media (Brand Finance 2016). By the same token, the share will vary across countries depending on their industry structure, not to mention the extent of their participation in the knowledge-based economy. Intuitively, different factors determine the share of intangibles by industry. Accordingly, it seems reasonable to use empirical estimates of Q by region and sector to generate estimates of the market value of the capital stocks already incorporated in the GTAP dataset.
- Intangible capital is comprised in part by IP and data; by the same token, the impact of measures in DCFTAs that affect the value of IP and/or access to and exploitation of data can be empirically linked to changes in the value of intangible capital.

Adding this dimension to CGE models would provide an industry- and country-specific perspective on the impact of measures in DCTFAs that are relevant in the knowledge-based and data-driven economy. Even if precise estimates would be beyond empirical reach, sensitivity analysis over a plausible range of values would serve to provide a quantitative lens through which to assess the potential impacts.

Asset Values and the Integrated Macroeconomic Accounts

Introducing intangible capital into the framework, together with the impacts that affect its market value, requires a conceptual shift from modelling the national accounts to modelling a simplified form of the integrated macroeconomic accounts, which combine the national accounts and financial balance sheets of an economy.

Following the 2008-2009 financial crisis, which revealed that understanding changes in net worth of an economic sector was critical to understanding the risks and prospects facing it, Group of Twenty finance ministers and central

Box 1: Tangible versus Intangible Assets

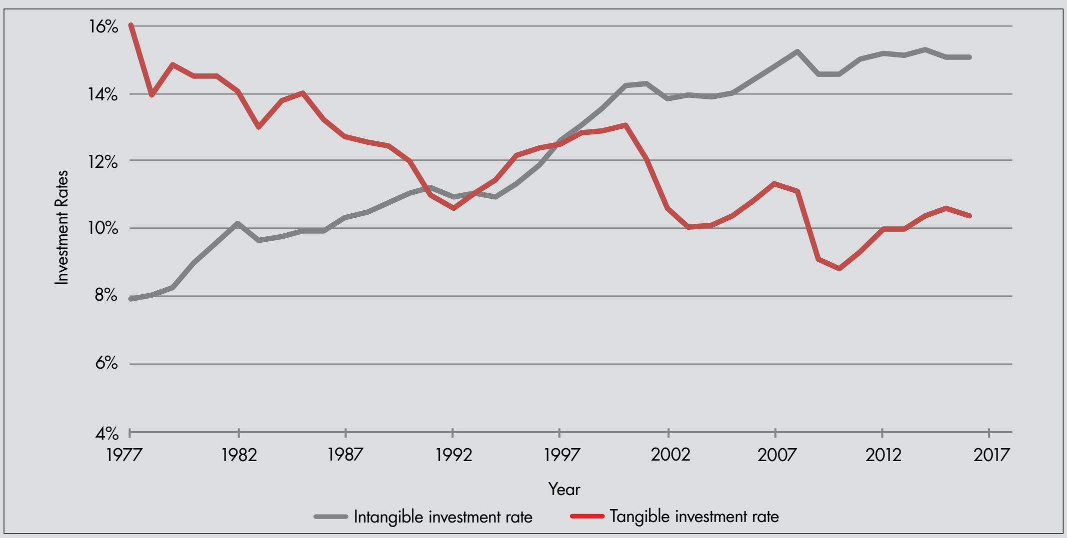
Tangible assets have a physical form; they include machinery, buildings, land and inventory. By contrast, intangible assets do not have a physical form; they include IP (patents, copyrights, trademarks and business methodologies), human capital, goodwill and brand recognition, cultivated customer relationships and distribution systems. For data-driven firms, databases are the most important form of intangible capital.

Intangible capital has grown substantially in the leading knowledge-based economies over the decades, by any measure; however, there are numerous measurement challenges, which result in varying estimates of currently existing stocks. For example, Leonard I. Nakamura (2009) shows that the perspective on total US investment, and hence on the size of its capital stock, changes greatly when expenditures on software, R&D, and marketing and organizational change are successively added to investment.

Carol A. Corrado and Charles R. Hulten (2010), building up estimates of US investment in intangible capital, find that the intangibles' share of total investment rose from 38 percent in the 1970s to 56 percent at the beginning of the 2000s. This share increased to the 60 percent range over the period to 2016, as shown in the figure below.

Importantly, the above percentages do not account for the value of data, which is not purchased but assembled without payment, largely from the use of the internet, with platform providers providing "free" services in exchange for the access to the data generated by the use of their services. For data-driven firms such as Facebook, the intangibles share is very high. Vipal Monga (2016) observes that the difference between Facebook's assets and its liabilities could serve as a proxy for the value of its user data, the algorithms it uses to mine the data and its brand. This places the share of intangibles in Facebook's assets at about 86 percent in 2014. The value placed by markets on firms also reflects the value placed by the market on other forms of intangible capital, including patents, copyrights, trade secrets, trademarks and geographic indications.

US Investment in Intangibles and Tangibles as a Share of Private Sector GDP, 1977–2016



Source: Unpublished update to Corrado and Hulten (2010) provided by Carol Corrado.

Notes: Figures for 2016 are preliminary. Private investment and industry gross value added exclude residential real estate.

bank governors endorsed the compilation of national accounts that included sectoral balance sheets and flows of funds, distinguishing between saving, borrowing, holding gains or losses, and other changes (Cagetti et al. 2012).

Two points are key for the conceptual framework to measure impacts on the knowledge-based and data-driven economy:

- First, the inclusion of asset revaluations in this accounting framework provides the link for taking into account the impact of changes in protection on IP assets.
- Second, the USITC (2011) was able to draw a link between China observing higher IP standards and the returns to US capital. Working through a standard capital asset pricing model, an estimate of increases in return to fixed knowledge assets could be translated into capital values.[7]

Capturing the Impact on Innovation and the Returns to IP

Modern trade agreements mandate a high degree of protection for IP. Increased IP protection increases the expected rate of return to capital to the individual firm by expanding supra-normal profits; in principle, this should induce more investment in the form of R&D.[8] At the same time, higher protection introduces costs for follow-on innovation, as it make access to existing knowledge capital inputs more expensive and may force other innovators to work around the existing patents (which is particularly likely when low-value patents protecting small inventive steps are issued; see Ciuriak and Curtis [2015] for a fuller discussion).

For the large IP-intensive firms, increased IP protection allows for the capture of greater market share internationally, including by excluding rival products, due to the enforcement provisions built into trade agreements. This international rent appropriation opportunity and the disproportionate incidence of the costs of excessive IP protection on potential future rivals help explain the strong lobbying efforts by major IP-intensive firms for stronger protection. The implied terms of trade gains explain the adoption of this as national policy by the major IP-owning economies, notwithstanding the potential net negative impact on the incentive to innovate (Ciuriak 2017a).

The net effect at the system level determines whether innovative activity is stimulated or dampened.[9] To shed light on this, the following elements would need to be introduced into the quantitative framework:

- Ideally, innovation would be modelled explicitly. This would involve introducing a stock-flow model for knowledge capital, in addition to the current stock-flow model for physical capital, into dynamic CGE models. A CGE model with knowledge stocks and R&D has been developed to model climate change with a focus on spillover effects. This would provide a point of departure for the modelling exercise.[10]
- A second requirement would be an index that provides a snapshot of IP protection in a country at a particular point in time, which would allow the quantification of changes in countries' IP protection as a result of a negotiated FTA. Several such indexes currently exist, but none are well articulated in terms of the measures incorporated in trade agreements. A good model for such an index would be the OECD's Services Trade Restrictiveness Index, which transforms qualitative information on regulation into binary variables ("yes" or "no" for the existence of a type of measure). With weights assigned on the basis of expert opinion, the index would provide a summary statistic as to the level of protection pre- and post-FTA.
- Finally, after the development of the index for a significant group of countries, it would be tested econometrically for its correlation/ causation with measures of business R&D and international flows of payments for IP use (royalties, licences and so on).

Such a system might be complemented in the case of the analysis of any particular FTA by external

7 The author (2017b) applied the 0.4 percent improvement in returns to US capital identified by USITC (2011) to the Standard & Poor's (S&P) 500 market capitalization of (then) US$15 trillion, discounting at the historic weighted average cost of capital for the S&P 500 of 8.3 percent over the horizon to 2035 and ignoring terminal values, and found an implied improvement in financial market estimates of the value of US capital of US$345 billion.

8 Whether this is the case in fact has not yet been conclusively established; see, for example, Boldrin and Levine (2012).

9 Adam B. Jaffe and Josh Lerner (2004) suggest a net negative effect; Joseph Allen (2015) offers a contrary view.

10 See Parrado Moscoso (2011), in particular the discussion of data sources and adaptation of the GTAP database starting at p. 52.

analyses of particular measures. An example is the analysis of the rent transfer effects of increasing copyright protection from 50 to 70 years as done for Canada and New Zealand in the context of the TPP.

International Asset Holdings and Income Flows

Households (including indirectly through pension funds) hold portfolio investments in firms in other countries and vice versa. Accordingly, one way for a country with limited or no ability to directly participate in the data-driven economy would be to make portfolio investments in data-driven-economy firms domiciled abroad, while focusing its own productive efforts on areas of its own comparative advantage. This would give the country an ownership stake in the data-driven economy without having a direct footprint in this economy. There are limitations to such a strategy, including the pronounced home bias in equity holdings (the equity home bias "puzzle"; see French and Poterba [1991]), foreign currency risk and so forth. Nonetheless, evaluating the national interest in a trade agreement where an important, if not the most important, element is its impact on asset values would require addressing this issue by taking into account international asset positions.

Taking into account international asset positions would imply expanding the indicators used to assess the impacts of trade agreements. Currently, models focus on GDP, which captures the impact on productive activity within an economy. However, in light of international income effects, it would be helpful to also identify the impacts on gross national product (GNP), which takes into account income earned abroad.

- → As a starting point for assigning international asset positions, GTAP-concorded matrices setting out bilateral investment stocks and foreign affiliate sales by region-sector have been developed by Csilla Lakatos, Terrie L. Walmsley and Thomas Chappuis (2011) and Tania Fukui and Csilla Lakatos (2012). These underpin the domestic capital/FDI splits in the GTAP-FDI model deployed by Global Affairs Canada and described in the study by Dan Ciuriak and Jingliang Xiao (2014) on the TPP.
- → There would be an additional issue of allocating portfolio positions, which would modify FDI-based allocations.
- → An additional set of flows related to international asset holdings would accordingly also be required to capture the flow of IP-related income, such as royalties and licence fees, together with investment income and repatriated profits.

Capturing the Impact of Data Flows

Data flows are integral to, and an essential enabler of, digital trade and digitally enabled trade, including e-commerce and the "cloud" business model — hence the strong interest by firms engaged in both areas to ensure that there is unfettered flow of data across borders and that no requirements are imposed to store data in any particular jurisdiction.

Data does not appear in conventional economic or trade accounts because data is captured or accessed, not purchased, so there are no formal transactions with invoices and receipts that assign a value to data; rather, there is an implicit barter exchange of data for services in kind — an individual uses an internet search engine freely made available and the provider of the search engine gets to know what the individual searched for.

Leonard Nakamura, Jon Samuels and Rachel Soleveichik (2017) discuss the barter terms of exchange and provide estimates of the value of the "free" consumption involved. For the United States in 2015, their estimate is a boost to GDP of 1.7 percent, or about US$316 billion.

On the other side of the barter exchange is the question of the value of the data. This can only be indirectly inferred from the valuation placed by markets on the intangible assets of data-driven firms such as Google (market cap US$714 billion) or Facebook (US$517 billion). The size of this market capitalization suggests that the value of the data obtained by the service providers greatly exceeds the cost of providing these platforms.

Assigning a value to the data generated by Canada, which accounts for some of the intangible assets of data-driven firms, would be an important first step to understanding the value proposition that the data clauses have in a trade negotiation. Key steps would be as follows:

- → Digital intensity coefficients would be developed, building on the work done by the USITC (2013) in developing indicators for digital intensity based on

  - the proportion of online sales (e-commerce);
  - the share of total input purchases that are information technology (IT)-related;
  - the proportion of employees in digital occupations; and
  - the share of total IT spending directed to cloud services.

→ Following USITC (2013), trade cost reductions would be estimated based on digital intensity for the measures addressing data flows in an agreement.

→ As regards international market shares, taking into account the evidence concerning market dynamics in the data-driven economy and the propensity for dominant firms to emerge, estimates of potential market share capture by leading-edge digital-intensive firms would be developed.

Income and Wealth Effects

With the above framework of tangible and intangible capital and related flows in place, income and wealth effects flowing from IP/data measures (and, indeed, conventional impacts on returns to capital) could be generated. Linkages could be built from these income and wealth effects to consumption and investment, and to market share capture, thus linking developments in the knowledge-based and data-driven economy to real GDP.

Conclusions

This paper suggests a way to think through, in a quantitative sense, the potential impacts of DCFTAs on the knowledge-based and data-driven economy. In particular, incorporating the impacts into an asset-augmented CGE framework, as suggested above, has the advantage of assessing the growth implications of capturing/not capturing international market share, while taking into account resource constraints, and allowing the analysis of GNP versus GDP distinctions in the sources of welfare and income gains. The framework would also shed light on the extent to which portfolio investments could serve as a complementary approach to accessing the benefits of the knowledge-based and data-driven economy.

The paper argues that Canada's success in the knowledge-based and data-driven economy will depend on its ability to capture a good share of global knowledge and data assets, which constitute essential capital for the modern economy. If Canada lags on this share, it will likely lag on income growth, experience declining market share globally and face marginalization.

In Canada's internationally integrated economy, industrial performance and policies are affected by the terms and conditions of trade agreements into which Canada enters. Drawing linkages from the terms of these agreements to the value of Canadian knowledge assets and the flows of payments and receipts is essential to measuring their impact, which, in turn, informs bottom-line decisions.

Canada has recently implemented CETA, is engaged in renegotiating NAFTA and the CPTPP, and is in exploratory talks with China. These economies include the dominant knowledge-based and data-driven economies in the world today. None of these agreements or negotiations has been evaluated for their impact on the knowledge-based and data-driven economy. The stakes might be very large — much greater than the typical estimates of the impact of trade agreements on the traditional industrial economy. Taking into account the impact of trade agreements on asset values is critical. The foregoing discussion makes the case for an urgent assessment of the implications of the IP and data commitments contained in modern DCFTAs for Canada's economy.

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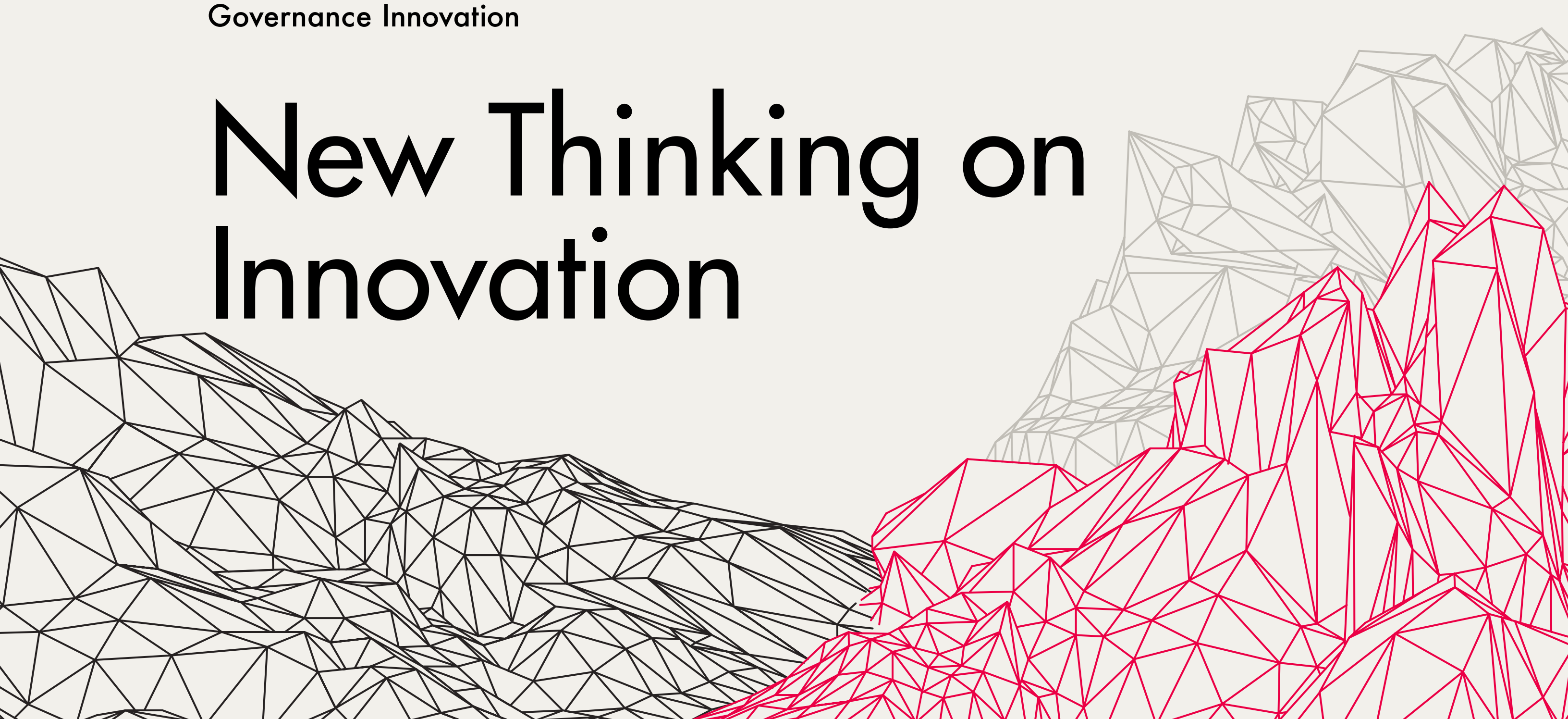

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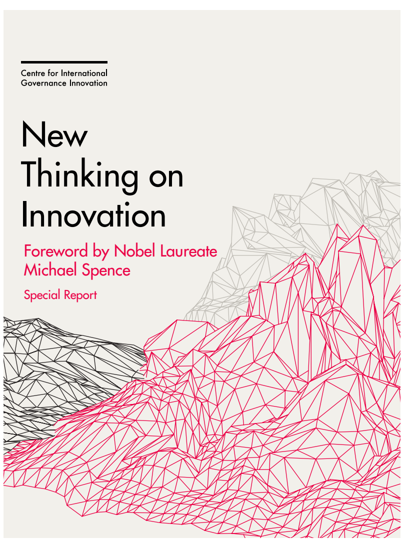

Foreword by **Nobel Laureate Michael Spence**

Introduction and epilogue by **Rohinton P. Medhora**

Innovation is at the centre of the current economic policy discourse in Canada. Innovation drives productivity, and with it, standards of living. Innovation is the process of using ideas, typically in the form of intellectual property (IP), to offer new or improved products or services for the same or lower overall cost of production. This collection of essays, first published online in the spring of 2017, marshalls new thinking on innovation, and brings together a community of scholars and practitioners who offer fresh approaches to innovation in Canada, and Canada's place in the world. The essays discuss the role that international trade plays in stimulating innovation, including the nature of trade agreements; consider domestic policy on innovation; and examine how global processes such as the World Trade Organization and the Group of Twenty might foster a climate in which the innovation strategies of smaller countries could be accommodated. An epilogue maps the key themes to emerge from the discussion and suggests a framework for an IP-centric innovation strategy. Rapid developments in technologies, often referred to as the Fourth Industrial Revolution, are upending established structures in every part of the economy and society. As in other facets of international negotiations, the starting point in efforts to bring order to and shape the current technology-fuelled environment for the global good is national policies and postures.

Essays by:

Karima Bawa
Benjamin Bergen
Joël Blit
Dan Ciuriak
Warren Clarke
Neil Desai
Michael Geist
E. Richard Gold
Blayne Haggart
Jesse Hirsh
Brian Kahin
Leah Lawrence
Domenico Lombardi
Myra Tawfik
Gus Van Harten
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Our research programs focus on governance of the global economy, global security and politics, and international law in collaboration with a range of strategic partners and support from the Government of Canada, the Government of Ontario, as well as founder Jim Balsillie.

À propos du CIGI

Au Centre pour l'innovation dans la gouvernance internationale (CIGI), nous formons un groupe de réflexion indépendant et non partisan qui formule des points de vue objectifs dont la portée est notamment mondiale. Nos recherches, nos avis et l'opinion publique ont des effets réels sur le monde d'aujourd'hui en apportant autant de la clarté qu'une réflexion novatrice dans l'élaboration des politiques à l'échelle internationale. En raison des travaux accomplis en collaboration et en partenariat avec des pairs et des spécialistes interdisciplinaires des plus compétents, nous sommes devenus une référence grâce à l'influence de nos recherches et à la fiabilité de nos analyses.

Nos programmes de recherche ont trait à la gouvernance dans les domaines suivants : l'économie mondiale, la sécurité et les politiques mondiales, et le droit international, et nous les exécutons avec la collaboration de nombreux partenaires stratégiques et le soutien des gouvernements du Canada et de l'Ontario ainsi que du fondateur du CIGI, Jim Balsillie.

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