Metro *North America*

Cities and Metros as Hubs of Advanced Industries and Integrated Goods Trade

Metropolitan Policy Program
at BROOKINGS

CONTENTS

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Cities and Metros as Hubs of Advanced Industries and Integrated Goods Trade

GLOBAL CITIES INITIATIVE
A JOINT PROJECT OF BROOKINGS AND JPMORGAN CHASE

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EXECUTIVE SUMMARY

Twenty years after the enactment of the North American Free Trade Agreement, advanced manufacturing sectors today extend their supply chains across the United States, Mexico, and Canada, anchored by productive metropolitan hubs in all three countries. With new opportunities emerging to boost North America's competitiveness for investment and jobs in advanced industries, this first-ever analysis of production and trade among North America's cities and metropolitan areas reveals that:

- **Metropolitan areas in the United States, Canada, and Mexico contain 77 percent of the three countries' total population but generate 86 percent of their combined GDP.** These 432 metropolitan areas with populations of at least 100,000 generate even higher shares of national and continental output in key advanced manufacturing sectors—aerospace, automotive, electronics, machinery, pharmaceuticals, and precision instruments.

- **U.S. metropolitan areas traded $512 billion in goods with Canadian and Mexican metropolitan areas in 2010.** This total represented a majority (58 percent) of the $885 billion in goods traded between the United States and Canada/Mexico. Twenty-five U.S.-Canada metro pairs, led by New York and Toronto ($3.7 billion), and 15 U.S.-Mexico metro pairs, led by Los Angeles and Mexico City ($2.2 billion), each traded more than $1 billion in goods in 2010.

- **Advanced industries—aerospace, automotive, electronics, machinery, pharmaceuticals, and precision instruments—account for 47 percent of goods trade in North America, and metro areas account for 69 percent of trade in advanced industries.** For the most technologically advanced goods, including aerospace, electronics, and pharmaceuticals, at least 75 percent of North American trade occurs among metro areas. More than three-quarters of advanced-industries trade with Mexican and Canadian metro areas originates or terminates in non-border U.S. metro areas.

- **Goods trade in key advanced industries binds distinct sets of metropolitan areas across North America.** The top 20 North American metro areas for automotive, electronics, and aerospace trade account for 15 percent, 18 percent, and 40 percent, respectively, of total trade between the United States and Canada/Mexico in those commodities. The largest trading relationships involve Detroit and Toronto in automotive, San Jose and Mexico City in electronics, and Seattle and Montreal in aerospace.

Over the past two decades, the North American share of world exports has steadily dropped. Working together, however, the United States, Mexico, and Canada can reverse this decline and reposition North America as a production platform for itself and the rest of the world. Because cities and metropolitan areas play an outsized role in that platform, efforts to strengthen North American competitiveness require a balanced approach involving both national and subnational leaders from government, business, and civil society in all three countries.

I. INTRODUCTION

Sometime in 2014, the first Learjet 85 business aircraft will roll out of a Bombardier factory in Wichita, Kansas.[1] While Wichita will be its final stop before taking flight, it is not the only place that will claim ownership of the Learjet 85.

Research and design of the Learjet 85 is mainly handled by engineers in Montreal at Bombardier's Business Aircraft site.[2] About 2,800 miles south, a factory in Querétaro, Mexico manufactures the Learjet 85's fuselage, wings, and electrical harnesses. These large structures are trucked north, first along Highway 57 in Mexico and then along U.S. Interstate 35, to Bombardier's plant in Wichita.[3] Here, they are assembled with the Learjet 85's other parts, including a Pratt & Whitney engine manufactured just outside Toronto.[4]

When international buyers purchase a Learjet 85, the final $18 million price tag will be ascribed to the United States, the state of Kansas, and the Wichita metropolitan area as an export.[5]

Yet not all $18 million of the Learjet 85's value can be credited to Wichita. For a product as complex as an airplane, it is difficult to quantify the full range of companies and places that together complete its design, production, and assembly. But clearly Montreal, Toronto, Querétaro, and other regional hubs are part of Bombardier's value chain, which the Organization for Economic Cooperation and Development (OECD) defines as the "full range of firms' activities, from the conception of a product to its end use and beyond."[6] When these chains of production stretch across borders, they become global value chains. And these chains increasingly characterize advanced industries—R&D-intensive pursuits such as aerospace, automotive production, electronics, and precision instruments that require workers with significant technical knowledge and skills.

Bombardier's global value chain does not extend randomly, but rather concentrates in the places with the specialized labor, tailored capital, innovation ecosystems, infrastructure networks, and supplier bases needed to create and trade products: cities and metropolitan areas.

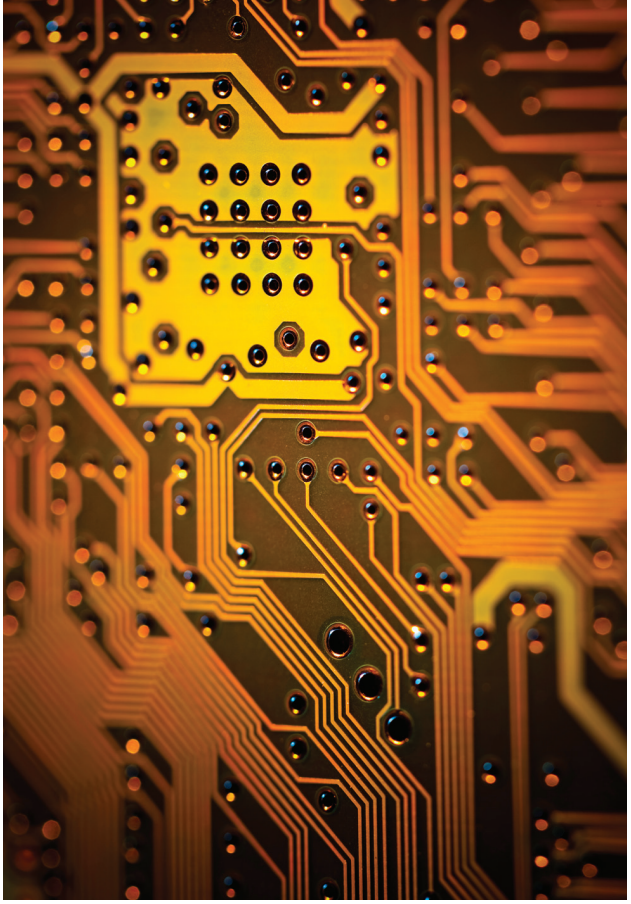
Bombardier's research and development operations are able to leverage the innovative capacity institutionalized in Greater Montreal through the Consortium for Research and Innovation in Aerospace in Quebec (CRIAQ).[7] Bombardier was

attracted to Querétaro by the state's well-educated population and the promise from federal and state governments to locate a new aerospace university, UNAQ (Universidad Aeronáutica en Querétaro), to supply the budding cluster with skilled workers.[8] In Wichita, the firm relies heavily on a deep labor pool and the world-class National Institute for Aviation Research for material and structural testing.[9] And strong infrastructure connectivity within North America and the North American Free Trade Agreement (NAFTA) facilitate the flow of Bombardier's goods between these cities. As a result, Bombardier's value chain for the Learjet 85 benefits from the distinct specializations of at least four metropolitan economies all within two time zones and one free trade area.

Bombardier's footprint offers one example of how advanced industries are increasingly *North American* in their reach, uniting research, design, production, and distribution centers across Canada, Mexico, and the United States. This co-production relationship also creates a shared interest in boosting continental exports. When a Learjet 85 is exported to Asia, Europe, or South America, Wichita, Montreal, and Querétaro all reap the economic benefits of that sale.

Twenty years after the enactment of NAFTA, North American trade is no longer characterized simply by exchange of finished goods. Today, the three NAFTA countries co-produce goods for the continental market and for the rest of the world. Yet little is known about the specific locations of these North American value chains, which national trade statistics obscure. The geography of the North American automotive value chain differs from the geography of value chains for electronics or aerospace production, all of which may differ from the flow of energy products. While new value-added trade statistics suggest deep regional linkages in critical industries, no comprehensive information is available to document where those linkages come to ground.

This report offers a new perspective on production and trade in North America. It unveils for the first time the metropolitan exchanges that fuel North



American trade, especially in advanced industries, and identifies the top trading partners for cities and metro areas so that community leaders can develop more informed and market-driven engagement strategies within the continent. This new information points to two imperatives: First, cities and states/provinces must invest in the assets that maintain and grow their competitive niches within the continental and global economy; and second, national leaders must engage with their subnational, metropolitan counterparts to advance a competitiveness agenda for the continent.

The report proceeds in four parts. It offers background on the North American economy, details the research methodology and data, unveils the role of metropolitan areas in continental goods trade, and concludes with relevant policy implications to bolster North American competitiveness. ■

II. BACKGROUND

THE PATH TO NORTH AMERICAN INTEGRATION

On January 1, 1994, NAFTA took effect as tectonic shifts in the global economy were still evolving. The internet was not yet in wide use, Thomas Friedman had not yet declared the world flat, and globalization was still a nascent concept in the public consciousness.

Two decades later, the world looks very different economically. The further opening of the global trading system (most notably through regional trade agreements and China's entry into the World Trade Organization in 2001); the effective doubling of the globally connected labor pool[10]; and sustained advancements in information, communication, and transportation technologies have changed the global economy profoundly. These dynamics have allowed companies to unbundle their production processes and disperse them across the world to locations where production can be conducted most efficiently and effectively, either through outsourcing or by expanding the company's own operations abroad. Companies then link different production stages in tightly integrated global value chains (see the box, "What Is a Global Value Chain?").[11]

Notwithstanding their global footprint, multinational corporations tend to situate value chains *regionally* when possible, preferring to source intermediate components closer to the sites of production and

WHAT IS A GLOBAL VALUE CHAIN?

Harvard economist Michael Porter uses the term *value chain* to describe how firms organize their activities to design, produce, market, deliver, and support their products.[12] Global value chains arise when firms disperse these activities across different countries. Sophisticated information, communication, and logistics management systems now allow firms to situate and integrate their operations in different parts of the world. Transactions within a global value chain may occur between different affiliates of a multinational firm or between multinationals and smaller suppliers, and apply to value creation in both production and services.[13]

In a world of global value chains, economies of scale still matter, but more so for activities rather than entire industries. Agglomeration and clustering still provide Detroit with competitive advantages in the automotive industry. But unlike in the days of Henry Ford, automakers do not design, source, and produce cars entirely from within Michigan. Detroit still maintains a central role in research and development and production, but it also sources parts from Canada, China, and Mexico. This practice has caused economists to conclude that trade in products has been joined by a "trade in tasks."[14] The places that provide the highest value-added segments of a value chain will reap the most economic rewards, regardless of where the final product is completed. Or, as a recent OECD report remarked: " 'what you do' matters more than 'what you sell.' "[15]

final consumption to minimize costs. An analysis by the OECD reveals that the foreign content of a country's exports disproportionately comes from neighboring economies within the same region.[16] Economists Robert Johnson and Guillermo Noguera come to a similar conclusion: fragmentation of production favors proximity, all else equal.[17]

Beyond firm-level activities, the proliferation of trade agreements over the last two decades has also advantaged trading within regions. As World Trade Organization negotiations stalled in the early 1990s, policymakers turned to regional trade agreements to help facilitate commerce. Since 1990, 235 regional trade agreements have been enacted, including NAFTA and the agreement forming the European Union's free trade zone.[18]

For its part, NAFTA certainly helped facilitate trade and investment within North America. Leaders in Canada, Mexico, and the United States signed the agreement to align the regulatory and trade facilitation environment with the realities of how trade occurred in the late 20th century. NAFTA aimed to lower trade and investment hurdles, ensure predictable rules and regulations, and in the process increase the economic competitiveness of the three countries.[19]

Trade and investment boomed following the agreement. Between 1994 and the end of the 2000s, trade in North America tripled and foreign direct investment grew six-fold.[20] Intraregional trade within North America increased from 41 percent of total trade in 1990 to 48 percent in 2011.[21] To be sure, debates still rage about whether NAFTA has been a successful economic policy overall. While no clear consensus exists, the agreement's impact on jobs and growth in all three countries demonstrates the broadly held view among economists that in the long run, trade liberalization furthers economic growth, but in the short run can impose significant costs on particular workers, industries, and places.[22]

Importantly, NAFTA took effect amid broader forces that were already shifting firm behavior, and therefore global production and trade patterns. Once firms operate within a broad region such as North America, Europe, or Asia, they tend to disperse their activities to where they can be conducted most cost effectively. For labor-intensive parts of the supply chain, production and jobs gravitate toward countries with relatively lower labor costs. Innovation-dependent stages will cluster in those places with the requisite skills and technologies. Infrastructure, taxes, regulations, rule of law, intellectual property protection, and quality of life all matter to companies as well.[23] Mexico's auto sector, for instance, has been booming of late, a trend that largely stems from Mexico's ability to offer lower labor costs to global producers. Mexico's share of all North American auto industry employment increased from 36 percent in 2010 to 39 percent in 2012, gains that have come partially at the expense of U.S. and Canadian producers in the Great Lakes region.[24]

In this way, global integration offers benefits that should be celebrated and exacts costs that cannot be ignored. Mexico's ascent from a largely poor country to a middle-income nation over the past three decades coincides with its transition from a largely agriculture- and natural resource-dependent economy to one focused on higher-value manufacturing.[25] Indeed, the average salary in Mexico's exporting sector is roughly three to four times higher than the average salary in Mexico's traditional economy, and the wealthiest parts of the country are those that are most globally integrated.[26] Yet these same market forces have also leveled costs on advanced economies, particularly for low- and middle-skill workers. Over the past few decades, U.S. manufacturing has shed jobs due to labor-saving technology and, to a lesser extent, offshoring, contributing in turn to rising inequality and a widening trade deficit.[27] These trends are apparent in other advanced economies as well.[28]

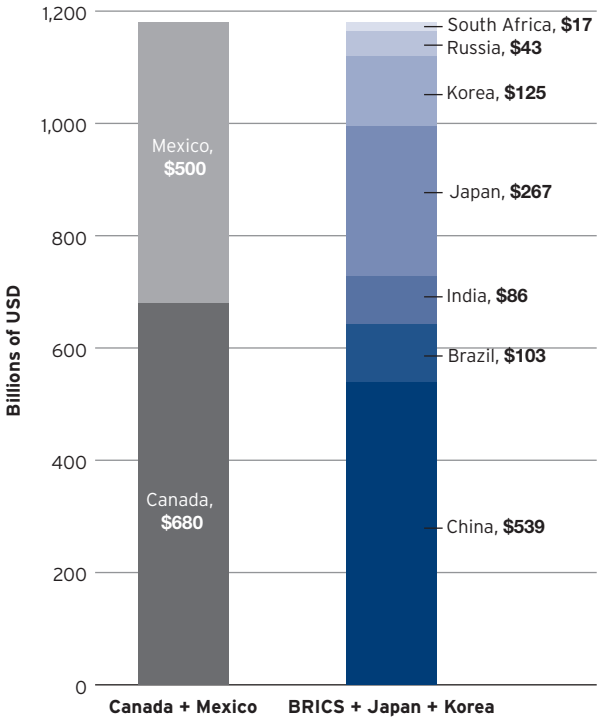
No one policy or trade agreement singlehandedly caused these shifts. Rather, they appear to be the result of market forces that individual countries are powerless to counteract.[29] After all, firms have also offshored operations to countries without free trade agreements, like China and India, in search of a

lower-cost environment. NAFTA has afforded a competitive advantage to firms that choose to situate operations across the three countries by extending them the benefits of a free trade area.[30]

After decades of continued economic integration, the quantity and quality of trade within North America is truly distinct. In 2011, the latest year for which goods and services trade data are both available, the United States exchanged nearly $1.2 trillion worth of goods and services with Canada and Mexico, the country's first- and third-largest trading partners, respectively. To put this number in perspective, total U.S. trade with Japan, Korea, and the BRICS nations—Brazil, Russia, India, China, and South Africa—is also about $1.2 trillion (Figure 1).[31]

Integrated value chains have united North America as one economic market that not only trades finished goods but shares in their production. Many products travel across the border several times to take advantage of each country's comparative advantages in manufacturing. Value-added trade data reveal that for every $100 in final goods value that the United States imports from Mexico, $40 is actually U.S.-made content. The equivalent share from Canada is $25. By contrast, for each $100 in imports from China and the European Union, only $4 and $2, respectively, are U.S. value.[32]

Figure 1. Total U.S. Trade with Canada/Mexico vs. BRICS/Japan/Korea, 2011



Source: Brookings analysis of U.S. Census data, 2011.

THE NORTH AMERICAN ADVANCED INDUSTRY EXPORT PLATFORM

Production sharing not only minimizes the cost of goods consumed in each of the three countries, but makes products exported to the rest of the world more competitive. In 2011, the North American bloc sent over $1.2 trillion in goods outside the region.[33] North America's most export-oriented sectors tend to be in manufacturing, particularly in advanced industries—R&D-intensive pursuits that require workers with significant technical knowledge and skills (see the box, "What Are Advanced Industries and Why Are They Important?").

Advanced industries such as electronics ($115 billion), transportation equipment ($100 billion), industrial machinery ($82 billion), pharmaceuticals ($39 billion), and medical devices ($26 billion) drive North American goods exports to the rest of the world. Though not included in the definition of advanced industries, energy commodities—oil, gas, and coal—are the other significant segment of North American exports ($108 billion).[34] And while this report does not focus on services, due to a lack of data, services play a critical role in advanced production sectors. For instance, every dollar of U.S. manufacturing output requires 19 cents of services, including logistics, advertising, and engineering.[35] In 2012, the U.S. economy posted a $200 billion trade surplus in services.[36]

Boosting North American advanced industry exports has clear advantages for each country. For the United States and Canada, both of which face widening trade deficits in manufacturing, advanced industries represent some of the most export-oriented segments of each economy. With little chance to compete on cost alone, each country recognizes

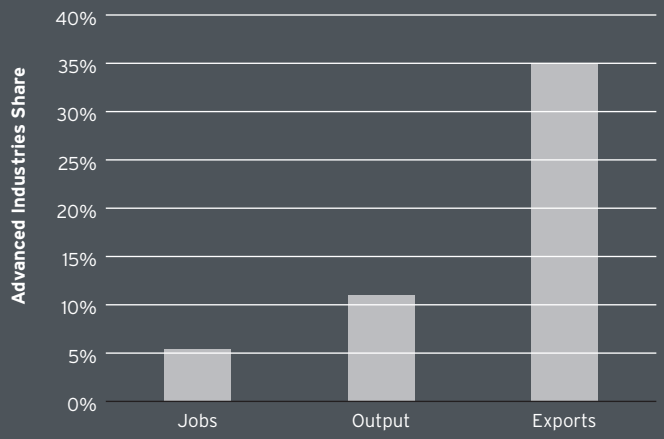
the increasing imperative to offer superior quality and value added.[37] For Mexico, which has experienced a cyclical boom due to competitive wages and a favorable exchange rate, advanced industries represent opportunities to move into more sophisticated parts of the value chain, improve productivity, and continue the nation's economic ascent.[38] Meeting the demand of developed economies in Europe and rising markets in Africa, Asia, and South America for advanced industry products helps meet each country's goals.

Production sharing means that the respective export economies of the United States, Canada, and Mexico rely greatly on intermediate imports from their continental neighbors. At first glance, the benefits of imports may seem counterintuitive. Sourcing imports internationally can displace domestic production and jobs, result in higher transportation costs for firms, and increase the risk of supply-chain disruptions.[40] Yet for both firms and countries, evidence shows that sourcing intermediate goods internationally increases access to high-

WHAT ARE ADVANCED INDUSTRIES AND WHY ARE THEY IMPORTANT?

Advanced industries (AIs) are high-value engineering and R&D-intensive industrial concerns that are the prime movers of regional and national prosperity. These industries drive and diffuse technological innovation, and in doing so contribute more to an economy than can be simply measured by their influence on productivity, employment, and wages (Figure 2). Ongoing work at the Brookings Institution's Metropolitan Policy Program has defined AIs as those industries in which R&D intensity exceeds the average for all R&D-performing industries, and intensity of knowledge in STEM (science, technology, engineering, and mathematics) fields exceeds the all-industries average. The indicators attempt to measure the two variables that drive the link between innovation and economic growth: discovery and diffusion. In other words, R&D intensity measures technological discovery and STEM knowledge intensity measures diffusion of technology. The resulting list of industries spans both manufacturing and services, and recognizes that the two are increasingly interrelated.

Figure 2. Advanced Industry Share of U.S. Employment, Output, and Exports, 2012



Source: Brookings analysis of Moody's Analytics and ExportNation data.

Advanced industries warrant exploration for several reasons. First, they are the economy's most innovative segment, and therefore likely represent the future of U.S. industrial activity. Second, AIs offer good jobs with high wages. Average annual wages in AIs are nearly double those for the economy as a whole ($95,000 vs. $49,000). Third, and perhaps most pertinent to this trade analysis, AIs drive a disproportionately large share of U.S. exports. AIs account for 5 percent of employment, 11 percent of national output, and 35 percent of U.S. exports. For methodological reasons this paper focuses solely on the goods-producing side of the AI definition, including aerospace, automotive, electronics, machinery, pharmaceuticals, and precision instruments. With only 3 percent of national employment, AIs within manufacturing generate 31 percent of national exports.[39] ■

Table 1. U.S. Share of Value Added Embodied in Foreign Country Gross Exports, 2009

Exporting Country	Chemicals and Non-metallic Mineral Products	Electrical and Optical Equipment	Machinery	Transportation Equipment	All Industries
Japan	2.2%	3.3%	1.8%	2.5%	2.2%
Germany	4.0%	2.9%	2.6%	3.7%	2.7%
China	4.4%	4.5%	4.3%	4.0%	3.6%
Canada	12.9%	13.7%	12.0%	19.6%	9.2%
Mexico	10.3%	19.5%	14.4%	15.9%	13.0%

Source: OECD-WTO Trade in Value Added (TiVA) Database.

quality inputs, lowers overall costs for firms, and as a result increases productivity and export prowess.[41] In other words, imports improve product quality and lower product cost, making exports more competitive in the global marketplace and ultimately supporting jobs and wages at home.

Co-production within North America also means that each country derives more value from its partner countries' exports to the rest of the world than from exports by other global trading partners. The United States, for example, accounts for 20 percent and 16 percent of the value in Canadian and Mexican transportation equipment exports, respectively, while Chinese, German, and Japanese transportation equipment exports all contain less than 4 percent U.S. value (Table 1). For electrical and optical equipment, 14 percent of Canadian exports and 20 percent of Mexican exports are U.S. value added, well above the U.S. content in such exports from China, Germany, and Japan. For machinery and chemicals, the same pattern holds.[42] Simply put, the United States benefits more economically from a Mexican or Canadian export than from a Chinese, Japanese, or German export.

CHANGING GLOBAL DYNAMICS APPEAR TO FAVOR NORTH AMERICAN PRODUCTION

More recent global dynamics also indicate that this is a unique moment for the North American production platform. Some experts suggest that changing global wage structures, fluctuating currencies, volatile energy prices, and rapidly changing technologies mean that North America, and the United States in particular, may be able to "reshore" manufacturing jobs that left for East Asia over the past two decades.[43] Others remain more pessimistic.[44]

Notwithstanding these uncertainties, it does appear that North America's free trade base and growing co-production in key advanced industries positions it more strongly for near-term manufacturing growth. Five additional advantages seem to favor the North American production platform: rising labor costs in China, transportation and logistical advantages from geographic proximity, production-enhancing technological advancements, the shale gas revolution, and the growing prominence of urban economies as sites of co-located design and production.

First, experts predict that rising wages in China will make North America's manufacturing base, particularly Mexico's, more cost-competitive vis-à-vis East Asia.[45] After decades of Chinese wages undercutting production in Mexico, Chinese and Mexican labor costs are converging.[46] Economists at JPMorgan Chase note that wage advantages, along with a favorable exchange rate, have been responsible for Mexico's manufacturing surge over the past couple of years.[47] Furthermore, changing wage dynamics do not impact all industries equally; the extent to which labor is a significant share of input costs will determine whether location decisions change as a result. In the case of advanced industries, where automation has already been widely implemented,

labor cost changes matter most in the assembly stages for high-value products such as electronics and precision instruments.[48]

Second, for manufacturers selling into the North American market, transportation costs and logistics advantages favor making products within North America over East Asia. The rise of "just in time" manufacturing processes also relies on fast, dependable shipping to lower warehousing costs and to keep factories running at full speed. Shipments from China can cost as much as $5,000 per container compared to $3,000 per container from Mexico.[49] Products from North American factories can reach U.S. supply chains in less than a few days; containers from China can take up to three months to reach their U.S. destination.[50] In the rush to offshore production to East Asia, many companies focused strictly on labor costs and overlooked costs associated with longer supply chains and more complex logistics.[51] As those costs have become more apparent over time, the calculus for firms seems to be changing, particularly for industries such as chemicals, machinery, and transportation equipment that rely on lean supply chains, locate production near final demand, and manufacture large and heavy products.[52]

Third, technological advancements are enhancing production in new and profound ways. One pervasive industrial change stems from advancements in digital technologies such as additive manufacturing, a process that employs 3-D printers to create a product from a digital model.[53] Currently, manufacturers are utilizing additive techniques to create prototypes and small component parts. But as the technology improves, and the costs of printers and printing materials come down, additive manufacturing has the potential to transform production on a larger scale through its ability to create products more efficiently and precisely. [54] The gains from additive manufacturing will likely eventually accrue to those countries with the talent, innovation infrastructure, and capital to invent, deploy, and scale the technology. Manufacturing's increasing dependence on software, where the U.S. maintains a durable global lead, remains another advantage.[55]

A fourth North American advantage concerns energy, where new drilling techniques have unlocked shale gas and oil reserves in Canada and the United States.[56] Canadian and U.S. shale gas production increased by 50 percent annually between 2007 and 2012. The spike in supply has lowered prices considerably in North America relative to Europe and Asia. Cheaper energy will not revolutionize all sectors of manufacturing, but it is reducing input costs for energy-intensive manufacturing firms and industries such as petrochemicals, iron and steel, and plastics.[57]

Finally, these dynamics and countless others are coming to ground in the continent's competitive units: cities and metropolitan areas. In these urban centers, the forces of agglomeration concentrate advanced manufacturing jobs and output to take advantage of dense labor pools, knowledge spillovers, and critical shared inputs such as universities, R&D centers, and financial institutions. Of course, the economic primacy of metropolitan areas applies worldwide—the world's 300 largest metropolitan economies account for 48 percent of global GDP but only 19 percent of global population—but North America is particularly metropolitan.[58] Of those 300 global metro areas, 85 are within North America, and they lead a network of more than 400 metro areas across the United States, Mexico, and Canada. The benefits of clustering in these major metros can be seen in automotive centers like Detroit, electronics and information technology hubs like Guadalajara, or aerospace regions like Montreal. The growing role of information technology in manufacturing, the speed and complexity of new product cycles, and the high demand for skilled STEM workers all favor firms that can reap the benefits of dense clusters. As Richard Florida writes, in an economy where knowledge remains the critical input to productivity gains and growth, "place has supplanted the industrial corporation as the key economic and social organizing unit."[59] ■

III. DATA AND METHODS

This report examines goods trade flows between metropolitan areas in the United States and those in Canada and Mexico based on origin of production and destination of consumption.

To estimate these flows, Brookings worked with the Economic Development Research Group (EDR) to create a database that assigns data on national goods trade to metropolitan areas. Brookings used this same database for a recent report that unveiled domestic freight flows between U.S. metropolitan areas and 40 international geographic locations.[60] This report uses the existing database's estimated freight flows between U.S. metropolitan areas and Canada and Mexico, at the national level, as a starting point.[61]

The same methodology used to estimate U.S. metropolitan-level international goods imports and exports was applied to Canada and Mexico in order to arrive at metro-level estimates for those countries. The database identifies U.S. origins and destinations for trade with Canada and Mexico, as well as border crossings (or ports of entry/exit). Brookings and EDR utilized existing U.S. metropolitan import and export estimates with Canada and Mexico, at the national level (e.g., imports and exports between Chicago and Mexico and Chicago and Canada). Using these existing estimates, we assigned those metro-to-country flows to subnational zones in Canada and Mexico.

The resulting database includes 369 U.S. metropolitan statistical areas (MSAs) and 48 rest-of-state zones; 59 census-defined Mexican metropolitan zones and 29 rest-of-state zones; and 33 Canadian census metropolitan areas (CMAs), nine rest-of-province zones, and four provincial zones. Bilateral trade flows, by value and weight, were estimated between U.S. and Mexican and U.S. and Canadian geographic areas for individual Standard Classification of Transported Goods (SCTG) commodity codes. This database does not include the $27.1 billion in Canada-Mexico bilateral goods trade in 2010, which represented less than 4 percent of merchandise trade within North America.[62]

Flows were estimated based on (1) production or consumption levels in those subnational zones, and (2) distance from U.S. port of entry or exit. This technique attempts to estimate where goods are

KEY TERMS

Metropolitan areas: This report uses the terms city, *metropolitan (metro) area*, and *urban region* interchangeably, to refer to interconnected local economies that represent the hubs of larger state and national economies. A metropolitan area is typically a collection of municipalities that together form a unified labor market, and is often defined statistically by the commuting patterns of its residents between home and work. Each country defines metropolitan areas slightly differently. For the purposes of this report, we have included metropolitan areas with a population of more than 100,000, of which there are 33 in Canada, 59 in Mexico, and 340 in the United States (Figure 3).[63]

Total trade: The total quantity of goods traded between the United States and Canada/Mexico at the country levels. This research shows flows by value (in United States dollars), weight (in tons), and value per ton (value divided by weight).

Metro-to-metro trade: The total quantity of goods traded between metropolitan areas in the United States and metropolitan areas in Canada and Mexico. This report refers to both total metro-to-metro trade (that is, total goods traded among the entire metropolitan network), and metro-to-metro trade flows between individual pairs of metropolitan areas.

Advanced industries: Research-and-development-intensive pursuits that require workers with significant technical knowledge and skills. For the purposes of this report, we use the following commodities to define trade in advanced industries: aircraft and spacecraft; electronics and electrical equipment; machinery; motor vehicles and parts; pharmaceutical products; and precision instruments.

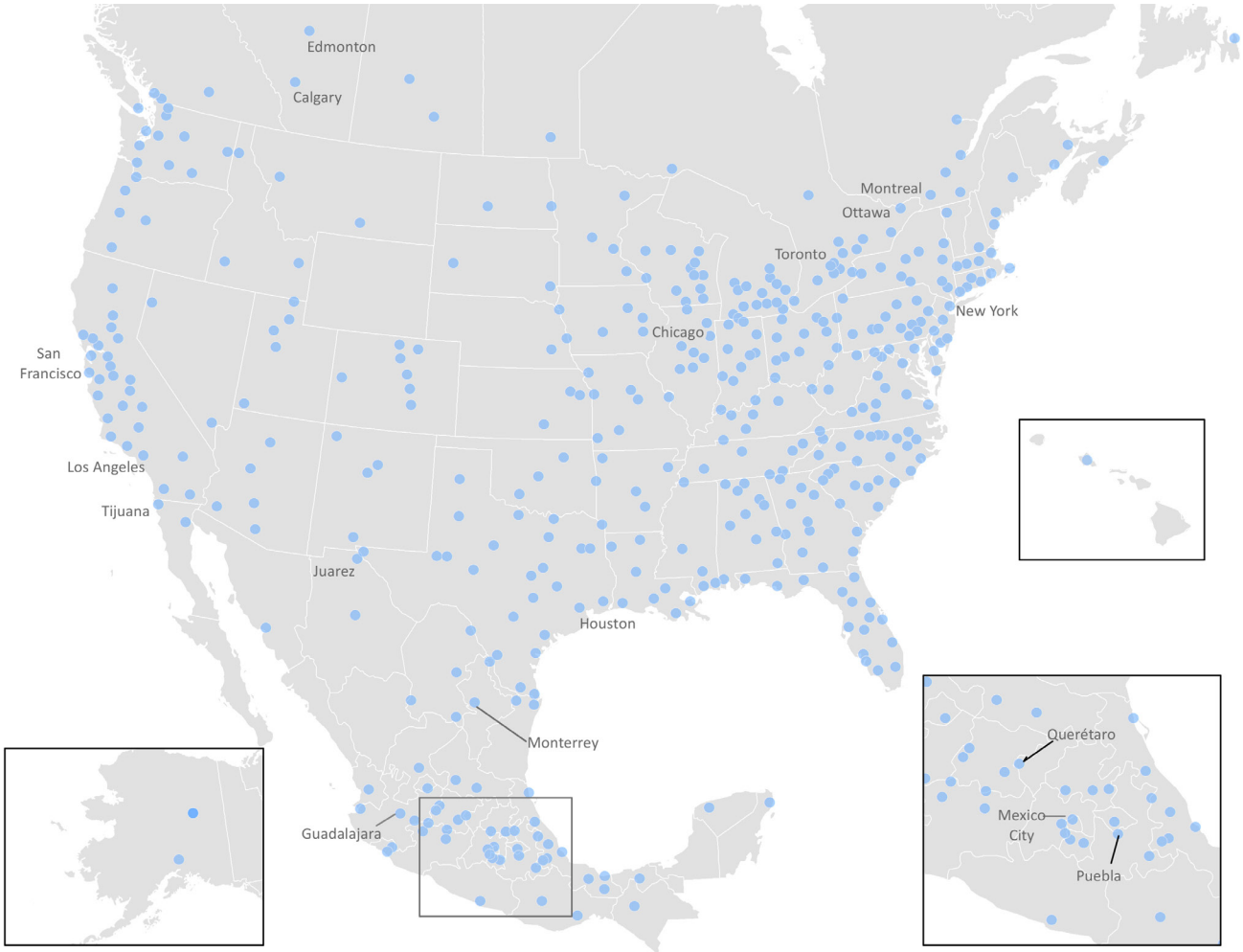
Global value chain: The OECD defines a value chain as the "full range of firms' activities, from the conception of a product to its end use and beyond."[64] When these activities stretch beyond domestic borders, they become global value chains. For the purposes of this report, the terms *value chains* and *supply chains* are used synonymously.

produced and where they are consumed, but these indicators should not be interpreted as measures of trade in value-added terms. While case studies in the report illustrate co-production among North American metro areas, the data do not identify whether flows actually represent intraindustry or intrafirm trade.

As these data represent the first attempt to take goods trade to the metropolitan scale, caution should be used in interpreting these estimates. Our methods combine top-down trade data with bottom-up consumption and production data, so trade flows may be underrepresented or overrepresented between certain metropolitan areas.

Appendix A describes the methodology in greater detail. ■

Figure 3. 432 North American Metro Areas with Population Over 100,000



Source: U.S. Census Bureau, Statistics Canada, and INEGI.

"Recent global dynamics—from changing wage structures abroad to new energy sources and technologies at home—indicate that this may be a unique moment for the North American production platform."

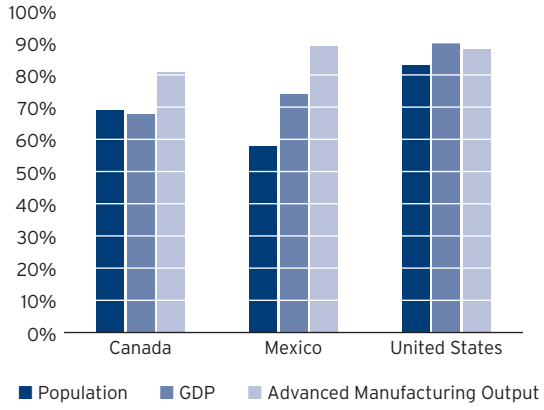
IV. FINDINGS

A. Metropolitan areas in the United States, Canada, and Mexico contain 77 percent of the three countries' total population but generate 86 percent of their combined GDP.
Metropolitan areas drive the North American economy. The 432 metropolitan areas in the United States, Mexico, and Canada with at least 100,000 residents account for 77 percent of continental population but generate 86 percent of North America's economic output.[65] These metro areas are highly productive because they concentrate key inputs such as innovative firms, highly skilled workers, risk-taking entrepreneurs, and supportive institutions and associations.[66]

In both the United States and Mexico, metropolitan areas contribute disproportionately to national output (Figure 4). The 340 U.S. metro areas house 83 percent of national population and generate 90 percent of national GDP. Within Mexico, 59 census-defined urban regions account for 58 percent of national population but generate 74 percent of national output.[67] Canada's 33 metro areas are home to 69 percent of that nation's population and 68 percent of its GDP, reflecting Canada's continued economic reliance on natural resources located outside major metropolitan regions.

North America's urban regions are a powerful network, but a collective view masks their incredible diversity in size and industrial specialization. The largest North American metro economies rival nations in their size. In 2012 GDP, New York topped South Korea, Mexico City exceeded South Africa, and Toronto outpaced Finland.[68] Major regional anchors including Atlanta, Dallas, Monterrey, Montreal, and Vancouver all registered GDP of at least $100 million in 2012.[69] Meanwhile, small and mid-sized metros in all three countries harbor critical assets as well. Columbus (Ohio), Kitchener, and Colima-Villa de Álvarez contain major institutions of higher learning. Norfolk, Halifax, and Veracruz are globally significant deep-water ports. And, because of the significant land borders the three countries share, binational metro areas like El Paso-Juarez, San Diego-Tijuana, Laredo-Nuevo Laredo, and Detroit-Windsor share regional labor markets and facilitate goods movement between the U.S. and Mexico and Canada.

Figure 4. Metro Area Share of Population, Total GDP, and GDP in Advanced Manufacturing Industries[70]



Note: Canada and Mexico data from 2009; U.S. data from 2010.
Source: Brookings analysis of Moody's Analytics, Statistics Canada, and INEGI data.

Metro areas in North America contribute even greater shares of their nations' output in knowledge-intensive manufacturing industries, export-oriented sectors that require the skilled workers, capital, and advanced research that metro areas uniquely combine. For instance, metro areas account for 93 percent of aerospace production in the United States, 86 percent in Canada, and 82 percent in Mexico (Table 2). In computers and electronics production, metro shares reach 92 percent in the United States, 91 percent in Canada, and 84

Table 2. Metro Area Share of GDP in Advanced Manufacturing Industries[71]

Industry	U.S.			Canada			Mexico		
	Metro GDP ($ mil)	Nat'l GDP ($ mil)	Metro Share	Metro GDP ($ mil)	Nat'l GDP ($ mil)	Metro Share	Metro GDP ($ mil)	Nat'l GDP ($ mil)	Metro Share
Aerospace	65,930	71,252	92.5%	17,745	20,598	86.2%	545	662	82.3%
Computers and Electronics	216,840	235,815	92.0%	12,510	13,805	90.6%	47,045	55,883	84.2%
Electrical Appliances & Equipment	29,056	37,574	77.3%	8,767	11,311	77.5%	15,695	17,437	90.0%
Machinery	29,991	36,431	82.3%	8,275	10,740	77.0%	2,281	2,366	96.4%
Precision Instruments	44,314	50,905	87.1%	3,003	3,773	79.6%	4,270	4,855	87.9%
Motor Vehicles	40,834	56,710	72.0%	49,504	64,628	76.6%	53,510	58,513	91.4%
Pharmaceuticals	90,660	102,458	88.5%	11,309	12,366	91.5%	15,041	15,376	97.8%

Note: Pharmaceuticals (NAICS 3254), Machinery (NAICS 3332,3333,3336), Computers and Electronics (NAICS 3341, 3342, 3343, 3344,3345,3346), Electrical Appliances and Equipment (3352,3353,3359), Motor Vehicles (3361,3363), Aerospace (3364), Medical Precision Instruments (3391), except for Canada where Computers and Electronics defined as NAICS (3341,3342,3344)
Metros defined as those over 100,000 population. Canada and Mexico data from 2009; U.S. data from 2010.
Source: Brookings analysis of Moody's Analytics, Statistics Canada, and INEGI data.

percent in Mexico. And in pharmaceutical manufacturing, each country concentrates more than 88 percent of GDP in its metropolitan areas.

These metro economies benefit not only from internal clustering, but also from trade. They generate new income when exporting firms sell their products and services to other markets. Economic growth occurs when firms and governments then use that income to reinvest in the assets that enhance competitiveness—human capital, infrastructure, research and development, and quality institutions. At the same time, metro areas also sustain their traded sectors by importing inputs that make their exported products more competitive. And for everything a metro area's stable of firms cannot produce, robust trading networks with domestic and international trading partners help fill the void and allow a regional economy to focus on that economic activity it does best. Thus, the productivity of North America's metro areas reflects in part the incredible volume of trade that occurs among them.

B. U.S. metropolitan areas traded $512 billion in goods with Canadian and Mexican metropolitan areas in 2010.

The U.S. economy depends greatly on trade with Canada and Mexico. In 2010, goods trade between the United States and Canada and the United States and Mexico totaled $885 billion and 724 million tons.[72] Canada maintained its position as the United States' top goods-trading partner, with $506 billion and 497 million tons in two-way trade. Mexico, the United States' third-largest goods-trading partner, exchanged $379 billion and 227 million tons in merchandise trade. On the average day, approximately $2.4 billion and nearly 2 million tons of goods move between the United States and its North American partners.

As the primary sites of production and consumption, metropolitan areas dominate North American goods trade (Figure 5). Roughly 85 percent of the value and 78 percent of the tonnage for all goods trade in North America either originates or terminates in a metro area.[73] Goods trade among the

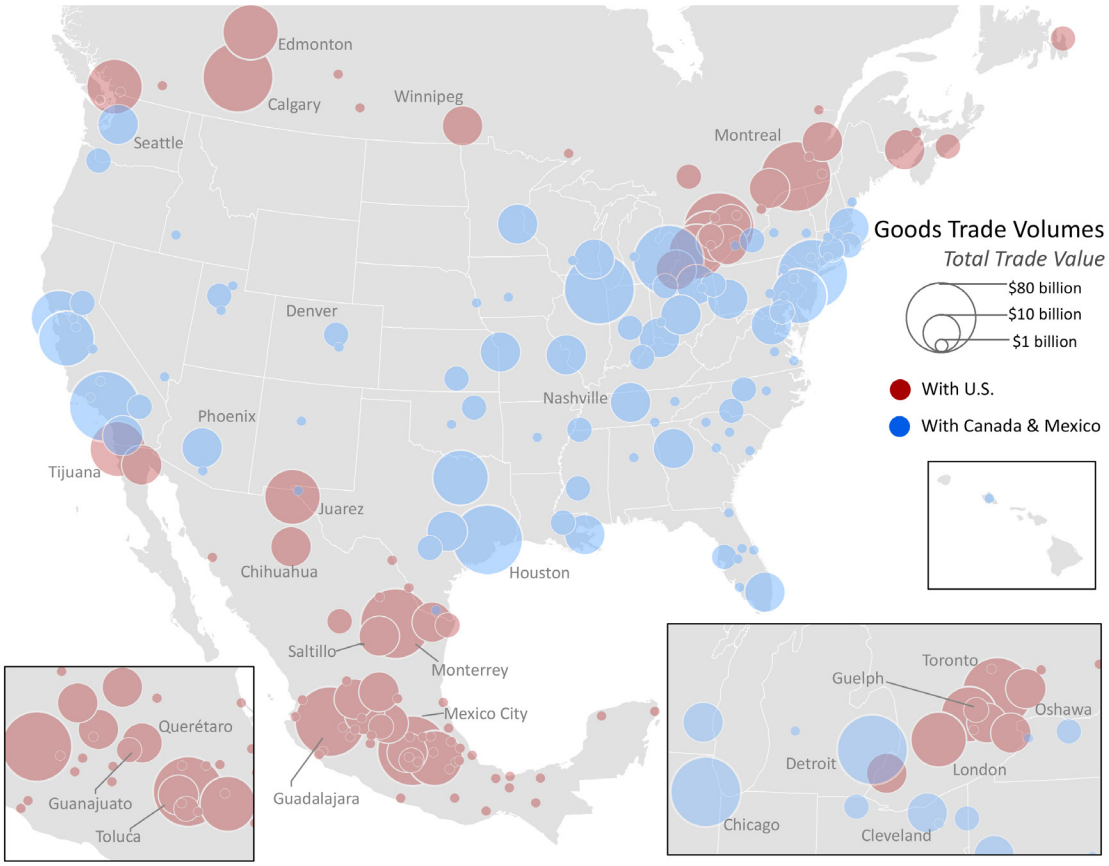
continent's network of 432 metropolitan areas—that is, between U.S. metro areas on the one hand and Canadian or Mexican metro areas on the other—totaled $512 billion in 2010, accounting for 58 percent of total value.[74]

Trade between the United States and Mexico is somewhat more likely to occur among metro economies than trade between the United States and Canada. Metro-to-metro trade with Canada amounts to 54 percent of total bilateral trade ($275 billion), while 63 percent of trade with Mexico ($237 billion) occurs between metro areas. As noted above, natural resources like petroleum and agricultural products, which constitute a significant share of goods traded between the U.S. and Canada, are more likely than other goods to originate in non-metropolitan areas.[75]

Notably, metro-to-metro goods trade is more valuable, on average, than total continental goods trade. While metro-to-metro trade accounts for 42 percent of total tonnage traded between the United States and Canada/Mexico, it accounts for 58 percent of total trade value. The average value per ton of all goods trade in North America is $1,222, which rises to $1,682 for metro-to-metro trade, a 38 percent premium. As the finding below explores, this reflects the fact that metro areas tend to trade (and, indeed, to co-produce) goods in high-value advanced industries.

Significant bilateral trading relationships between particular metro hubs demonstrate the value of North American metro trade. In 2010, 40 pairs of metro areas registered at least $1 billion in two-way goods trade, together accounting for 12 percent

Figure 5. Total Goods Trade Volumes in Largest 100 U.S., 59 Mexican, and 33 Canadian Metro Areas, 2010



Source: Brookings analysis of Economic Development Research Group data.

Table 3. Metro Area Trading Pairs Over $1 Billion, U.S.–Canada, 2010

Rank	U.S. Metropolitan Area	Canadian Metropolitan Area	Total Trade ($mil)	Total Trade (ths. tons)	Value Per Ton ($ per ton)	Top Commodity
1	New York-Northern New Jersey-Long Island, NY-NJ-PA	Toronto, ON	3,688	1,285	2,868	Motorized and Other Vehicles (includes parts)
2	Detroit-Warren-Livonia, MI	Toronto, ON	3,654	856	4,267	Motorized and Other Vehicles (includes parts)
3	Chicago-Naperville-Joliet, IL-IN-WI	Toronto, ON	2,876	1,278	2,249	Motorized and Other Vehicles (includes parts)
4	Houston-Baytown-Sugar Land, TX	Calgary, AB	2,635	6,196	425	Crude Petroleum
5	New York-Northern New Jersey-Long Island, NY-NJ-PA	Montreal, QC	1,868	1,030	1,814	Electronic and other Electrical Equipment and Components
6	Houston-Baytown-Sugar Land, TX	Toronto, ON	1,827	1,266	1,443	Machinery
7	Los Angeles-Long Beach-Santa Ana, CA	Toronto, ON	1,820	747	2,435	Motorized and Other Vehicles (includes parts)
8	Dallas-Fort Worth-Arlington, TX	Toronto, ON	1,659	540	3,074	Electronic and other Electrical Equipment and Components
9	San Francisco-Oakland-Fremont, CA	Calgary, AB	1,485	3,667	405	Crude Petroleum
10	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	Toronto, ON	1,449	634	2,284	Motorized and Other Vehicles (includes parts)
11	Chicago-Naperville-Joliet, IL-IN-WI	Montreal, QC	1,443	901	1,592	Electronic and other Electrical Equipment and Components
12	Boston-Cambridge-Quincy, MA-NH	Toronto, ON	1,416	381	3,722	Electronic and other Electrical Equipment and Components
13	New York-Northern New Jersey-Long Island, NY-NJ-PA	Calgary, AB	1,395	2,659	525	Other Coal and Petroleum Products
14	Los Angeles-Long Beach-Santa Ana, CA	Calgary, AB	1,325	2,784	476	Crude Petroleum
15	Houston-Baytown-Sugar Land, TX	Montreal, QC	1,281	1,333	961	Other Coal and Petroleum Products
16	Chicago-Naperville-Joliet, IL-IN-WI	Calgary, AB	1,280	2,378	538	Other Coal and Petroleum Products
17	Dallas-Fort Worth-Arlington, TX	Montreal, QC	1,186	429	2,765	Aircraft and Spacecraft
18	San Jose-Sunnyvale-Santa Clara, CA	Toronto, ON	1,183	170	6,954	Electronic and other Electrical Equipment and Components
19	Los Angeles-Long Beach-Santa Ana, CA	Montreal, QC	1,163	649	1,793	Aircraft and Spacecraft
20	Detroit-Warren-Livonia, MI	Montreal, QC	1,160	405	2,868	Motorized and Other Vehicles (includes parts)
21	Kansas City, MO-KS	Toronto, ON	1,159	307	3,779	Motorized and Other Vehicles (includes parts)
22	Houston-Baytown-Sugar Land, TX	Edmonton, AB	1,042	2,054	507	Crude Petroleum
23	Minneapolis-St. Paul-Bloomington, MN-WI	Toronto, ON	1,021	372	2,748	Motorized and Other Vehicles (includes parts)
24	Washington-Arlington-Alexandria, DC-MD-VA	Toronto, ON	1,006	280	3,598	Motorized and Other Vehicles (includes parts)
25	Atlanta-Sandy Springs-Marietta, GA	Toronto, ON	1,001	437	2,289	Motorized and Other Vehicles (includes parts)

Source: Brookings analysis of Economic Development Research Group data.

of total metro-to-metro trade. Of the 40 pairs, 25 involve U.S. and Canadian metro areas (Table 3). The largest relationship exists between the two largest metro markets in each country, New York and Toronto ($3.7 billion). The large trading volumes between Detroit and Toronto ($3.7 billion) and Chicago and Toronto ($2.9 billion) reflect intensive co-production in the automotive industry between those regions. Similarly, Houston and Calgary ($2.6 billion) represent energy hubs within each nation.[76]

Among the 15 metro-to-metro trading relationships between the United States and Mexico that exceed $1 billion (Table 4), Mexico City and metro areas in California and Texas predominate. Los Angeles and Mexico City ($2.2 billion), San Jose and Mexico City ($2.1 billion), and Houston and Mexico City ($2.1 billion) top the list. Many of the largest U.S. metro economies, such as Los Angeles, Houston, New York, Chicago, San Francisco, and Dallas, appear on the list. San Jose, the nation's 16th-largest regional economy, appears three times due to its high degree of specialization in computers and electronics, a significant shared industry between the United States and Mexico. More than half of the largest bilateral metro relationships feature Mexico City, due to the tremendous concentration of population and economic activity in Mexico's largest urban area. Monterrey and Guadalajara, the country's second- and third-largest metro areas

Table 4. Metro Area Trading Pairs Over $1 Billion, U.S.–Mexico, 2010

Rank	U.S. Metropolitan Area	Mexican Metropolitan Area	Total Trade ($mil)	Total Trade (ths. tons)	Value Per Ton ($ per ton)	Top Commodity
1	Los Angeles-Long Beach-Santa Ana, CA	Mexico City	2,180	868	2,512	Electronic and other Electrical Equipment and Components
2	San Jose-Sunnyvale-Santa Clara, CA	Mexico City	2,147	312	6,880	Electronic and other Electrical Equipment and Components
3	Houston-Baytown-Sugar Land, TX	Mexico City	2,140	1,799	1,190	Petroleum and Coal Products
4	New York-Northern New Jersey-Long Island, NY-NJ-PA	Mexico City	1,862	651	2,861	Electronic and other Electrical Equipment and Components
5	San Jose-Sunnyvale-Santa Clara, CA	Monterrey	1,837	236	7,766	Electronic and other Electrical Equipment and Components
6	Chicago-Naperville-Joliet, IL-IN-WI	Mexico City	1,727	819	2,109	Electronic and other Electrical Equipment and Components
7	San Francisco-Oakland-Fremont, CA	Mexico City	1,554	1,514	1,026	Petroleum and Coal Products
8	Los Angeles-Long Beach-Santa Ana, CA	Monterrey	1,542	508	3,036	Electronic and other Electrical Equipment and Components
9	Houston-Baytown-Sugar Land	Monterrey	1,464	947	1,546	Electronic and other Electrical Equipment and Components
10	Dallas-Fort Worth-Arlington, TX	Mexico City	1,384	398	3,478	Electronic and other Electrical Equipment and Components
11	New York-Northern New Jersey-Long Island, NY-NJ-PA	Monterrey	1,235	415	2,975	Electronic and other Electrical Equipment and Components
12	Chicago-Naperville-Joliet, IL-IN-WI	Monterrey	1,199	476	2,543	Electronic and other Electrical Equipment and Components
13	San Jose-Sunnyvale-Santa Clara, CA	Guadalajara	1,107	138	8,009	Electronic and other Electrical Equipment and Components
14	Dallas-Fort Worth-Arlington, TX	Monterrey	1,096	285	3,8393	Electronic and other Electrical Equipment and Components
15	Detroit-Warren-Livonia, MI	Mexico City	1,082	297	3,644	Motorized and Other Vehicles (includes parts)

Source: Brookings analysis of Economic Development Research Group data.

respectively, round out the remainder of Mexico's billion-dollar hubs.

These major metro-to-metro exchanges illustrate that North American trade extends well beyond the border. Indeed, of the $512 billion in goods that U.S. metro areas traded with their Mexican and Canadian counterparts in 2010, $395 billion (77 percent) originated or arrived in a U.S. metro area not located in one of the major border states.[77] Trade with Canadian metro areas tended to cluster slightly more in border states than did trade with Mexican metro areas (25 percent for Canada versus 20 percent for Mexico). Major U.S. markets for production and consumption that lay hundreds of miles from the Mexican and Canadian borders thus have a critical stake in ensuring a strong platform for continental trade.

Some border metro areas do stand out in the degree to which they focus on North American imports and exports in their trading base. Of the 100 largest U.S. metro areas, 12 exchange at least one-third of their internationally traded goods with Mexico or Canada (Table 5). Among the group are major border metro areas such as El Paso and Detroit, and others not far away such as Bakersfield and Columbus. At the same time, interior production centers such as Kansas City and Nashville in automotive and Tulsa in energy products also rely heavily on exchange with their North American trading partners.

Table 5. U.S. Metro Areas With Greater Than 1/3 of International Goods Trade Within North America, 2010

Rank	Metropolitan Area	Mexico Trade ($ mil)	Canada Trade ($ mil)	North America Trade ($ mil)	All International Trade ($ mil)	North American Trade Share
1	Bakersfield, CA	927	1,142	2,068	4,664	44%
2	El Paso, TX	$823	901	1,724	4,250	41%
3	Detroit-Warren-Livonia, MI	8,318	15,993	24,311	61,635	39%
4	Jackson, MS	1,513	1,828	3,341	8,472	39%
5	Youngstown-Warren-Boardman, OH	1,044	2,053	3,096	7,872	39%
6	Toledo, OH	1,720	3,077	4,796	12,938	37%
7	Louisville, KY	2,237	3,452	5,689	15,784	36%
8	Nashville-Davidson-Murfreesboro, TN	2,543	3,651	6,195	17,554	35%
9	Kansas City, KS	3,859	5,350	9,209	26,905	34%
10	Tulsa, OK	1,996	2,682	4,678	13,809	34%
11	Columbus, OH	2,417	4,267	6,684	19,738	34%
12	Modesto, CA	391	443	835	2,559	33%

Source: Brookings analysis of Economic Development Research Group data.

C. Advanced manufacturing industries—aerospace, automotive, electronics, machinery, pharmaceuticals, and precision instruments—account for 47 percent of goods trade in North America, and metro areas account for 69 percent of trade in advanced industries.

Advanced industries (AIs) are high-value engineering and R&D-intensive industrial concerns that are the prime movers of regional and national prosperity.[78] In this analysis of North American goods trade, we examine commodity flows across six advanced industries: aircraft, electronics and electrical equipment, machinery, motorized vehicles, pharmaceuticals, and precision instruments.[79] These six industries drive and diffuse technological innovation, and in doing so contribute more to economic growth than their employment, wages, and output alone reflect. Within the United States, these industries are highly export oriented, accounting for 31 percent of total U.S. exports but just 3 percent of total U.S. employment.[80]

Advanced industries represent a critical segment of North American goods trade. At $417 billion, trade in advanced industry goods between the United States and Canada and Mexico accounts for 47 percent of total goods-trade value. U.S. trade with Mexico is slightly more AI-intensive than trade with Canada, reflecting the higher natural resource orientation of U.S.-Canada trade. AIs account for 56 percent of total goods trade, by value, between the U.S. and Mexico ($212 billion), versus 41 percent of U.S.-Canada bilateral goods trade ($205 billion).

Canada and Mexico differ in their participation in advanced industry trade with the United States, reflecting distinctive and evolving co-production relationships across advanced industries:

- Motorized vehicles and parts account for $144 billion in trade between the U.S. and Canada and Mexico, more than one-third (35 percent) of total AI trade. While the Mexican auto industry has been booming, Canada still accounts for a majority (62 percent) of auto trade with the United States.
- Electronics and electrical equipment represent the second-largest commodity flow among the countries, at $133 billion (32 percent of total AI trade). Here, Mexico looms much larger, accounting for 73 percent of trade with the United States in that industry.
- Machinery ranks third among advanced industries in North American trade at $98 billion (23 percent of AI trade). U.S.-Canada trade in machinery ($53 billion), which includes industrial machinery, turbine and power transmission equipment, and other mechanical machinery, slightly outpaced U.S.-Mexico trade ($45 billion).
- Precision instruments ($23 billion), aerospace ($11 billion), and pharmaceuticals ($9 billion) account for lower shares of North American trade, but remain critical industries because of the high value of their products. Precision instruments include products such as medical devices and navigational equipment, in which Mexico accounts for a majority of U.S. trade in North America ($13 billion). As the more advanced economy, it is not surprising that Canada still accounts for an overwhelming share of trade in pharmaceuticals (90 percent) and aerospace (86 percent).

The advanced industry products traded within North America are much more valuable than other goods traded among the three countries. The average value per ton for all AI trade in North America is around $8,700, seven times the average value per ton for all goods trade ($1,200). Low-weight, high-value commodities such as pharmaceuticals ($39,400 per ton) and precision instruments ($30,600 per ton) are the most valuable by weight, while even motor vehicles and parts ($6,000 per ton) register nearly five times the average value per ton of all goods trade.

North American metro areas, in turn, account for the bulk of trade in advanced industry goods. Fully 69 percent ($286 billion) of total North American AI trade occurs between metro areas in the United States and Canada/Mexico, compared with 58 percent of all commodity trade (Table 6). As dis-

Table 6. Metro Share of Trade in Advanced Industry Commodities, 2010

Commodity	Metro-to-Metro Trade			All North American Trade ($ mil)	Metropolitan Share
	U.S.-Mexico Trade ($ mil)	U.S.-Canada Trade ($ mil)	North American Trade ($ mil)		
Machinery	30,546	29,063	59,609	97,947	61%
Motor Vehicles and Parts	40,687	55,848	96,535	144,555	67%
Precision Instruments	10,341	6,473	16,814	22,917	73%
Electronics	72,909	25,015	97,924	131,388	75%
Pharmaceuticals	747	5,848	6,595	8,751	75%
Aircraft and Spacecraft	1,175	7,391	8,566	11,154	77%
All Advanced Industries	**156,405**	**129,638**	**286,043**	**416,712**	**69%**
Total Trade	236,753	275,105	511,858	884,779	58%

Source: Brookings analysis of Economic Development Research Group data.

cussed above, firms in advanced industries concentrate their operations in metropolitan areas to reap the benefits of clustering, such as access to specialized workers, suppliers, and customers, as well as knowledge spillovers that breed new ideas and innovations.[81] This is particularly the case for aerospace, electronics, and pharmaceuticals, all of which see at least 75 percent of flows occur among metro areas. Metro areas' focus in advanced industry trade explains why the average value per ton of metro-to-metro trade is 38 percent higher than all North American trade.

D. Goods trade in key advanced industries binds distinct sets of metropolitan areas across North America.

Advanced industries tend to concentrate in metropolitan areas because they rely on dense concentrations of innovative firms, highly skilled workers, and critical infrastructure. Across the North American metropolitan landscape, however, each advanced industry tends to cluster in a distinctive set of urban economies. Over time, firms in each country have linked these metropolitan clusters through the exchange of goods, investment, workers, and research and development.

Three North American commodity flows—motor vehicles and parts, electronics and electrical equipment, and aircraft and parts—reveal where their related industries concentrate across the three countries, and how goods trade creates a network of metropolitan economies.

Motor Vehicles and Parts

The automotive industry is quintessentially North American. With $144 billion in trade between the United States and Canada and Mexico, motor vehicles and parts make up a greater share of total trade than any other commodity category.

Rapid changes in the auto industry are changing the nature of trade in North America. Automotive production relies on a value-chain framework that starts with original equipment manufacturers (OEMs) and moves down to a base of suppliers. The economist Timothy Sturgeon and his colleagues point to four key trends. First, both OEMs (like Ford and Toyota) and their suppliers have gone through a wave of mergers and are now increasingly global in their footprint. Second, the rise of "just in time" processes and stronger industry standards have pushed more production down into tier I, tier II, and tier III suppliers, in effect elongating the supply chain. Third, automakers typically engage in parts production and final assembly in the same region as end consumers, meaning that most North American parts and vehicles produced on the continent stay

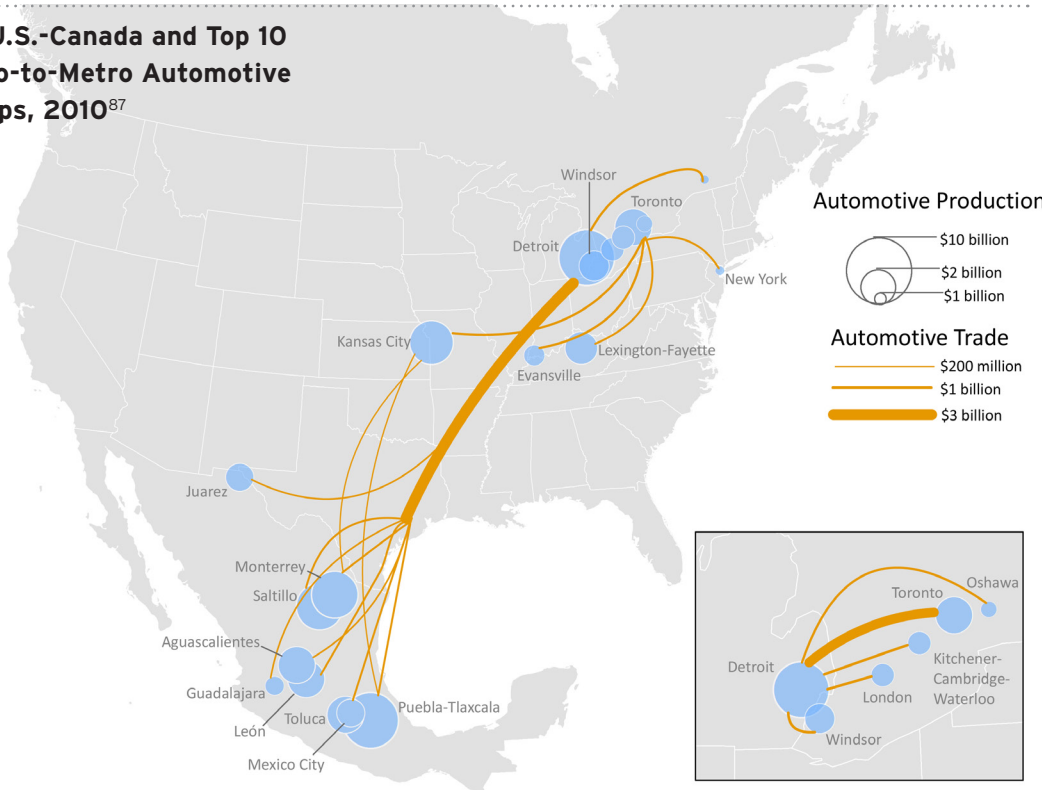
on the continent. And fourth, the economic geography of the auto industry still tends to be both localized—clustered in certain metropolitan areas—and regionalized—integrated in major global regions (East Asia, Europe, North America) with less global sourcing than other industries.[82] Indeed, research has shown that a car manufactured in North America crosses a border an estimated eight times prior to its final assembly.[83]

Over the past two decades, auto production in North America has concentrated in "Automotive Alley"—the north-south corridor from the Great Lakes to the Gulf of Mexico.[84] Within that geographic area, foreign producers have located final assembly plants in southern states such as Kentucky, Tennessee, Alabama, Mississippi, South Carolina, and Texas. At the same time, Mexico's share of automotive production has steadily climbed, with the country overtaking Canada as the continent's second-largest producer of light vehicles in 2008.[85]

Shifts in the auto industry are coming to ground in the continent's major hubs of auto production and trade. Nowhere has this been more apparent than in Detroit, which remains the undisputed center of North American auto trade. Despite brutal restructuring following the Great Recession, Detroit still maintains strong anchors in the "Big Three" (Ford, General Motors, and Chrysler) and a cluster of large and small suppliers.

The top metropolitan automotive trading relationships between the United States and Canada (Figure 6 and Table 7) reveal Detroit's legacy of integration with metro areas in Ontario, which dates back to the 1965 Canada-United States Automotive Products Agreement.[86] Detroit and Toronto alone, the latter both a significant automotive producer and a large site for final purchases, traded $2.9 billion in motor vehicles and parts in 2010. Detroit's automotive trading relationships with three other Ontario metro areas—Windsor, London, and Kitchener-Cambridge-Waterloo—rank second, third, and fourth on the

Figure 6. Top 10 U.S.-Canada and Top 10 U.S.-Mexico Metro-to-Metro Automotive Trade Relationships, 2010[87]



Source: Brookings analysis of Economic Development Research Group, Moody's Analytics, INEGI, and Statistics Canada data.

Table 7. Top 10 U.S.-Canada and Top 10 U.S.-Mexico Metro-to-Metro Automotive Trade Relationships, 2010

Rank	U.S. Metropolitan Area	Canadian Metropolitan Area	Total Trade ($ mil)
1	Detroit-Warren-Livonia, MI	Toronto, ON	2,856
2	Detroit-Warren-Livonia, MI	Windsor, ON	814
3	Detroit-Warren-Livonia, MI	London, ON	776
4	Detroit-Warren-Livonia, MI	Kitchener-Cambridge-Waterloo, ON	725
5	Kansas City, MO-KS	Toronto, ON	717
6	Detroit-Warren-Livonia, MI	Montreal, QC	703
7	Evansville, IN	Toronto, ON	608
8	Detroit-Warren-Livonia, MI	Oshawa, ON	600
9	Lexington-Fayette, KY	Toronto, ON	591
10	New York-Northern New Jersey-Long Island, NY-NJ-PA	Toronto, ON	579

Rank	U.S. Metropolitan Area	Mexican Metropolitan Area	Total Trade ($ mil)
1	Detroit-Warren-Livonia, MI	Mexico City, DF-MX-HG	567
2	Detroit-Warren-Livonia, MI	Puebla-Tlaxcala, PU	519
3	Detroit-Warren-Livonia, MI	Monterrey, NL	511
4	Detroit-Warren-Livonia, MI	Saltillo, CO	406
5	Detroit-Warren-Livonia, MI	Toluca, MX	281
6	Detroit-Warren-Livonia, MI	León, GT	278
7	Detroit-Warren-Livonia, MI	Aguascalientes, AG	261
8	Detroit-Warren-Livonia, MI	Juárez, CH	245
9	Detroit-Warren-Livonia, MI	Guadalajara, JA	225
10	Kansas City, MO-KS	Puebla-Tlaxcala, PU	196

Source: Brookings analysis of Economic Development Research Group data.

list. Beyond Detroit, a range of large and small U.S. metro areas, most located in Automotive Alley, trade significant volumes of motor vehicles and parts with the Toronto metro area.

Similarly, Mexico has become a critical player in the North American auto industry. NAFTA drastically lowered tariffs on automotive trade between the U.S. and Mexico; since then Mexico has accounted for an increasing share of U.S. motor vehicle imports, particularly in component parts.[88] By 2011, Mexico accounted for 31 percent of U.S. motor vehicle parts imports. While the technological capacity of Mexico's auto industry has dramatically improved, it still heavily relies on imported components from the United States; 31 percent of U.S. component part exports are destined for Mexico.[89] This suggests a unique co-production relationship between the two auto economies.

The nine largest metro-to-metro automotive trading relationships between the United States and Mexico all include Detroit, and feature both Detroit's steady stream of exports to the large Mexico City consumer market and significant co-production relationships with smaller Mexican auto hubs like Puebla, Saltillo, and Toluca. These findings reinforce Detroit's primacy within North America, and con-

firm research suggesting that auto supplier location decisions are still based, in part, on proximity to Detroit.[90] As suppliers continue to concentrate in the region, they rely heavily on exchange with Mexico's auto clusters to support profits and jobs (see the box, "What a Glassmaker Tells Us About the North American Auto Industry").

To be sure, auto production and trade extends well beyond Detroit. Midwestern metro areas such as Columbus, Evansville, and Fort Wayne all exhibit strong linkages to Toronto and other Canadian metro areas along the Great Lakes. Further south, Kansas City, Lexington, and Nashville—each housing a large assembly plant—are also prominent American nodes in the continental auto network. New York, Los Angeles, and Chicago have a relatively small automotive presence given their size, but rank high due to their huge consumer markets. Indeed, all metro areas participate in auto trade on the consumer side given high rates of car ownership in the United States and Canada and the growing rates in Mexico. Still, much of automotive trade concentrates in a group of 20 North American metro areas that together exchange more than $21 billion in motor vehicles and parts, 15 percent of total auto trade in North America.[92]

The large volumes of trade in motor vehicles and parts across metro areas in the United States, Canada, and Mexico affirm other research finding that, due to high costs of transporting those goods, most auto production occurs in the end-market region. Of all U.S., Canadian, and Mexican auto exports in 2011, only 29 percent were destined for markets outside North America.[93] Most cars made in North America are sold to North American consumers.

Yet emerging markets in Asia, particularly China, represent fast-growing consumer markets; China is predicted to overtake both the United States and Europe in auto sales and market share by 2020.[94] Its rise presents an incredible market opportunity for the North American auto industry. While most North American auto production will continue to serve the continental marketplace, there are nascent signs of North America's potential as an auto export platform to the rest of the world. Foreign automakers such as Honda and BMW have established product lines in the United States not only to serve the North American market but also to export back to Europe and Japan.[95] Others such as Volkswagen and Nissan have located in Mexico to use the country,

What a Glassmaker Tells Us About the North American Auto Industry[91]

Vitro, a small Mexican automotive glassmaker, is not typically mentioned alongside the iconic firms that define global auto production. Yet the Monterrey-based manufacturer's story offers a helpful illustration of the dynamics that shape the North American auto industry. Shortly after NAFTA's passage in 1994, Vitro began supplying the Detroit-based automakers Chrysler, Ford, and General Motors with finished glass from its factory in the Monterrey metropolitan area by rail. Once in Detroit, additional component parts were added before the windshields were sent for final assembly in one of the Big Three's factories.

Eventually, intense pressure to cut costs forced the Big Three to push a greater share of the value-added process down to its suppliers, requiring Vitro to add those component parts to the glass in-house. With the additional parts, Vitro could ship only 30 windshields instead of 75, increasing the transportation costs of its exports. The increase in transportation costs led Vitro to open up its own assembly and distribution in Greater Detroit in 2008, where it now employs several dozen workers. Vitro still makes the glass portions of its windshields in Monterrey and exports them to Detroit. That represents but one small slice of the $500 million in two-way trade between Detroit and Monterrey in 2010. These trade flows allow each regional economy to leverage the respective strengths of the other, increasing the competitiveness of the North American auto industry and supporting jobs in each metro in the process.

"Across the North American metropolitan landscape, each advanced industry tends to cluster in a distinctive set of urban economies. Over time, firms in each country have linked these metropolitan clusters through the exchange of goods, investment, workers, and research and development."

which has 10 trade agreements with 45 countries, as an export platform to both the United States and fast-growing Latin American markets, particularly Brazil.[96]

Electronics and Other Electrical Equipment

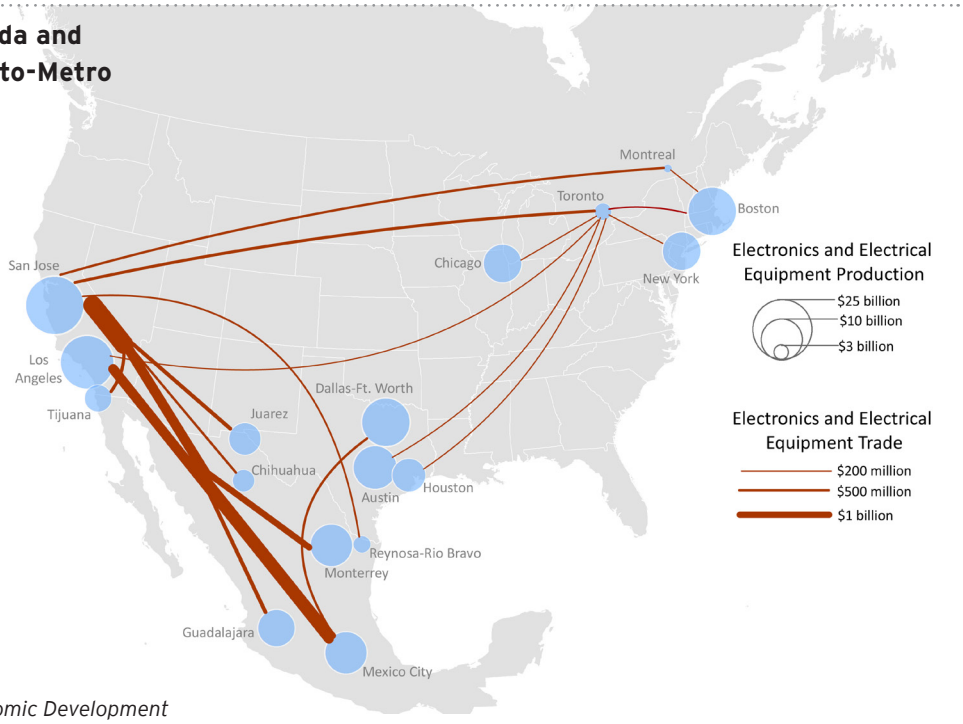
Electronics and electrical equipment manufacturing remains a much more globally integrated industry than either the automotive or aerospace industries, which are more regional in their footprints. The very high value-to-weight ratio of electronic components, and the relatively labor-intensive processes required in their assembly, have produced within-region differences in the location of electronics manufacturing, design, and R&D, as well as significant outsourcing of manufacturing and assembly. Around 63 percent of global electronics production occurs in East Asia; North America accounts for 18 percent.[97]

Within North America, trade in electronics and other electrical equipment totals $133 billion, with about three-quarters of that occurring between Mexico and the United States (Figure 7 and Table 8). Mexico has historically been a leading global producer of consumer electronics and appliances, mainly assembling products for export to the U.S. market. According to OECD/WTO trade data, nearly three-quarters of Mexico's total intermediate imports of electronics and equipment are subsequently re-exported, indicating that Mexico still relies heavily on the United States, and increasingly on East Asia, to source higher-value components.[98]

Within Mexico, Tijuana leads the country in electronics manufacturing, mostly due to the presence of maquiladora assembly plants on the border. This cluster is the primary producer of flat-screen TVs and displays sold in the United States.[99] Similar *maquiladora* clusters focusing on both electronics and appliances are found in other border states around cities like Chihuahua, Juarez, Monterrey, and Reynosa. Guadalajara, in Jalisco, is becoming a center of high-tech electronics manufacturing. Beginning with companies like Kodak and Hewlett Packard, today the Guadalajara metro area hosts numerous multinational production facilities such as Motorola, Intel, IBM, Foxconn, General Electric, and Siemens.[100] Mexico City also remains a significant producer of electronics and electrical equipment.

San Jose, the home of Silicon Valley and the country's most globally integrated high-tech hub, maintains strong relationships with Mexican metro areas specializing in electronics manufacturing. Beginning in the 1980s, electronics firms in San Jose and other U.S. metro areas began locating production facilities in Mexico in an attempt to lower the costs of final assembly.[101] Trade flows spiked as computer, electronics, and equipment parts that required technological sophistication not available in the Mexican part of the supply chain were sourced from firms in the U.S. (see box, "Seeing the New Geography of Electronics Manufacturing Through a Supplier's Footprint"). Similar to automotive production, it was not uncommon for electronics products to cross the border multiple times before completion.

Figure 7. Top 10 U.S.-Canada and Top 10 U.S.-Mexico Metro-to-Metro Electronics Trade Relationships, 2010[102]



Source: Brookings analysis of Economic Development Research Group, Moody's Analytics, INEGI, and Statistics Canada data.

Table 8. Top 10 U.S.-Canada and Top 10 U.S.-Mexico Metro-to-Metro Electronics Trade Relationships, 2010

Rank	U.S. Metropolitan Area	Canadian Metropolitan Area	Total Trade ($ mil)
1	San Jose-Sunnyvale-Santa Clara, CA	Toronto, ON	771
2	San Jose-Sunnyvale-Santa Clara, CA	Montreal, QC	486
3	Boston-Cambridge-Quincy, MA-NH	Toronto, ON	364
4	New York-Northern New Jersey-Long Island, NY-NJ-PA	Toronto, ON	360
5	Dallas-Fort Worth-Arlington, TX	Toronto, ON	312
6	Chicago-Naperville-Joliet, IL-IN-WI	Toronto, ON	249
7	Austin-Round Rock, TX	Toronto, ON	248
8	Los Angeles-Long Beach-Santa Ana, CA	Toronto, ON	247
9	Houston-Baytown-Sugar Land, TX	Toronto, ON	235
10	Boston-Cambridge-Quincy, MA-NH	Montreal, QC	233

Rank	U.S. Metropolitan Area	Mexican Metropolitan Area	Total Trade ($ mil)
1	San Jose-Sunnyvale-Santa Clara, CA	Mexico City, DF-MX-HG	1,716
2	San Jose-Sunnyvale-Santa Clara, CA	Monterrey, NL	1,467
3	San Jose-Sunnyvale-Santa Clara, CA	Guadalajara, JA	963
4	San Jose-Sunnyvale-Santa Clara, CA	Juárez, CH	863
5	San Jose-Sunnyvale-Santa Clara, CA	Tijuana, BC	786
6	Los Angeles-Long Beach-Santa Ana, CA	Mexico City, DF-MX-HG	638
7	San Jose-Sunnyvale-Santa Clara, CA	Chihuahua, CH	608
8	Los Angeles-Long Beach-Santa Ana	Monterrey, NL	606
9	Dallas-Fort Worth-Arlington, TX	Mexico City, DF-MX-HG	491
10	San Jose-Sunnyvale-Santa Clara, CA	Reynosa-Río Bravo, TM	455

Source: Brookings analysis of Economic Development Research Group data.

Seeing the New Geography of Electronics Manufacturing Through a Supplier's Footprint

One of the most pervasive trends in electronics manufacturing has been for lead firms to outsource non-core manufacturing services to their supply base. These suppliers, referred to as electronic manufacturing services (EMS) providers, may handle different responsibilities throughout the design, manufacturing, and distribution process. Increasingly, they are fully integrated in the global market and are able to contract with distant firms due to advances in communications and logistics management technologies.[103]

SMTC Corporation, a mid-tier provider of end-to-end EMS services, has thrived because it offers lead firms more flexibility in their entire manufacturing value chain, lowers product costs, and reduces time to market. To meet the brutal demands of the industry for speed and agility in accommodating customer requests, SMTC maintains a global footprint. SMTC's headquarters are just outside Toronto, but the majority of its revenues are generated in Mexico and the United States. SMTC's largest assembly operation is in Chihuahua, a metro area with just under 1 million people and one of Mexico's rising manufacturing centers. SMTC's facility in San Jose specializes in new product integration, printed circuit board assemblies, and system integration. Finally, SMTC operates two large factories in China (one in Chang'an and one in Suzhou) and a procurement office in Hong Kong.[104]

SMTC's locations illustrate that tasks in the electronics value chain are handled in different nations, but within each country the firm joins others in dense clusters for electronics manufacturing, as in San Jose, Chihuahua, and Suzhou. Sophisticated logistics management software allows SMTC to tightly coordinate activities across these distant locations, while leveraging the distinct advantages of each regional economy. For instance, SMTC recently announced a manufacturing partnership with Vocera Communications, a maker of a hands-free communication badge used in hospitals. According to the announcement, "Vocera will leverage SMTC's regional manufacturing footprint in San Jose, California to support the development and introduction of their next generation communication badge prior to transitioning the product to SMTC's lower-cost production facility in Chihuahua, Mexico."[105] In this way, SMTC's ability to provide companies like Vocera with the competitive advantages of its North American footprint supports the economies in all three countries.

While the U.S. role in the manufacturing of electronics and electrical equipment has waned, significant metro-to-metro trading relationships still exist between the U.S. and Mexico. Beyond San Jose, sites of electronics production such as Austin, Dallas, Portland, and Phoenix all trade significant amounts with their Mexican metropolitan counterparts, likely relying on them for the more labor-intensive parts of the value chain. Large trade volumes between Mexican sites of electronics production and large markets like Chicago, Los Angeles, New York, and Washington indicate how heavily U.S. consumers rely on Mexican-made electronics. On the Canadian side, a similar set of U.S. regions dominate metro-to-metro trade, led by San Jose, Boston, New York, Dallas, Chicago, and Austin. Toronto is overwhelmingly the largest trader on the Canadian side, followed by Montreal, Vancouver, Calgary, Ottawa, and Kitchener-Cambridge-Waterloo. A network of 20 metropolitan areas generates over 18 percent of total electronics and electrical equipment trade in North America.[106]

Aircraft and Parts

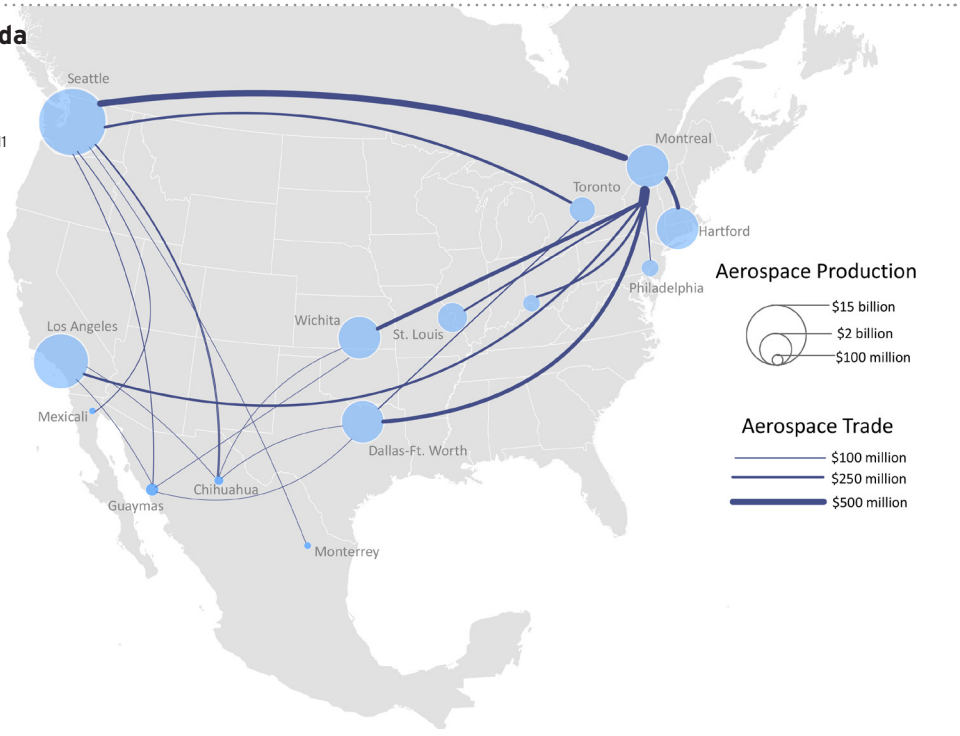
While North American trade in electronics and motor vehicles and parts dwarfs that in finished aircraft and aerospace parts, aerospace remains a priority industry for each of the three countries in their efforts to create good jobs and boost exports. At the same time, the industry increasingly involves value chains that stretch across the continent.

The United States is the world's largest aerospace producer, and the industry continues to be one of the few manufacturing sectors in which the nation maintains an international trade surplus.[107] Canada ranks fifth in global aerospace production, behind the United States, France, the United Kingdom, and Germany.[108] Canada's aerospace industry is heavily export-oriented: 80 percent of its revenue comes from foreign sales, half of which are to the United States. And for Mexico, a budding network of aerospace component suppliers has been a critical component of the country's broader desire to break into aerospace production and eventually climb the value chain.[109] Indeed, Mexico has announced an ambitious goal to design, assemble, and launch a domestically produced aircraft in the next decade.

This national picture is set against the backdrop of structural changes in the aerospace industry. Increasingly, large OEMs such as Boeing, EADS, and Bombardier consider themselves more responsible for supply-chain integration and supplier management than for actual manufacturing activities. As materials, electronics systems, and even interior designs become more intricate and high tech, the skills and capabilities needed for manufacturing have increased throughout the value chain, even to tier II and III suppliers. At the same time, intense cost competition is pressuring all parts of the value chain, forcing different stages of production to be placed in those locations that maximize product quality at minimal cost.

To respond to these industry dynamics, aerospace firms must maintain a well-trained workforce, constantly innovate, and maintain flexibility in their value chains by having quick and efficient access to other markets. As a result, aerospace trade in North America tends to concentrate in a relatively few urban areas that house these required assets. Indeed, a network of 20 North American metros account for over $4.5 billion in two-way trade, nearly 40 percent of total aerospace trade between the U.S. and Canada and Mexico (Figure 8 and Table 9).[110]

Figure 8. Top 10 U.S.-Canada and Top 10 U.S.-Mexico Metro-to-Metro Aerospace Trade Relationships, 2010[111]



Source: Brookings analysis of Economic Development Research Group, Moody's Analytics, INEGI, and Statistics Canada data.

Table 9. Top 10 U.S.-Canada and Top 10 U.S.-Mexico Metro-to-Metro Aerospace Trade Relationships, 2010

Rank	U.S. Metropolitan Area	Canadian Metropolitan Area	Total Trade ($ mil)
1	Seattle-Tacoma-Bellevue, WA	Montreal, QC	541
2	Dallas-Fort Worth-Arlington, TX	Montreal, QC	367
3	Wichita, KS	Montreal, QC	355
4	Hartford-West Hartford-East Hartford, CT	Montreal, QC	293
5	Los Angeles-Long Beach-Santa Ana, CA	Montreal, QC	207
6	Cincinnati-Middletown, OH-KY-IN	Montreal, QC	182
7	Seattle-Tacoma-Bellevue, WA	Toronto, ON	179
8	St. Louis, MO-IL	Montreal, QC	171
9	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	Montreal, QC	124
10	Dallas-Fort Worth-Arlington, TX	Toronto, ON	122

Rank	U.S. Metropolitan Area	Mexican Metropolitan Area	Total Trade ($ mil)
1	Seattle-Tacoma-Bellevue, WA	Guaymas, SO	54
2	Seattle-Tacoma-Bellevue, WA	Chihuahua, CH	43
3	Dallas-Fort Worth-Arlington, TX	Guaymas, SO	34
4	Los Angeles-Long Beach-Santa Ana, CA	Guaymas, SO	29
5	Wichita, KS	Guaymas, SO	28
6	Dallas-Fort Worth-Arlington, TX	Chihuahua, CH	28
7	Seattle-Tacoma-Bellevue, WA	Mexicali, BC	27
8	Seattle-Tacoma-Bellevue, WA	Monterrey, NL	26
9	Los Angeles-Long Beach-Santa Ana, CA	Chihuahua, CH	23
10	Wichita, KS	Chihuahua, CH	23

Source: Brookings analysis of Economic Development Research Group data.

The two major metro poles for aerospace trade in North America are Seattle and Montreal. Each houses a major OEM and a robust network of smaller firms. Boeing maintains two of its three final assembly plants in the Seattle area, and Bombardier houses a significant share of its engineering and production in Greater Montreal. These two OEMs, along with the educational institutions and research centers that support them, have helped create dense clusters of suppliers and support firms that also drive trade (see box, "In Seattle and Montreal, Supplier Relationships Help Drive Trade"). Montreal officials boast that their metro area is one of the few places on earth where a plane can be conceived, built, and launched with sources within only a 30-mile radius.[112] Montreal, and to a lesser extent Toronto, also share significant trading relationships with other U.S. aerospace hubs such as Dallas-Fort Worth, Hartford, and Wichita.

In Seattle and Montreal, Supplier Relationships Help Drive Trade

In the aerospace industry, Seattle and Montreal, two of the world's preeminent hubs, are often considered synonymous with their respective hometown firms Boeing and Bombardier. Yet as these aerospace giants push more and more responsibilities to their suppliers, trade and economic activity within the aerospace industry are increasingly driven by companies of all sizes that participate across the two markets.

In the Seattle region, Royell Manufacturing, based in Everett, manufactures precision components, kits, and assemblies and calls Bombardier a customer.[113] Similarly, Korry Electronics in Seattle will provide the integrated cockpit control panels for the Bombardier CSeries using solid-state switching technology.[114] The Montreal-based supplier Precision SF Tech produces complex medium-sized components used on the Boeing 777 and 787, both of which are assembled in Boeing's Everett factory.[115]

Other parts of Boeing's supply chain come to ground in Montreal. The Boeing 737 engine, which is installed in Greater Seattle, is tested by GE Aviation in Bromont, Quebec just outside Montreal at the firm's Global Robotics, Automation, and Instrumentation R&D Centre.[116] Indeed, Aéro Montréal, Quebec's aerospace industry association, estimates that nearly half of Montreal's supplier base calls Boeing a customer.[117]

Firms are not the only connectors in Seattle and Montreal's relationship. In 2012, Aéro Montréal and the Pacific Northwest Aerospace Alliance (PNAA) formed an agreement to help further integrate the two clusters. Through the collaboration, each organization will exchange information about member companies' needs and strengths in an effort to leverage each region's competencies, strengthening each hub of the value chain in the process.[118] ■

Mexico's nascent role in the North American aerospace value chain arises from changing industry fundamentals and the country's ability to translate its legacy in automotive and electronics production into aerospace. Guaymas, a relatively small city in the northern state of Sonora, has established its own budding aerospace cluster focused on engine parts.[119] Other regions, such as Querétaro and Monterrey, have leveraged their legacy of automotive, equipment, and machinery manufacturing to transition into aerospace. As a still-developing aerospace economy, Mexico is still primarily manufacturing labor-intensive components for export to final assembly plants in the United States and Canada. For instance, the Monterrey-based company Frisa manufactures the forged rings and casings used in Pratt & Whitney's turbofan engines that are assembled and tested in Greater Montreal before being installed in Bombardier's CSeries jet.[120] In addition, Mexico's aerospace industry still relies heavily on imported inputs from U.S. manufacturers, meaning that Mexico's total value added in aerospace remains relatively low.

Capitalizing on each country's distinct niche in the aerospace value chain competitively positions North American exports. More foreign companies may choose North America as an aerospace production platform, as Airbus's decision to locate production in Alabama suggests. Currently, two-thirds of U.S., Mexican, and Canadian aerospace exports are shipped off continent. That share may continue to rise as emerging markets increase their demand across market segments—defense spending, large commercial aircraft, and private jets.[121] Over the next 20 years, deliveries of new aircraft to East Asia are expected to account for more than one-third of all new orders, with China's pace of aircraft purchases forecast to grow at 6.2 percent annually over that period. In contrast, the growth rate in North America is expected to be only 1.6 percent; in Europe, 2.3 percent.[122] ■

V. IMPLICATIONS

This report unveils the central role of cities and metropolitan areas in North American trade. Goods trade among the United States, Mexico, and Canada is substantial, particularly in a series of advanced industries that not only service the North American marketplace but also export high-value goods to the rest of the world. Those industries, in turn, are rooted in a network of metropolitan economies that stretch well beyond the border, trading and co-producing with one another as they anchor an increasingly integrated North American economy.

The geographic expansion of trade derives in part from the continued integration of advanced industries across the continent. Companies—the primary architects of this phenomenon—have unbundled different stages of production and dispersed them across the three countries to where those activities are most cost-effective. The trade flows shown in this paper, then, represent the ties that bind the operations of companies and the metropolitan economies in which the operations cluster.

In many ways, a more cohesive North American economy can be a powerful productivity spur for cities and metropolitan areas. The market forces that integrated the continent force metro economies to specialize in those industries and activities in which they are most competitive, and thus hone their economic niche. Each metro area benefits from being part of a highly integrated continental trading network that leverages the distinct advantages of each place.

But this new trading environment entails costs, too. Global economic integration causes dislocation and decline in cities whose industries are no longer competitive globally. The growing ease of doing business across the world has intensified the competition between cities to maintain market share. Those same challenges apply to North America as a whole. How can Canada, Mexico, and the United States build on their unique economic relationship to position the continent as a competitive production platform for itself and the rest of the world?

The economic primacy of cities and metropolitan areas in North America demands a new role for subnational leaders in the North America conversation. North American advanced industries are fundamentally metropolitan in their geography, and the actions of local, regional, and state leaders will determine their future success. At the same time, there are certain functions, policies, and investments that must reside with national governments. In short, the imperative to strengthen North American competitiveness requires a more balanced approach that involves government, business, and civic leaders at both the national and subnational levels in all three countries.

FEDERAL LEADERS SHOULD SET A STRONG PLATFORM FOR NORTH AMERICAN TRADE

National actors are critical to a sound trade strategy, both because they possess the sovereignty to regulate international trade and borders, and because they uniquely possess the fiscal latitude and geographic scope to finance important public goods that facilitate trade. Notwithstanding the budget pressures and political gridlock characterizing the U.S. federal government, there remain four key areas in which national actors in each country must operate to set the platform for greater North American trade and competitiveness.

First, they must take the lead in financing and delivering the infrastructure required to better ***enable goods movement.*** Outdated and inadequate border infrastructure remains a serious hindrance to the competitiveness of the North American production platform. Because production sharing requires goods to be shipped multiple times back and forth across the border before final completion, the costs of delay are exacerbated with each trip.[123] New, fully staffed border crossings are required. Amid federal budget constraints, strategies that leverage local, state, and private money in addition to federal investments are promising solutions. The United States and Mexico should also follow Canada in developing a national freight strategy to better coordinate road, air, rail, sea, and pipeline investments beyond the border.[124] In addition to new infrastructure investment, preclearance strategies and trusted shipper programs are cost-effective ways to hasten border crossings absent large new investments in infrastructure and staffing.[125]

Second, beyond the congestion-driven delays at the border, firms face added costs to trade in North America when ***regulations and customs paperwork*** becomes overly onerous. Regulatory compliance initiatives are underway between the U.S. and Canada (Regulatory Compliance Council) and the U.S. and Mexico (High Level Regulatory Cooperation Council) in an effort to align standards in ways that reduce costs for regional manufacturers and retailers; these should be continued and potentially merged.[126]

Complying with NAFTA's preferential tariffs can also be a complex task for companies. Single-window electronic compliance arrangements modernize customs and regulatory compliance by offering a "one-stop shop" for firms to submit and process product documentation.[127] Canada, Mexico, and the United States all currently have separate single windows; harmonization efforts such as the U.S.-Canada Single Window Initiative are nascent but promising steps to streamline systems across the continent.[128] Further action should be taken in coordination with Mexico as its single window evolves.

Third, policies that improve firms' ability to do their business in North America make the continent more attractive to foreign direct investment and enhance its ability to produce goods for the rest of the world. On the latter point, ongoing trade negotiations like the Trans-Pacific Partnership (TPP) and the Transatlantic Trade and Investment Partnership (TTIP) present opportunities to better integrate North America with foreign markets in a system of free and fair trade. Canada, Mexico, and the United States are participating in the TPP negotiations with nine other Pacific Rim countries.

Both TPP and TTIP represent the most ambitious attempts to date to enforce next-generation trade rules around thorny issues such as intellectual property protection, services trade liberalization, and treatment of state-owned enterprises. If done correctly, these agreements could change the ground rules for trade between North America and the other two major global trading regions, and in doing so set a new common denominator for regional and multilateral trade agreements going forward.[129]

Fourth, similar to their shared global engagement on trade facilitation, North American leaders are beginning to merge ***foreign direct investment attraction*** efforts. In October 2013, the High Commission of Canada, the Embassy of Mexico, and the Embassy of the United States hosted an "Invest in North America" conference in London to pitch

the world's investors on the attractiveness of the North American market as both a large consumer base and a competitive platform for manufacturing.[130] Indeed, the approach recognizes that each country benefits when foreign direct investment occurs anywhere on the continent because of the unique levels of integration in the economy. Just as President Obama motivated efforts around exports through the National Export Initiative goal of doubling exports in five years, a North American FDI goal could catalyze similar urgency around attracting the world's investment to the continent.

SUBNATIONAL LEADERS SHOULD DEVELOP AND EXECUTE TAILORED TRADE STRATEGIES

Beyond advocating for smart federal policies, city, metropolitan, and state/provincial leaders across North America have a critical role to play in shaping their own economies and positioning themselves for success in advanced industries. This involves establishing a vision for their own trading economy, investing in the critical assets that drive trade, and networking globally with new and existing trading partners.

SET A VISION

At the city and metropolitan levels, networks of leaders—across government, industry, and civil society—should set a vision for their economies and develop market-driven approaches that take into account each location's distinctive industrial specializations. In the United States, approximately a dozen regions, from Los Angeles to San Antonio to Syracuse, are developing regional export strategies. Leaders in these places are conducting market analyses to better understand the performance of their traded sectors, assessing the needs of firms in those sectors, and determining how to marshal new and existing assets to help them thrive in the international marketplace.[131] Successful initiatives require the blended perspectives, buy-in, and shared commitment to measurable outcomes from politicians, business executives, university and community college leaders, and civic and non-profit leaders.

INVEST IN WHAT MATTERS

Subnational leaders must then act in the service of that vision by ***investing in what matters*** for economic competitiveness and growth. Investments in three critical inputs—innovation, human capital, and infrastructure—should all be attuned to the particular economic specialties of a place.

Innovation—the ability to generate new ideas, methods, products, and technologies—is the first pillar of productivity growth and economic competitiveness, particularly in advanced industries.[132] Networks of local business leaders, elected officials, and university officials lead the institutions that together drive a metropolitan area's knowledge economy, and they are therefore uniquely positioned to tailor innovation strategies to their regions' industrial specializations. For example, Ontario's Collaboration Voucher program links firms with universities, colleges, and hospitals by providing a credit that firms can redeem for expertise and resources at their chosen research institution. The program includes vouchers focused in four areas: innovation and productivity, commercialization, e-business, and broader research and development.[133]

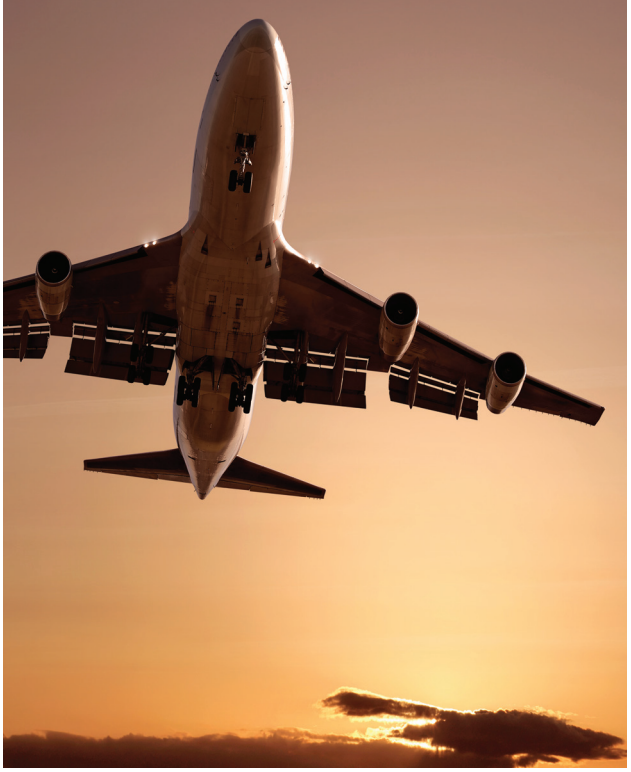
Efforts to bolster the innovative capacity of firms may also support regional innovation clusters. One example is the Northeast Ohio Partnership for Regional Innovation Services to Manufacturers (PRISM), a collaborative effort between several economic development organizations that helps small and medium-sized manufacturers innovate products, enter new markets, and accelerate growth.[134]

Innovation relies on high levels of ***human capital*** to interact with new technologies to drive productivity and regional economic growth.[135] Technological gains in manufacturing are changing what is required of workers. Firms are demanding more sophisticated workers in the STEM fields (science, technology, engineering, and math), and this imperative applies not only to engineers and managers, but also to production workers asked to manage the information technology systems of a 21st century factory.[136]

Subnational leaders' local perspective and critical role in the career training system in all three countries uniquely position them to align workforce skills development programs to the specific requirements of industries that make up their key export sectors. The state of Querétaro is implementing innovative education and employment programs that prepare workers for its budding aerospace industry cluster. Mexico's first aerospace university, Universidad Aeronáutica de Querétaro (UNAQ), has been instrumental in supplying the skilled production workers and engineers demanded by firms like Bombardier. Of the 1,800 workers at Bombardier's Querétaro facility, nearly two-thirds were trained at UNAQ, and the firm works closely with the university to tailor the curriculum for all rungs of the aerospace career ladder.[137]

Finally, cities and metros are increasingly financing and building the ***infrastructure*** required to connect them to metropolitan economies in North America and beyond. Transportation infrastructure enables economic development by allowing firms to send and receive products from other places.

Metropolitan leaders are connecting their key economic priorities to freight infrastructure planning through efforts like the Twin Cities Metropolitan Area Freight Initiative in Minneapolis-Saint Paul. Through the initiative, regional leaders aim to better coordinate freight and logistics efforts with the private sector, learn from best practices from other cities, and more rigorously measure their performance and progress through agreed-upon metrics. Accounting for the specific goods that Minneapolis imports and exports helps inform freight infrastructure needs. For instance, the region's role as a large exporter of high-value precision instruments, a commodity typically moved through air, points to the need to prioritize investments in airports and related logistics. In these ways, subnational infrastructure decisions have important ramifications for economic growth and job creation.[138]



NETWORK GLOBALLY

Finally, metropolitan leaders have a unique opportunity to ***network with their peers in North America*** to strengthen economic relationships.

Bilateral business associations and elected-official organizations such as the Border Governor's Association, the Border Mayor's Association, and the Great Lakes and St. Lawrence Cities Initiative have made significant progress on issues ranging from immigration to infrastructure to natural resources. The 175 current Sister Cities partnerships between U.S. cities and Canadian and Mexican cities also reveal a rich heritage of cultural and economic exchange.[139] Yet many of these relationships tend to cluster around the border, and when they do extend to the rest of the country the partnerships rarely address issues of trade, investment, and competitiveness.

One promising model of deeper economic collaboration is the Pacific Northwest Economic Region (PNWER), an economic partnership between Alaska, Idaho, Oregon, Montana, and Washington and the Canadian provinces of British Columbia, Alberta, and Saskatchewan and the Yukon and Northwest Territories. PNWER seeks to collaborate across state and national borders to enhance competitiveness,

influence policymakers in Washington and Ottawa, and achieve broad-based growth.[140] This level of cooperation, however, remains the exception rather than the rule. Market dynamics have linked cities in a robust trading network, but the institutions that support and drive metro economies—regional business associations, universities, nongovernmental organizations, and subnational governments—are still catching up.

By unveiling continental metro-to-metro goods-trading relationships for the first time, this report and accompanying interactive data can help guide cities and metro areas to their top trading partners as they develop global engagement strategies within North America. Already a torrent of subnational actors in the United States, from Columbus and Phoenix to Michigan and Nevada, has led recent trips and trade missions to Mexico. In many cases, these engagements could benefit from more information about where and how trade occurs at the subnational level.

With new data and a clearer understanding of their respective starting points, structured economic collaborations between cities, metros, states, and provinces can take into account shared specializations and industry clusters. This new form of local economic development can take advantage of the way in which key advanced industries tend to concentrate in particular metro areas in each country. For instance, auto suppliers in Detroit would be wise to look toward other auto hubs like Toronto or Aguascalientes where there may be distinct export and investment opportunities based on the niche products, services, and capital demanded by that cluster. Working across multiple metros that specialize in a particular industry can have benefits both locally, as Detroit firms gain access to foreign clusters, and regionally, as the entire North American value chain becomes more efficient by matching firms with the products and services they demand.

Local business associations, which typically have a better sense of local firms and economic dynamics than do their federal counterparts, can help facilitate relationship building between businesses and clusters. For smaller companies particularly, market insights such as these can help curb the anxiety of entering foreign markets for the first time. For instance, the El Paso-Juarez region has created a database that lists local manufacturing companies participating all along the supply chain for those looking to do business within the region.[141] And as described earlier, the Pacific Northwest Aerospace Alliance and Aéro Montréal, representing two of the world's largest aerospace clusters, signed an agreement to help connect their supplier bases to opportunities within the other's supply chain. ■

Reinvigorate the North American Competitiveness Council

The 20th anniversary of NAFTA, and the recently announced U.S.-Mexico High Level Economic Dialogue, point to a new moment for efforts to strengthen North American competitiveness and the advanced industries that undergird it. And the new metro map of North American trade reveals that such efforts must involve trilateral collaboration among local, state/provincial, and federal government partners, along with the private sector and civil society. The now-disbanded North American Competitiveness Council sought to engage executives from large multinational companies in a dialogue about how to increase economic integration on the continent, but it lacked a broader cross-section of stakeholders who could sustain momentum and impact. A reconstituted council involving a broader network of stakeholders—mayors, governors, university and college presidents, small business owners, union officials, environmental leaders, and non-profit heads—could facilitate productive exchanges around policies, investments, and collaborations that reflect the true distributed nature of North American trade. ■

VI. CONCLUSION

Geographic proximity, a free trade platform, and the tendency for firms in trade-intensive manufacturing sectors to extend their operations regionally have created an abundance of trade within North America. Ongoing efforts to bolster exports and achieve positive trade balances in all three countries must recognize and capitalize on the integrated advanced industry value chains that drive continental exports to the rest of the world. By embracing each other as partners rather than competitors, the United States, Canada, and Mexico would recognize that nascent trends toward re-shoring and near shoring, and shifting labor, energy, and technology dynamics, are favorably positioning North America as a production platform for the world.

Yet this macro view overlooks the metro origins of economic growth in each country. North America's cities and metropolitan areas house 77 percent of population but generate 86 percent of continental GDP. Metros are also the centers for trade: Goods trade between U.S. cities and metropolitan areas and their Canadian and Mexican counterparts exceeded $500 billion in 2010. And for those advanced industries that help drive continental exports to the rest of the world—electronics, machinery, pharmaceuticals, precision instruments, and transportation equipment—trade among metro areas accounted for 69 percent of the continental total.

Twenty years ago, North America's three federal governments formed a trilateral agreement of historic proportions. Since then, however, the North American share of world exports has steadily declined. How can the three countries reverse this decline and reposition themselves together on the global stage? To be sure, federal efforts remain critical: The continent needs an infrastructure upgrade, a more streamlined regulatory and trade environment, and access to foreign markets through free and fair trade. Yet, as this analysis has shown, bolstering North American competitiveness begins with the continent's metropolitan engines. As such, subnational leaders must also act with new purpose, setting globally oriented economic visions for their places, investing smartly in the service of those visions, and leveraging their distinct sets of continental trading partners to mutual benefit. In doing so, they will not only determine the long-term trajectory of their own economies, but also that of North America as a whole. ■

APPENDIX A - METHODOLOGY

GOODS TRADE DATABASE

To estimate flows between metropolitan areas, Brookings worked with the Economic Development Research Group (EDR) to create a database that allocates national goods trade to the metropolitan scale. It builds on a database created by Brookings and EDR that estimated international goods-trade flows between 369 U.S. metropolitan areas and 40 international geographic areas (18 countries, 11 larger country groups, and 11 continental remainders). We used this existing database's estimated freight flows from U.S. metropolitan areas to Canada and Mexico, at the national level, as a starting point.

These flows were estimated using trade data from the World Institute for Strategic Economic Research (WISER) for 2010. The methodology used a gravity constraint to link the origin for exports and destination for imports more directly in terms of each metropolitan area's and "rest of state" regions' production and consumption. Estimates for consumption and production were based on EDR's access to IMPLAN data on local industrial activity. This database presented trade flows in terms of the Standard Classification of Transported Goods (SCTG) system's two-digit level (43 commodity categories).

It should be noted that this Brookings database shares a 0.91 correlation with ExportNation's 2010 goods data. However, because this report and ExportNation use different statistical bases, and only ExportNation includes service exports, the actual numbers will not match between the two datasets. It should be noted that a special process was used to allocate crude petroleum (SCTG 16). Limited by the sample size for this commodity—as well as by the suppression of numerous industry records for confidentiality—our database allocates these missing flows to counties with non-suppressed refinery data. As such, our estimates may overrepresent or underrepresent petroleum flows between certain geographic zones.

Where this analysis differs from previous Brookings research on freight flows is that it down-allocates goods movement from the national level to the metropolitan level in Canada and Mexico. To do this, the same methodology used to estimate U.S. metropolitan-level international goods imports and exports was applied to Canada and Mexico. Using 2010 WISER data for U.S. metropolitan trade with Canada and Mexico, the database identifies U.S. origins and destinations, as well as border crossings (or ports of entry/exit). Brookings and EDR then allocated existing U.S. metropolitan import and export estimates from the national level in Canada and Mexico to subnational zones in each country.

The resulting database includes 369 U.S. core based statistical area (CBSAs) and 48 rest-of-state zones; 59 census-defined Mexican metropolitan zones and 29 rest-of-state zones; and 33 Canadian census metropolitan areas (CMAs), nine rest-of-province zones, and four province zones. Bilateral trade flows, by value and weight, were estimated between U.S. and Mexican and U.S. and Canadian geographic areas for individual SCTG commodity codes.

ESTIMATING COMMODITY CONSUMPTION AND PRODUCTION SUBNATIONALLY IN CANADA AND MEXICO

Prior to down-allocating trade flows, Brookings and EDR used several data sources to estimate commodity consumption and production for subnational zones in Canada and Mexico. To do this, three pieces of information were necessary:

- Industry output and value added for all detailed zones in Canada and Mexico, at approximately three-digit NAICS industry detail.

- A make and use table with industry dimension matching the industry detail in the above bullet (for each country), and with a crosswalk on the commodity dimension to the SCTG-based target commodity detail.

- Final demand data for all detailed zones, with a crosswalk to the target SCTG commodity codes.

For Mexico, industry output and value-added data for metropolitan zones were compiled through INEGI's 2009 Economic Census and data from the Secretariat of Agriculture, Livestock, Rural Development, Fisheries, and Food. National input-output data and state-level value added were obtained from the INEGI National Accounts database. After updating Mexico's 2003 make-use tables to 2009 levels, final demand (by SCTG commodity code) for each zone was determined for each Mexican geographic zone. National household consumption was allocated based on the zone's share of national value added. Government consumption was allocated based on the zone's share of government expenditure. Capital investment was allocated based on the zone's share of national employment in construction and manufacturing industries. Finally, inventory changes were allocated based on the zone's share of manufacturing and trade employment.

For Canada, Statistics Canada provided industry data at a detailed NAICS level for 2009, but only for provinces, while the only identified CMA data were employment at the two-digit NAICS level. Therefore, we used Canadian Business Pattern data from 2009 at the six-digit NAICS level to down-allocate provincial-level industry data to Canadian CMAs. Statistics Canada provides detailed provincial-level make-use tables for 2009. Finally, provincial final demand was apportioned to CMAs by population estimated total value added (for household consumption), total employment estimated manufacturing output (for business investment and inventory change), and estimated government employment output (for government consumption). As with industry activity, final demand not accounted for in CMAs was assigned to "Rest of Province."

For each country, make-use tables were used to convert metropolitan industry activity to commodity supply and demand. In each case, an aggregation template (or crosswalk, if the aggregation is many-to-many) was developed for the commodity side of the make-use table to convert commodity production and consumption to an SCTG basis. These data were used to estimate total commodity supply and demand for each detailed geographic zone at the target SCTG commodity detail. Commodity demand for each geographic zone was estimated as the sum of intermediate demand (industry demand) and final demand. Intermediate demand is calculated as industry purchases (output minus value added) matrix-multiplied by the absorption table, then aggregated to SCTG commodities. Final demand is simply aggregated from NAICS-based commodity definitions to SCTG categories.

Table A1. Commodities Included in U.S.-Canada Goods Trade Database

SCTG Code	Commodity
1	Animals and Fish (live)
2	Cereal Grains (includes seed)
3	Agricultural Products (excludes Animal Feed, Cereal Grains, and Forage Products)
4	Animal Feed, Eggs, Honey, and Other Products of Animal Origin
5	Meat, Poultry, Fish, Seafood, and their Preparations
6	Milled Grain Products and Preparations, and Bakery Products
7	Other Prepared Foodstuffs, Fats and Oils
8	Alcoholic Beverages and Denatured Alcohol
9	Tobacco Products
10	Monumental or Building Stone
11_12	Natural Sands, Gravel and Crushed Stone (excludes Dolomite and Slate)
13	Other Non-Metallic Minerals not elsewhere classified
14	Metallic Ores and Concentrates
15	Coal
16	Crude Petroleum
17	Gasoline, Aviation Turbine Fuel, and Ethanol (includes Kersone, and Fuel Alcohols)
18	Fuel Oils (includes Diesel, Bunker C, and Biodiesel)
19	Other Coal and Petroleum Products, not elsewhere classified
20	Basic Chemicals
21	Pharmaceutical Products
22	Fertilizers
23	Other Chemical Products and Preparations
24	Plastic and Rubber
25	Logs and Other Wood in the Rough
26	Wood Products
27	Pulp, Newsprint, Paper, and Paperboard
28	Paper or Paperboard Articles
29	Printed Products
30	Textiles, Leather, and Articles of Textiles or Leather
31	Non-Metallic Mineral Products
32	Base Metal in Primary or Semi-Finshed Forms and in Finished Basic Shapes
33	Articles of Base Metal
34	Machinery
35	Electronic and other Electrical Equipment and Components, and Office Equipment
36	Motorized and Other Vehicles (includes parts)
371	Railway Equipment
372	Aircraft and Spacecraft
373	Ships, Boats, and Floating Structures
38	Precision Instruments and Apparatus
39	Furniture, Mattresses, and Mattress Supports, Lamps, Lighting Fittings, and Illuminated Signs
40	Miscellaneous Manufactured Products

Source: Brookings and Economic Development Research Group.

Table A2. Commodities Included in U.S.-Mexico Goods Trade Database

SCTG Code	Commodity
1	Animals and Fish (live)
02_03	Cereal Grains (includes seed), Agricultural Products (excludes Animal Feed, Cereal Grains, and Forage Products)
04_07	Animal Feed, Eggs, Honey, and Other Products of Animal Origin, Meat, Poultry, Fish, Seafood, and their Preparations, Milled Grain Products and Preparations, and Bakery Products, Other Prepared Foodstuffs, Fats and Oils
08_09	Alcoholic Beverages and Denatured Alcohol, Tobacco Products
10_13	Monumental or Building Stone, Natural Sands, Gravel and Crushed Stone (excludes Dolomite and Slate) Other Non-Metallic Minerals not elsewhere classified
14	Metallic Ores and Concentrates
15	Coal
16_19	Crude Petroleum, Gasoline, Aviation Turbine Fuel, and Ethanol (includes Kersone, and Fuel Alcohols), Fuel Oils (includes Diesel, Bunker C, and Biodiesel), Other Coal and Petroleum Products, not elsewhere classified
20	Basic Chemicals
21	Pharmaceutical Products
22	Fertilizers
23	Other Chemical Products and Preparations
24	Plastic and Rubber
25	Logs and Other Wood in the Rough
26	Wood Products
27_28	Pulp, Newsprint, Paper, and Paperboard, Paper or Paperboard Articles
29	Printed Products
30	Textiles, Leather, and Articles of Textiles or Leather
31	Non-Metallic Mineral Products
32	Base Metal in Primary or Semi-Finshed Forms and in Finished Basic Shapes
33	Articles of Base Metal
34	Machinery
35	Electronic and other Electrical Equipment and Components, and Office Equipment
36	Motorized and Other Vehicles (includes parts)
371	Railway Equipment
372	Aircraft and Spacecraft
373	Ships, Boats, and Floating Structures
38	Precision Instruments and Apparatus
39	Furniture, Mattresses, and Mattress Supports, Lamps, Lighting Fittings, and Illuminated Signs
40	Miscellaneous Manufactured Products
32	Base Metal in Primary or Semi-Finshed Forms and in Finished Basic Shapes
33	Articles of Base Metal
34	Machinery
35	Electronic and other Electrical Equipment and Components, and Office Equipment
36	Motorized and Other Vehicles (includes parts)
371	Railway Equipment
372	Aircraft and Spacecraft
373	Ships, Boats, and Floating Structures
38	Precision Instruments and Apparatus
39	Furniture, Mattresses, and Mattress Supports, Lamps, Lighting Fittings, and Illuminated Signs
40	Miscellaneous Manufactured Products

Source: Brookings and Economic Development Research Group.

ALLOCATING U.S. RELATED TRADE

Based on commodity production and consumption estimates of the previous step, existing trade flows from U.S. CBSAs and rest-of-state zones were allocated to subnational Canadian and Mexican geographic zones.

From the existing Brookings-EDR database, we determined all exports of a commodity to Canada/Mexico from the U.S. geographic zones, by border crossing. This step, then, used an optimization technique to match the supply of U.S. commodity exports with the demand for imports by Canadian/Mexican zones. This method allocated border crossing throughput to Mexican zones proportionally to commodity demand, but with a gravity constraint. The gravity constraint "forces" commodity throughput to be consumed more by Mexican zones close to the border crossing than those far away (all else equal). The gravity constraint was applied to flows crossing the border via truck, rail, and pipeline but not to goods flows moving by air and sea. WISER data do not specify the airport and marine port for foreign trading partners. These flows were allocated based on production and consumption.

This optimization technique was applied four times for each commodity: U.S. exports to Mexico, U.S. imports from Mexico, U.S. exports to Canada, and U.S. imports from Canada. The result of this process was four commodity-specific down-allocation vectors from each border crossing to detailed partner zones.

Again, it is important to stress that our down-allocation methodology apportions trade flows on a proportional basis. That is, starting with known border throughput totals (where data collection is most accurate and exhaustive), we allocate imports and exports to specific geographic zones based on the proportion in which those zones demand or supply those commodities. This methodology gives us the best estimation of the interplay between subnational zones in terms of their economic production and consumption, but caution should be used when interpreting these estimates. Our methodology may overestimate or underestimate flows between geographic zones. ■

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72. Goods trade totals do not include waste and scrap or mixed freight.

73. This statistic incorporates, for example, petroleum flowing from rural Alberta to Chicago or corn exports from outstate Iowa to Monterrey.

74. To put this number in perspective, if North American metro areas traded with one another proportional to their share of GDP, metro-to-metro trade would amount to 63 percent of total goods trade.

75. If agriculture commodities (SCTG 1-9), stones and ores (SCTG 10-14), energy products (SCTG 15-19), and wood products (SCTG25-29) are removed, then metros account for 59 percent of remaining goods trade between Canada and the United States.

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The Global Cities Initiative aims to equip metropolitan leaders with the information, policy ideas, and global connections they need to bolster their positions within the global economy. Combining Brookings' deep expertise in fact-based, metropolitan-focused research and JPMorgan Chase's longstanding commitment to investing in cities, this initiative aims to:

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