How Technology Is Changing Toronto Employment

400,000 JOBS AND GROWING

Report by

TECH TORONTO

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Introduction

In recent years, technology and entrepreneurship have been promoted as the future of our economy. They are expected to create the prosperity and jobs we need to keep Toronto a vibrant world-class city.

TechToronto believes this to be true, but we also believe that the average Torontonian doesn't appreciate the extent to which technology has already transformed our economy. The Internet, mobile technologies, wearables, big data and machine learning have created thousands of new companies and jobs in Toronto.

We undertook this study to demonstrate the impact of technology on the Toronto economy and suggest ways to help the technology ecosystem to prosper and grow. This study defines the Toronto tech ecosystem and measures the ecosystem's resilience, robustness and impact on the economy.

The report consists of two sections. The first two sections provide a quantitative overview of both the Toronto economy at large and the growing tech ecosystem within it. The third section outlines our policy recommendations.

This report uses data about jobs and industries available from Statistics Canada and through Emsi's Analyst tool to chart the dimensions of the tech ecosystem in Toronto (see the Technical appendix for more information).

This study was inspired by the methodology of *The New York City tech ecosystem report*, which included all jobs from tech industries, as well as tech jobs in non-tech industries.[1] Using this methodology, the report identifies the ecosystem and shows how it drives a significant part of our current and future economy.

The policy recommendations are intended to generate an active discussion about how to support the continued growth and dynamism of Toronto's tech ecosystem. Its goal is to contribute to a better understanding of the overall contribution of the tech ecosystem to Toronto's regional economy and align public policy to support its future growth.

Source: HR&A Advisors, Inc.

Purpose of this study:

1

Recognition
Identify the tech ecosystems importance to our economy.

2

Local Awareness
Build awareness of the contribution of the tech ecosystem to the local economy.

3

Support Progress
Start a conversation around improved support for the tech ecosystem by our public policy leaders and the general public.

Acknowledgements

We hope you find this report useful, and we would like to thank the following people for making it happen.

For more information on *How Technology Is Changing Toronto Employment,* visit **www.techtoronto.org**
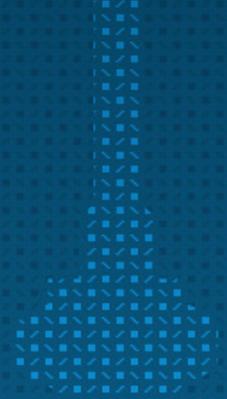
The Toronto Tech Ecosystem

As of 2015, there were **2.7 million people** employed in Toronto.

For the purpose of this report, "Toronto" is defined as comprising the Toronto, Peel and York census divisions.

This region housed a diverse population of 5.4 million people in 2015—with 49%[DW1] of the population made up of immigrants.[1] As the economic hub of Canada, Toronto houses major parts of the country's economy, and sectors within this ecosystem have a growing percentage of technology-driven employees to consider.

Main Sectors

Toronto workers are spread across many industry sectors of the economy.
As depicted below, 45% of Toronto's employed population works in these sectors.

Top 5 Toronto Industries By Employee Count.
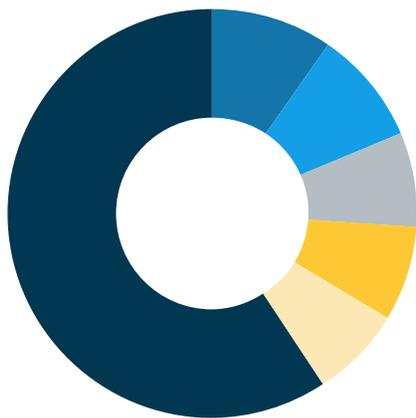
- **Retail Trade**
  NAICS : 44 - 45 | Employees : 275,000 | **10.4%**

- **Manufacturing**
  NAICS : 31 - 33 | Employees : 265,000 | **10%**

- **Health Care & Social Assistance**
  NAICS : 62 | Employees: 230,000 | **8.7%**

- **Professional Scientific & Technical Services**
  NAICS : 54 | Employees : 214,000 | **8%**

- **Finance & Insurance**
  NAICS : 52 | Employees : 211,000 | **7.9%**

- **Everything Else**
  NAICS : - | Employees : 1,196,000 | **55%**

Other Sectors Can Be Broken Down Into 3 Major Types In Toronto.
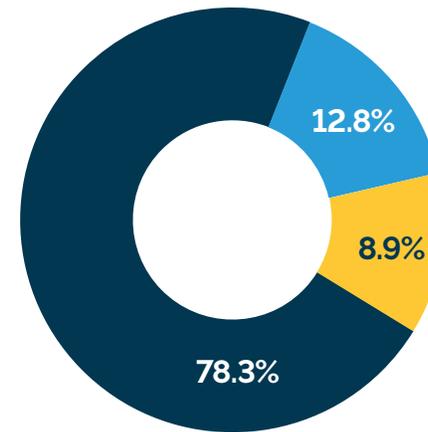
- **Goods-Producing**
- **Service-Based**
- **Government & Institutional**

12.8%
8.9%
78.3%

Other Contributing Sectors

Wholesale Trade
NAICS : 41 | Employees : 181,000 | **6.8%**

Educational Services
NAICS : 61 | Employees : 178,000 | **6.7%**

**Admin & Support, Waste Management**
NAICS : 56 | Employees : 173,000 | **6.5%**

Transportation & Warehousing
NAICS : 48 - 49 | Employees : 132,000 | **5%**

Public Administration
NAICS : 91 | Employees : 130,000 | **4.9%**

Construction
NAICS : 23 | Employees : 121,000 | **4.6%**

Other Services (except public administration)
NAICS : 81 | Employees : 110,000 | **4.1%**

Information & Culture Industries
NAICS : 51 | Employees : 93,000 | **3.5%**

Real Estate, Rental & Leasing
NAICS : 53 | Employees : 62,000 | **2.3%**

Unclassified
NAICS : X0 | Employees : 41,000 | **1.5%**

Arts, Entertainment & Recreation
NAICS : 71 | Employees : 37,000 | **1.4%**

Management of Companies & Enterprises
NAICS : 55 | Employees : 22,000 | **0.8%**

Utillities
NAICS : 22 | Employees : 12,000 | **0.4%**

Agriculture, Forestry, Fishing & Hunting
NAICS : 11 | Employees : 4,000 | **0.2%**

Mining, Quarrying, Oil & Gas Extraction
NAICS : 21 | Employees : 4,000 | **0.2%**

TOTAL by employee count: **2,661,000**

All of these sectors include tech jobs and, more than ever, there's a need to recognize that this growing ecosystem extends beyond the sectors of the economy usually identified as technology sectors.

Toronto Economy Facts

Toronto has North America's third largest public transit system.

In 2015, the Toronto Transit Commission set an all-time annual ridership record of 538 million rides, surpassing its previous record of 535 million set in 2014. Annual ridership in 2015 for GO transit was 69.5 million rides.

• PUBLIC TRANSPORTATION

Toronto's film and television cluster ranks third in North America with television series production growing an average of 17% over the past five years.

• FILM AND TELEVISION

Toronto is home to 30% of all financial services headquarters in Canada, including Canada's five largest banks.

• FINANCE

Toronto is Canada's largest retail market with more than 4,600 fashion retail stores generating annual sales of $2.6 billion.

• RETAIL

There are more biotech companies per capita in Canada than in any other country in the world; 50% of Canada's life sciences companies are located in Toronto.

• BIOTECH

Housing in Toronto is reflective of the booming metropolis, as the average house price in June 2016 was $746,000, over $200,000 more than the average house price nationally.[2]

• HOUSING

When it comes to Internet infrastructure, 87.9% of households have access to Internet.[3]

• INTERNET

Source: Toronto Financial Services Alliance, The Canadian Real Estate Association, Statistics Canada: *CANSIM*, City of Toronto.

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The Toronto Ecosystem

A "tech ecosystem" is "a network of organizations that enable the provision of goods or services rather than an isolated, independent industry. For example, the computer systems administrator employed by a hospital's information technology department is directly employed by the healthcare sector but also needs to be considered in evaluating the complete tech ecosystem."[4]

An ecosystem is classified by the amount of employment and economic benefits which are generated within a specific region.

What is it and how do we measure it?

Beyond the traditional view of what constitutes the tech industry, we also consider how much the impact of technical jobs in non-tech industries are having on a local economy. For the purposes of this report, we measured the tech ecosystem using three types of employment:

1 **All tech jobs in the tech industry**
Ex. Computer Programmer at Nascent Digital

2 **All non-tech jobs in tech industries**
Ex. Sales Representative at SoapboxHQ

3 **All tech jobs in non-tech industries**
Ex. Technical Support job at RBC

Since technology is found in all sectors of the economy, we see technical jobs not just in tech companies but in traditional industries like manufacturing, natural resources and finance.

Toronto has the greatest tech presence in Canada and its growth in tech surpasses the national average—this is why the region is so highly respected globally as a source of tech talent and investments.

NOC	The Most Common Jobs In The Tech Ecosystem	Employed in Industry Group 2015	Median Hourly Earnings
2171	Information Systems Analysts & Consultants	26,980	$34.99
2174	Computer Programmers & Interactive Media Developers	22,146	$38.77
2173	Software Engineers & Designer	8,510	$47.00
0213	Computer & Information Systems Managers	6,423	$47.97
2281	Computer Network Technicians	4,408	$30.88
2175	Web Designers & Developers	4,181	$38.21
2147	Computer Engineers (except software engineers & designers)	2,986	$16.01
9523	Electronics Assemblers, Fabricators, Inspectors & Testers	2,881	$32.52
2172	Database Analysts & Data Administrators	2,982	$28.12
2242	Electronic Service Technicians (household and business equipment)	1,980	$26.49

For a full list of the jobs used in this report, see the Technical Appendix.

The Toronto tech ecosystem has a total of:

401,000 jobs = 15% of all Toronto jobs

Of these, 93,000 jobs are held by self-employed professionals, accounting for 23% of the ecosystem, which is more significant than other industries in Toronto. In comparison to two other significant Toronto industries in 2015, only 4% of the manufacturing workforce was self-employed, and only 8% of the finance and insurance workforce was self-employed.

In Toronto, 72,000 people are working non-tech jobs in a tech company, 231,000 people are working in tech jobs in non-tech companies and 98,000 people are working at a tech company in a tech jobs.

72k Non-tech jobs in tech companies	**98k** Tech jobs in tech companies	**231k** Tech jobs in non-tech companies

The tech ecosystem has added 51,000 jobs since 2010, while in the same time period, finance (industry of 232,000 jobs in 2015) has added 17,000 jobs and manufacturing (industry of 278,000 jobs in 2015) has reduced by 5,000 jobs.

170k All jobs in tech industries **98k** overlap **329k** All jobs in tech occupations
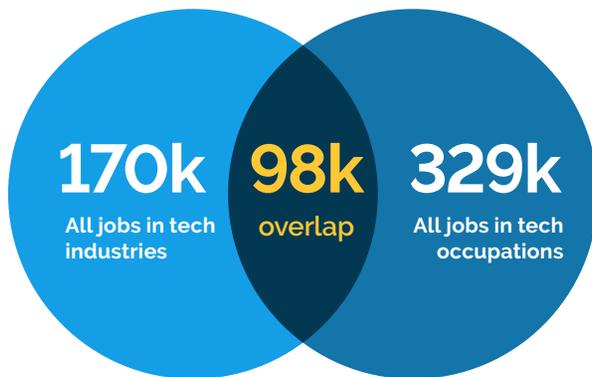
Job Growth By Industry (2010-2015)

Percent Growth

Tech + 14.6%

Finance + 7.9%

Manufacturing - 1.8%
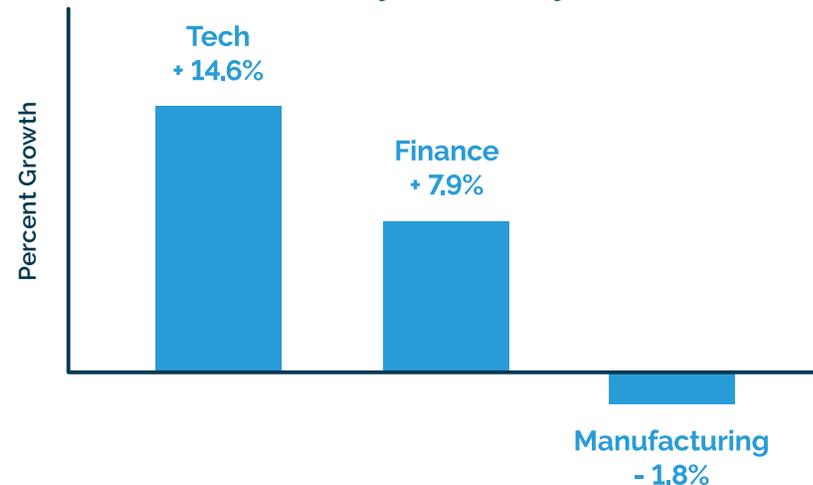
Toronto Startups

A large part of any successful tech ecosystem is its startup network. Some of the biggest tech companies in the world (Apple, Microsoft, Facebook and Google) began as startup companies. Today Toronto has a growing startup ecosystem containing 2,500–4,100 active tech startups.

In 2015, Compass released its Global Startup Ecosystem Ranking, which saw Toronto fall nine spots since 2012 (from #8 to #17). This drop can be attributed to lower startup experience than other Canadian cities like Vancouver and Montreal and the high cost of spaces to work and live within the city. Despite the change in ranking, Toronto maintained its rank as the strongest startup ecosystem in Canada due to its competitive market reach and a skilled, low-cost talent pool. Compass also recommended that to compete on a global level, Toronto could improve local access to venture capital rather than relying on US-based VC firms for later-stage investments.

Expansion of existing firms into Toronto

Some of the top social media companies such as LinkedIn, Facebook and Twitter have established their Canadian head offices in Toronto.

Established top Canadian tech firms that are headquartered in Toronto include Rogers Communications, Celestica, Constellation Software, Softchoice, D+H and Procom Consultants Group. 6 of the top 20 Canadian information and communications technology (ICT) companies are based in Toronto.[5]

The top 5 international ICT firms all have Canadian headquarters in the GTA:

1. **IBM Canada**, Markham ON
2. **Alphabet (Google),** Toronto ON
3. **HP Canada**, Mississauga, ON
4. **Cisco Systems Canada**, Toronto ON
5. **Microsoft Canada**, Mississauga ON

*Based on revenues generated in Canada, Branham Group Inc.

The backbone of the technology sector in the Toronto region is its telecommunications infrastructure. For the entire Toronto tech ecosystem, telecommunications accounts for 7.4% of jobs.

Economic & Fiscal Impact Analysis

Growth Of The Tech Ecosystem In Toronto

It is clear that Toronto's tech ecosystem is growing substantially, adding 51,000 new jobs in the last 6 years. But how much of this growth is truly attributable to Toronto as a tech hub? Some of the growth can surely be attributed to general trends in the overall Canadian economy, and some is likely due to tech's increasing footprint across the entire country—not exclusively in Toronto. Emsi's economic modelling tool allows us to conduct shift share analysis—a technique that helps determine how much of regional job growth can be attributed to national trends and how much is due to unique factors within the region itself.

Shift share breaks down regional job growth into 3 constituent factors:

1. **General nationwide economic growth**
2. **Tech ecosystem growth nationwide**
3. **Tech ecosystem growth in Toronto**

General nationwide economic growth is enough to account for 41.5% of the new jobs in the ecosystem (over 21,000 jobs). Another 9.8% of the new jobs can be attributed to steady Tech ecosystem growth nationwide (over 5,000 jobs). This means that a whopping 48.8% of Toronto's tech ecosystem job growth since 2010 is due to some unique factors within the city itself.

Shift Share For Tech Ecosystem Growth

- ● General nationwide economic growth
- ● Tech ecosystem growth nationwide
- ● Tech ecosystem growth in Toronto

41.5%

9.8%

48.8%
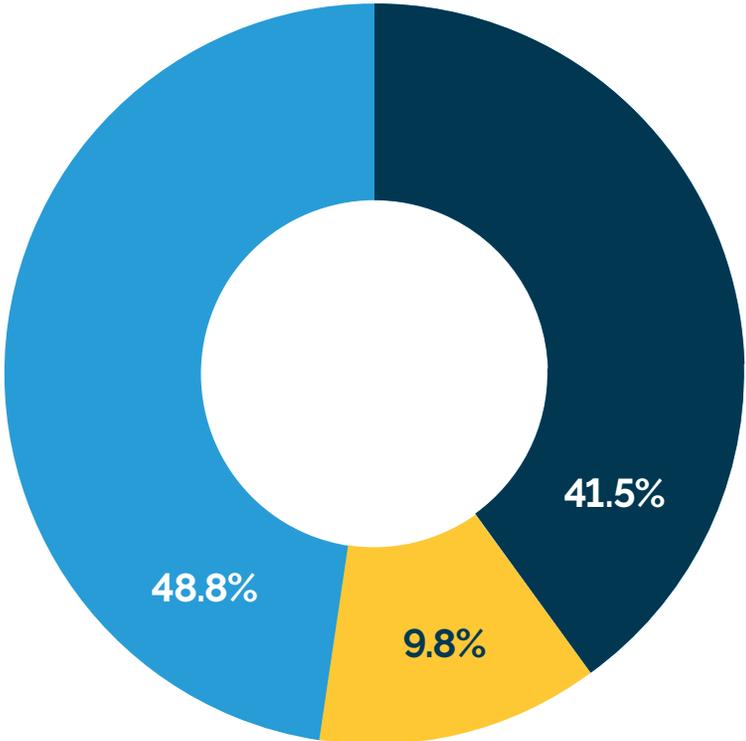
Growth Of The Tech Ecosystem In Toronto

Since 2010, the Toronto tech ecosystem has grown faster than the general economy and tech ecosystem in the rest of the country combined, adding 25,000 jobs beyond what was expected.

But this Toronto-centric growth isn't uniform across the entire ecosystem. Since 2010, there's been no growth in the number of non-tech jobs in tech industries, (in fact they declined by 1.1%). Tech jobs in non-tech industries grew by 15.7%, while tech jobs in tech industries saw the largest percentage growth, at 27.1%.

Toronto Tech Ecosystem Growth Since 2010

Number of New Jobs

60,000

51,000

45,000

30,000

26,000

15,000

0

2010   2015

● Actual Growth   ● Expected Growth
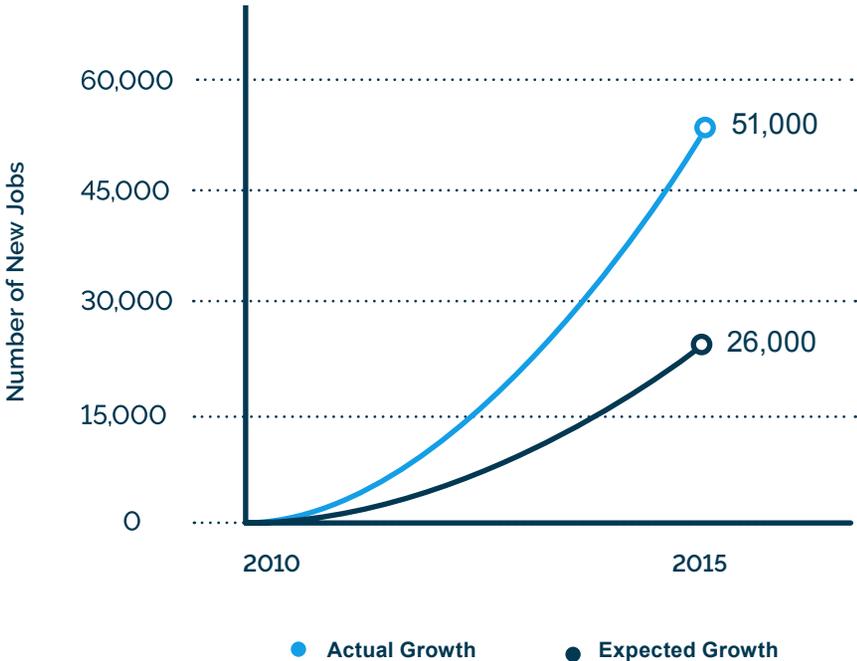
Toronto tech growth

2x

more than

national tech growth

Compensation And Salaries

The average 2015 salary for Toronto tech ecosystem employees was $61,000. This figure is 11% higher than the average Toronto salary of $55,000.

2015 Average Hourly Earnings

$40.00	
$30.00	$36.79
$29.35	$31.12
$20.00	
$10.00	

Non-tech jobs in tech industries | Tech jobs in tech industries | Tech jobs in non-tech industries
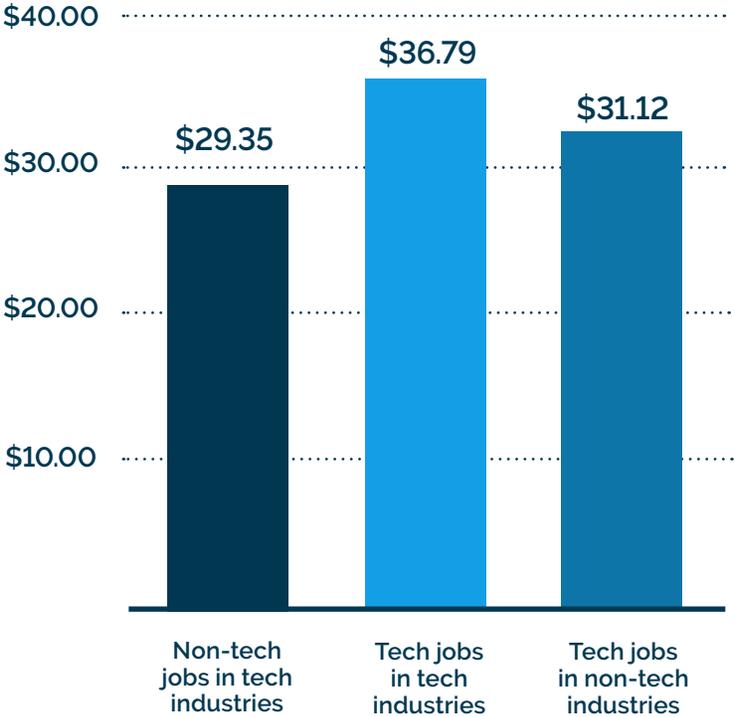
$32.19
Tech ecosystem

$25.66
Toronto

Tech jobs in tech industries have the highest average hourly wage in the ecosystem at $36.79 per hour. The lowest average wages in the ecosystem go to non-tech jobs in tech industries at $29.35. But all of these are higher than the average Toronto wage of $25.66.

In total, the tech ecosystem in Toronto paid out over $24 billion in salaries. This represents 17% of all the compensation paid in the city in 2015, compared to 15% of the city's employment.

Economic Resilience

Compensation and GDP are great indicators of economic performance, but the recent financial crisis and recession have demonstrated that scale isn't everything. The resilience of an economy is a measure of growing importance to business owners and policy makers. Resilience can be defined as an economy's vulnerability to crises and its capacity to absorb and overcome shocks while supporting strong growth.[7]

Economic resilience is an active area of research, with institutions like MIT[8], University of Toronto[9], University of California, Berkeley [10] and others across the globe[11] [12] [13] exploring the factors that make for an economy that can bounce back from a crisis.

The following pages will focus on diversification, decentralization and income equality. But other factors associated with resilient city economies include affordability of housing, access to talent and human capital, as well as venture capital and government funding—all of which are addressed in the Public Policy Recommendations section.

While there's no consensus yet on a specific set of criteria,
academics have converged on a few key metrics for economic resilience:

1

Diversification

2

Decentralization

3

Income Equality

Diversification

Diversification describes the degree to which jobs are spread out across multiple industries. An economy where jobs are spread across multiple industries carries less economic risk. If jobs are heavily concentrated in one or two sectors, then the economy is more susceptible to booms and busts in these industries and, hence, is quite fragile. Think about Detroit and the auto industry. This page looks at the diversity of Toronto's economy overall, while the next page explores the role that tech plays in diversified economies.

How diversified is Toronto's employment profile overall?

The Economic Complexity Index (ECI) is a way to measure the economic diversity of a city in the context of the entire country. It counts the number of industries in a city and assesses the uniqueness of the city's industry profile in comparison to other regions. An ECI above zero is a sign the city employs a diverse range of industries, including ones that are relatively rare when compared to other regions. An ECI below zero suggests that a city employs relatively few industries, tending towards ones that are more common across regions. Past research has shown that ECI is a strong predictor of future GDP-per-capita growth.[14]

Top And Bottom 5 Canadian Cities By Diversification
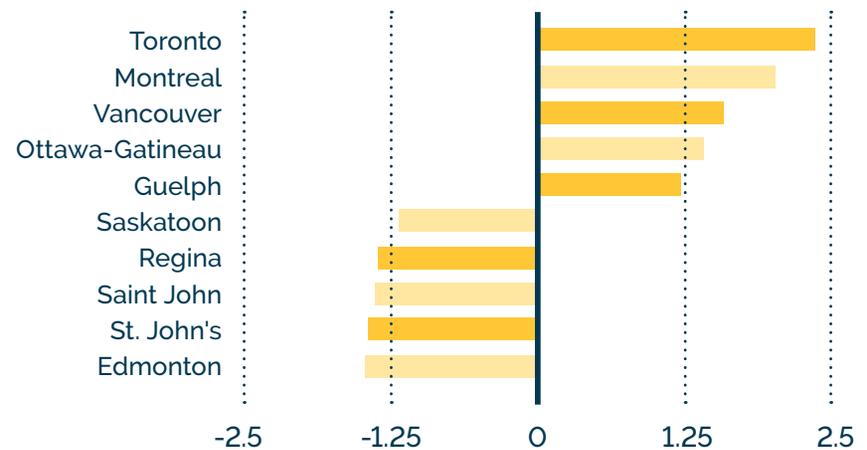
At 2.36, Toronto has the highest ECI of all cities across Canada. This means that the city has a diverse and unique employment profile.

Diversification

ECI analysis also reveals that the tech industry is strongly associated with diverse city economies. Canadian cities with above-average levels of tech industry employment tend to have a much higher ECI. The average ECI of cities with high tech employment is 1.68, while cities with lower tech employment have an average ECI of -0.30.

In general, economies more reliant on natural resources and primary industries tend to have lower ECIs, whereas economies weighted towards complex products and services tend to have higher ECIs.[15]

Interestingly, while the ECI is calculated using industry diversification, its creators actually see the metric as an indicator of the amount of knowledge embedded in a society.[16] To the economists who developed the metric, a high ECI is a sign that a diverse group of people have come together to turn something simple into something complex. They've moved from extracting silicon to building silicon microchips or from building microchips to designing data warehouses that enable others to innovate at a new scale.

Diversity Vs. Tech Employment By City

"New ideas generate the experimentation needed to make the most of the fourth industrial revolution…Our natural resources are important, and they always will be. But Canadians know that what it takes to grow and prosper isn't just what's under our feet, it's what's between our ears."
—Justin Trudeau, World Economic Forum

Decentralization

Decentralization is similar to diversification but narrows its lens to focus on a single industry. Is the entire industry in a city concentrated into a single company? Then this industry is highly centralized and not particularly resilient. If this company were to fold, be acquired or leave town, then the industry's economy would be decimated. A multitude of different organizations of different sizes and complexities make for an industry that's more adaptable to change and more robust to failure.

The very fact that we're talking about the tech ecosystem in Toronto implies that it's already relatively decentralized. The spread of tech into non-tech industries is highly beneficial for the resilience of the ecosystem. In a sense, all industries are becoming tech industries, with the number of tech jobs in non-tech industries outnumbering tech industry employment in 2015 by 36%.

But even setting non-tech industries aside, we see strong signs of decentralization within tech industries in Toronto. There are no less than 18 different incubators and accelerators across Toronto's universities and colleges (see Public Policy Recommendations section), so there will be continued opportunities for young entrepreneurs if any one of them were to enter a crisis. And the wide range of startups, mid-sized and large enterprises is a sign that our economy can support tech organizations across scales.

But there are some red flags in the Toronto economy when it comes to centralization. Government support is being disproportionately concentrated into large organizations. The Public Policy Recommendations section explores this issue in more detail.

There Are More Tech Jobs Outside Of The Tech Industry Than There Are Within In It

231,000 — Tech Jobs In Non-Tech Industries
170,000 — All Jobs In Tech Industries

Y-axis: 0, 60,000, 120,000, 180,000, 240,000
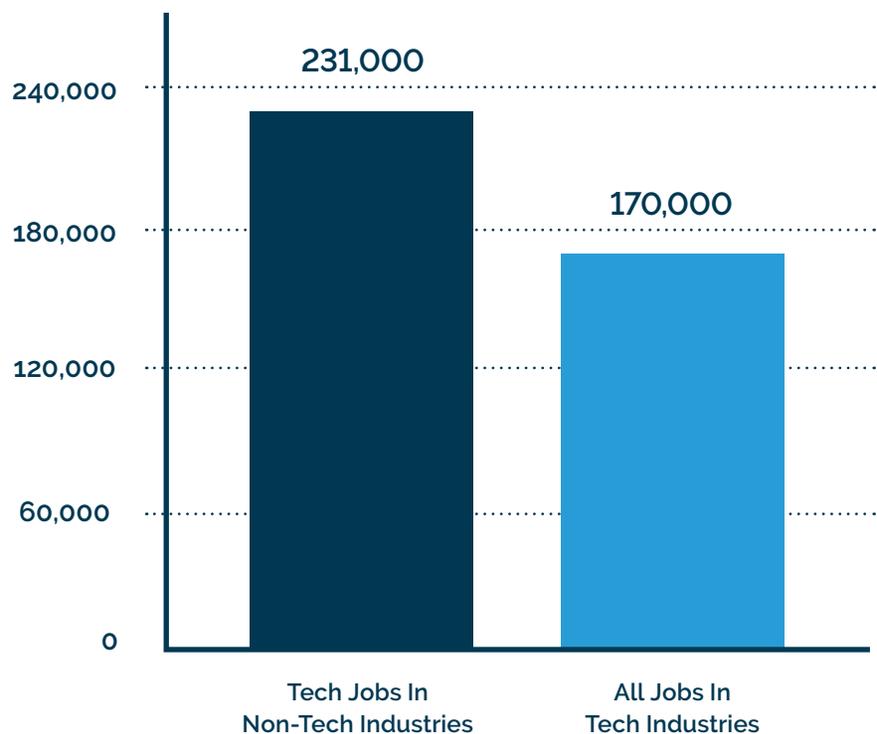
Income Equality

Income equality is the final measure of economic resilience that we'll consider. Why does income equality matter to resilience? The more equal a region's distribution of economic resources, the more cohesive and widespread the response can be to a disturbance.[18] If a crisis were to strike a city's economy but only the elite could afford to weather the storm, then the overall economy would struggle to recover. A population with more balanced wealth is more adaptable. Societies with more equal income distributions tend to have more durable growth.[19]

The most common measure of income inequality is the Gini coefficient. Ranging from zero to one, a Gini coefficient of zero represents perfect equality, where every citizen earns the exact same amount, while a Gini coefficient of one represents extreme inequality, where all of the wealth is concentrated into a single individual.

When we compare the Toronto tech ecosystem to the broader Toronto economy, we see lower levels of inequality within tech. This means that average salaries within tech are more evenly distributed, and this is a good thing when considering the resilience of the ecosystem.

But it's important to note that this analysis only scratches the surface of income equality. The wage gap between men and women has increased since the recession, with women now earning only 72% as much as men for the same type of work—and this issue persists across all industries, including tech.[20] The Public Policy Recommendations section dives deeper to consider gender and minority representation within the tech ecosystem.

Gini Coefficients In Toronto

	Toronto Tech Ecosystem	Toronto Overall
Gini Coefficient	0.16	0.22
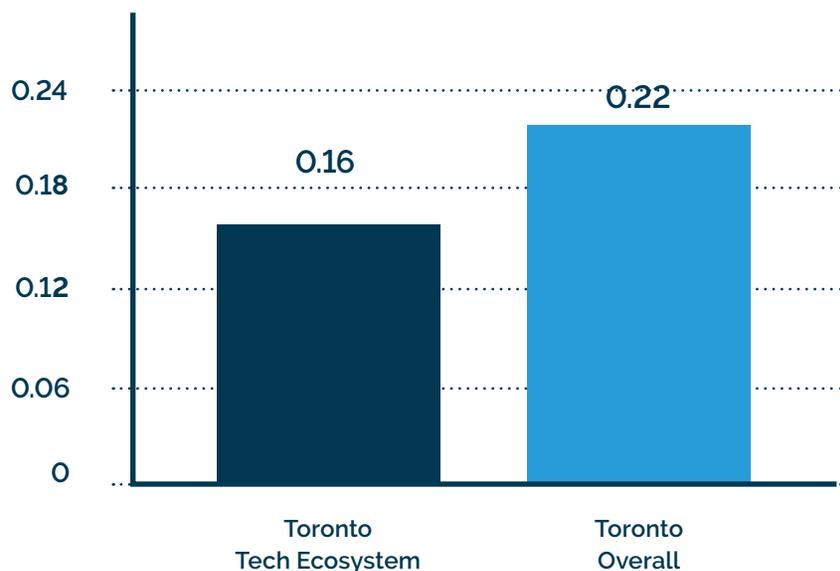
Public Policy Recommendations

Public Policy Recommendations

While the Toronto tech ecosystem is the strongest in Canada we can still improve its overall competitiveness and growth rate. We recommend that the various levels of government adopt the following changes to public policy.

Attraction & Retention

1 Make Toronto-Waterloo world renowned for fintech and machine learning.

2 Introduce fast track immigration visa for tech talents.

Workforce & Education

3 Increase enrollment and diversity in post secondary STEM programs.

4 Pay companies to train and hire re-trained workers.

Infrastructure

5 Make housing better and more affordable.

6 Make it easier for tech companies to choose the right accelerator/incubator.

Regulation

7 Modernize and harmonize the regulatory environment.

Government Business Support And Procurement

8 Re-distribute government funds from incumbent tech companies to scale-ups and start-ups.

9 Solve civic problems and strengthen local tech companies via procurement.

Make Toronto-Waterloo world renowned for fintech and machine learning.

The first two sections of this report show that Toronto's tech sector is a large, growing and globally competitive contributor to regional and national economic success. But in spite of this, the sector and its government supporters have been criticized as not doing enough to increase global awareness of the sector's successes. This is illustrated by a quotation from Toronto-based LegalX Founder Aron Solomon in the Compass 2015 Global Startup Ecosystem report: "We wear an albatross of modesty that you don't see in the Silicon Valleys and Tel Avivs of the world. We can sometimes be too meek and apologetic to clearly convey our desire for top-level success." [21]

Policymakers need to act as passionate champions to promote the tech sector's successes on the global stage. A great example of this is when Toronto Mayor John Tory and Kitchener Mayor Berry Vrbanovic travelled to Silicon Valley in April 2016 aiming "to put the Toronto-Waterloo corridor on the map as a global hub of innovation, to broadcast our accomplishments, and clearly state our ambitions as part of a longer play to attract and retain investment and talent to the region, while cultivating growth."[22]

But these types of trips need to be augmented with a more coordinated approach to promotion. The "We Are Made in NY" campaign offers a best practice in this regard. The initiative expanded the "Made in NY" logo program beyond the film and television industry and included an advertising campaign that highlighted Made in NY tech companies through digital ads and ads on subways and buses.[23] To be eligible for the Made in NY distinction and use of the Made in NY mark, digital companies must have a base of at least 75% of their development in New York City, employ at least one person full-time in New York City and have at least 10,000 users or monthly visitors.[24] The City of Toronto's online portal StartUp HERE Toronto currently profiles Toronto startups and could be expanded to include wider promotional initiatives.

We recommend that government promotional initiatives focus on building awareness of two tech clusters in which Toronto already has a recognized advantage: Fintech and machine learning.

Attraction & Retention

Fintech and machine learning have emerged as two subsectors with indicators of future global competitiveness. The Martin Prosperity Institute's system for identifying local industrial strengths and future prospects examines the detailed occupational profiles of Ontario's city regions and maps these onto industries that need specific sets of workers.[25] Toronto's existing talent base appears well suited for Fintech competitiveness, with 9 of the top 10 industrial strengths with tight fits between the types of workers in Toronto's labour market and the demand for such workers by these particular industries in either technology or finance.[26]

NAICS Code	Industry	Labour Market Suitability	Location Quotient	Labour Market Size	Average Full-time Employment Income
5239	Other financial investment activities	4.89	1.81	25,920	$100,505
5231	Securities and commodity contracts intermediation and brokerage	4.96	2.00	15,300	$139,056
5221	Depository credit intermediation	5.22	1.82	101,670	$70,364
4173	Computer and communications equipment and supplies wholesaler-distributors	4.51	2.05	23,255	$86,316
5232	Securities and commodity exchanges	4.93	2.23	940	$111,238
5261	Pension funds	4.83	3.24	1,330	$107,313
5222	Non-depository credit intermediation	4.61	1.73	11,295	$71,972
5415	Computer systems design and related services	4.44	1.46	64,965	$74,156
5269	Other funds and financial vehicles	4.88	2.14	1,600	$90,560
5418	Advertising, public relations, and related services	4.91	1.91	24,570	$60,968

Source: Pathways to Ontario's Knowledge Economy, Rotman School of Management. Machine learning is the second subsector where Toronto has indicators of real potential to be world leading. University of Toronto faculty have asserted that "Canada has a golden opportunity to develop an industrial cluster and compete in a vast array of markets due to an innovation lead in artificial intelligence."[27] As Mayor John Tory notes, the cluster's development is at a pivotal moment: "Toronto has the most PhDs in artificial intelligence, a field that is transforming industry. This talent is being recruited out of the country at an alarming pace, and we should all be doing more to keep them here." [28]

Geoffrey Hinton, UofT and Google
How a Toronto professor's research revolutionized artificial intelligence

TechTO August 2016: Benjamin Alarie
BlueJ Legal presents Toronto Machine Learning Capital of the World

Introduce fast track immigration visa for tech talents.

A barrier to growth faced by the Toronto tech sector is the complex and lengthy process firms must go through to secure and attract foreign talent. Under the existing Express Entry system, implemented by the federal government in 2013, employers who offer jobs to foreign citizens must submit a Labour Market Impact Assessment, demonstrating their inability to fill the position with Canadian workers. Application approval times can be extremely lengthy, so it can take up to six months to approve a foreign worker. This places quickly growing tech startups at a disadvantage as they're forced to participate in Express Entry's bureaucratic and drawn-out processes, making them less competitive in landing highly sought after global talent.

Not only does the Express Entry system negatively impact Toronto's tech sector's global competitiveness, but it also inhibits the tech industry from addressing growing skills shortages. Allen Lau, founder of Wattpad, argues that Canada will need to fill 182,000 ICT positions by 2019.[29] Toronto and the tech sector globally face major skills shortages, with the supply of talent outpaced by the demand for tech skilled workers. Lau states that in the United States alone, the ratio of ICT job postings to skilled workers is 1.42:1, demonstrating a high requirement and demand for ICT workers.[30]

Countries such as France and New Zealand have begun to implement streamlined foreign worker programs to attract and retain top tech talent.[31] If Toronto is to grow, or even just maintain, its tech sector, startups must have access to a streamlined process to acquire top global talent. Currently, Toronto's tech sector and local government leaders agree that immigration policy should be more streamlined to allow Toronto firms to compete for international talent. Mayor of Toronto John Tory echoed this sentiment: "Our federal partners must also streamline the immigration process for highly skilled talent, so that our companies can recruit the very best in the world."[32]

This report recommends that the federal government amend the Express Entry system to facilitate the recruitment of global talent as a means to establish Toronto as a global tech leader and address national and international tech skills shortages. Immigration Minister John McCallum has signalled his awareness that the tech sector's "idea of a quick [immigration] processing time is more like six days rather than six months" and acknowledged that although "six days would be a stretch... we want to open our doors to the best and the brightest…so, obviously, I will be working very hard to try to accommodate their needs as best I can." [33]

Increase enrollment and diversity in post secondary STEM programs.

While this report has shown that Toronto's tech sector workforce is large and dynamic, research indicates that demand will continue to grow significantly. A 2015–2019 labour market outlook by the Information and Communications Technology Council surveyed over 1,000 firms and found that by 2019, Toronto will experience cumulative hiring requirements (combination of employment growth and replacement requirements) of 52,741 (24%) above 2015 levels of ICT workers. [34] Toronto's ICT workforce demand accounts for much of provincial and national requirements, with Toronto's growth expected to account for 69% of Ontario's expected hiring requirements of 76,263 and 29% of Canada's expected hiring requirements of 182,700. Meeting this significant demand for ICT workers will require policy action in increasing and diversifying enrolment in tech-related post-secondary education.

Supporting Toronto's tech workforce are the city's many prominent universities, including the University of Toronto, York University and Ryerson University. These universities have more than 470 faculty members in teaching and research positions in ICT and related technologies programs such as computer sciences, including computer systems and game design.[35]

Toronto's universities contribute significantly to Toronto's tech workforce, with a total of 2,559 full-time students enrolled in a computer sciences program.

85% in undergraduate programs

7% in master's programs

8% in doctoral programs
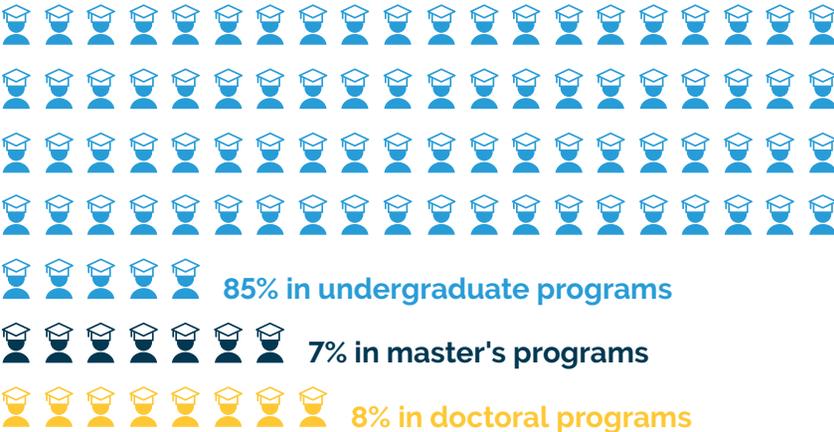
Figures based on 2011/2012 academic year.[36]

In addition, Toronto's four colleges—Seneca College, Humber College, Centennial College and George Brown College—had 5,935 students in the 2011/2012 academic year in programs such as software systems, computer engineering, health informatics technology, computer animation and enterprise database management.[37]

Workforce & Education

Despite the region's strength in post-secondary education, groups such as women and aboriginals remain underrepresented in the tech labour force.

Women (51% of the population) represent just 29.6% of individuals with a post-secondary science, technology, engineering and mathematics (STEM) credential and 26.9% of those employed in a STEM-intensive occupation.[38] Aboriginals (3.9% of the population) represent just 1.4% of individuals with a post-secondary STEM credential.

STEM Education & Employment in Canada by Gender, Immigrant Status, and Aboriginal Identity

	Total	Women % of Total	Immigrants % of Total	Aboriginal % of Total
Population aged 25-54	14,044,940	51.1%	24.5%	3.9%
Post-secondary credential	9,340,495	52.5%	26.1%	2.5%*
Post-secondary credential in a STEM field	1,814,075	29.6%	39.9%	1.4%*
Post-secondary credential in a STEM field and employed in a STEM-intensive occupation	606,520	18.9%	37.5%	N/A
% of those with a STEM credential employed in a STEM-intensive occupation	38.9%	26.9%	39.1%	N/A

Data Source: StatCan (2013a, 2013i, 2014n) and Panel calculations
Source: Some Assembly Required, Council of Canadian Academics

Meeting the labour shortage will require education policymakers to expand programs that target youth at key junctures in their career decision-making processes, both before and during high school.

The Information and Communications Technology Council views these types of early outreach programs as essential to addressing the labour shortage and diversity problems in the ICT workforce.[39] Similarly, the Canadian Council of Academies' Expert Panel of STEM Skills for the Future concluded that "support for early interventions that build on children's informal knowledge" and the development of "strong foundations in STEM literacy (enabled by effective teachers, research-based pedagogical methods, and engaging instruction and curricular materials)" is essential to preventing future labour supply bottlenecks.[40]

Workforce & Education

Finally, the Council asserted that "early interventions to support diverse learners are critical."[41] So policymakers should explore partnership possibilities with organizations like **Girls Learning Code** when expanding and designing tech programming aimed at youth.

The primary responsibility for expanding these types of early intervention programs will fall to provincial education policymakers. But there are opportunities at the local level to expose Toronto's youth to the exciting pathways offered in the tech sector. For example, the City of Toronto's Startup Ecosystem Strategy identified a need to "partner with business incubators and the school boards in Toronto to showcase programming and startup success stories to high school students."[42] These increased programming efforts should be linked with partners in Toronto's tech sector.

Workforce & Education

Promote increased and diversified enrollment in post-secondary tech education programs in Toronto through early intervention initiatives

Toronto is one of the most highly concentrated tech sector labour force cities in the world, with many community training programs offering avenues for continued skill enhancement. On October 28, 2015, CivicAction and LinkedIn, in partnership with the City of Toronto and the Province of Ontario, released never-before-seen research with real-time data on the Toronto region's tech sector.[43] LinkedIn's data shows that of its 1.9 million members in the Toronto census metropolitan area (CMA), 11%, or 214,000, report having technology skills.[44]

Toronto is ranked fifth in concentration of tech skills.[45]

Top 20 Technology Skill Categories by Membership

1. IT Infrastructure and System Management
2. Software Engineering Management & Requirements Gathering
3. Web Programming
4. C/C++
5. Microsoft Windows Systems
6. Computer Network & Network Admin
7. Database Management and Software
8. Software QA and User Testing
9. Computer Graphics & Animation
10. Microsoft Application Development

Technology Skilled Members Per City as a Percentage of the Total

1. San Francisco Bay Area, USA | 14.9%
2. Greater Seattle Area, USA | 13.1%
3. Sydney, Australia | 11.4%
4. Stockholm, Sweden | 11%
5. Toronto, Canada | 10.8%
6. Greater Boston Area, USA | 10.6%
7. Montreal, Canada | 10.6%
8. London, United Kingdom | 10.5%
9. Berlin, Germany | 10.4%
10. Oslo, Norway | 10.3%

Pay companies to train and hire re-trained workers.

The report noted that while 31% of the population aged 25–64 in the Toronto CMA doesn't hold a post-secondary certificate, diploma or degree, "technology skills may represent one area where a lack of education may not pose such a barrier to job seekers."[46] Indeed, Toronto's network of both private and non-profit coding schools presents many opportunities for workers to undertake skill enhancement. Toronto has many private sector actors that provide opportunities for workers to further develop their tech sector-specific skills (such as Lighthouse Labs and Bitmaker Labs). The charitable sector also offers training programs that equip marginalized/underrepresented groups with tech sector skills, such as **NPower Canada**[47] and **Ladies Learning Code**[48]. Andrew Reddin of NPower Canada noted that "many employers are open to the idea of hiring those without post-secondary [credentials], but greater awareness is needed."[49]

Policymakers should support graduates from these programs in converting their newly acquired skills into employment. Existing wage subsidy programs should be expanded to include community training program graduates whose experience was gained outside traditional post-secondary institutions. The Information and Communications Technology Council (ICTC) report notes that "programs to support on-the-job training—through mechanisms such as wage subsidies—that improves the job-readiness of youth or enables 'nearly qualified'

candidates to acquire necessary work-related skills are vital going forward."[50]

One example of such a program is the ICTC's CareerConnect, which harnesses federal government funding to subsidize half a young post-secondary graduate's salary, up to $14,000.[51] NRC-IRAP's Youth Employment Programs are another example of a wage subsidy that should be expanded to apply to graduates of community training programs.[52]

Finally, existing programs at the municipal level could dovetail with these efforts. For example, the Partnership to Advance Youth Employment (PAYE) is a joint initiative between the City of Toronto and 140 private sector partners that has successfully matched hundreds of young people from priority neighbourhoods with jobs.[53] The City of Toronto's Employment and Social Services Division hosted the PAYE IT Skills Learning Forum in March 2016, signaling positive momentum.[54] Efforts must be continued to expand the employer base of these programs to include partners from the tech sector. Expanding employment programs such as wage subsidies and matchmaking initiatives to graduates of community training programs will help relieve Toronto's tech sector's talent shortage.

Source: Ibid., 31, npower.org, ladieslearningcode.com, CivicAction, The Information and Communication Technology Council, ictc-ctic.ca, Government of Canada, City of Toronto.

How Technology Is Changing Toronto Employment · 30

Make housing better and more affordable.

The City of Toronto currently faces an affordable housing problem, particularly in relation to other major Canadian cities. As of June 2016, the average house price in Toronto was $746,546—over $200,000 more than the average house price nationally.[55] This has significant effects on the ability of inhabitants to acquire appropriate, affordable housing. Almost half of Toronto's population is precariously housed, with 43.6% using more than 30% of their gross income on housing. Average rental costs are increasing, with the average condo rental fees in Toronto for the first quarter of 2016 as follows: bachelor, $1,376 (a 3.8% year-over-year increase); one-bedroom, $1,662 (a 4.8% year-over-year increase) and two-bedroom, $2,375 (an 8.9% year-over-year increase).[56]

Compass Global Startup Ecosystem rankings for 2015 saw Toronto fall nine spots since 2012 (from #8 to #17) and cited cost of living as a top policy issue.[57] The financial burden imposed on Torontonians by high housing expenditures could have a substantial and negative impact on the Toronto and Ontario economies. Affordable housing can stimulate job growth indirectly by supporting a healthy and well-educated workforce.[58] This improvement in human capital works in turn to attract employers and business investment.

We can see the importance of affordable housing to the success of the tech sector by looking at the housing policy of the City of Palo Alto, home to the largest tech hub in the world, where rapid economic growth has led to increasingly unaffordable housing. In response, the City of Palo Alto now requires that developers contribute at least 15% of units at below market rates when developing five or more residential units.[59] This inclusionary zoning policy implemented by the City of Palo Alto recognizes the important relationship between affordable housing supply and the continued growth of the tech sector.

In May 2016 the Government of Ontario introduced Bill 204, Promoting Affordable Housing Act, 2016. Bill 204, if adopted, would provide a framework for inclusionary zoning and enable the Minister of Municipal Affairs and Housing to introduce additional regulation.[60] This report recommends that the Ontario government implement Bill 204 and develop increased affordable housing supply through the use of inclusionary zoning.

Source: The Canadian Real Estate Association, Toronto Real Estate Board, Compass, Ontario Non-Profit Housing Association, City of Palo Alto, Ontario Ministry of Municipal Affairs and Ministry of Housing.

How Technology Is Changing Toronto Employment · 31

Infrastructure

Make it easier for tech companies to choose the right accelerator/incubator.

Despite Toronto's strong innovation infrastructure base of incubators and accelerators, there's not enough data available to help tech firms identify the best fit for their business. Incubator and accelerator infrastructure has been supported by a mix of private sector and public funding from various levels of government. Accelerators and incubators that explicitly serve Toronto's tech sector include: Brightspark Venture, Driven Accelerator Group, Highline, INcubes, Kinetic Café, MaRS, Multiplicity, OneEleven, University of Toronto's Creative Lab Destruction, Ryerson DMZ and Next Canada.[61] The notable example is the University of Toronto's Creative Destruction Lab, which leads all other accelerators with over $180 million in equity raised across 36 companies as a result of its monthly competition model, which concentrates resources into select high-potential firms.[62]

One prominent provincially funded program is the Ontario Network of Entrepreneurs (ONE), which includes 17 Regional Innovation Centres (RICs) around the province, two within this report's territory (Toronto's MaRS and Mississauga's RIC), as well as three neighbouring centres (Oakville's Haltech, Oshawa's Spark Centre and Markham's Venture Lab).[63]

ONE also includes the Ontario Centres of Excellence's (OCE's) Campus-Linked Accelerator program, which "provides funding to post-secondary institutions to create, improve and sustain a culture of entrepreneurship among students and youth in their regions, and to integrate these entrepreneurial activities with investors, industry, and other stakeholders in their region."[64] Toronto is well represented in OCE's list of Campus-Linked Accelerators, with 24 out of 37 located in the GTA.[65] The City of Toronto also provides programming support to many incubators and accelerators in the city.

Source: City of Toronto, Centre for Digital Entrepreneurship and Economic Performance, Ontario Centres of Excellence.

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Infrastructure

In its extensive 2015 investigation, the Centre for Digital Entrepreneurship and Economic Performance (DEEP Centre) identified some problems with the current landscape of incubators and accelerators.[66] The lack of standardized data reporting requirements for incubators and accelerators is creating a troubling status quo where Toronto tech firms have difficulty navigating the landscape because they don't have access to centralized information to compare offerings and performance. The DEEP Centre notes that "standardized annual reporting would better inform firms in their search for support, provide the required transparency for public and private funders to allocate resource[s] efficiently, and allow themselves [incubators and accelerators] to benchmark their own performance against their peers."[67]

Achieving a standardized reporting framework will benefit Toronto's tech sector because firms will be able to quickly navigate the services available to best suit their needs. The City of Toronto's Startup Ecosystem Strategy indicates support for "a standard set of metrics [that] could assist incubators and accelerators in improving entrepreneurship programming while attracting more entrepreneurs and investors to the ecosystem through demonstrable results."[69] But those responsible for incubator and accelerator programs in Toronto must continuously engage with tech sector firms and other stakeholders to make sure the services offered by these programs are meeting their needs.

Canadian policymakers should implement the DEEP Centre's recommendations of introducing a standardized reporting framework.

This will require five steps:

1. **Agree on standardization**

2. **Pilot standardized reporting with a few organizational leaders**

3. **Centralize collection and reporting**

4. **Mandate data sharing through contractual agreements**

5. **Undertake robust statistical analysis in partnership with Statistics Canada**[68]

Modernize and harmonize the regulatory environment.

Regulators at all levels of government must adopt a nimble and collaborative approach to regulating the tech sector to make sure Toronto tech firms aren't at a regulatory disadvantage compared to their global competitors. One example where regulations may be stifling Toronto's tech sector is in Fintech, where Toronto firms are falling behind other jurisdictions in restricted areas like peer-to-peer lending.[70] A 2015 report by the Innovation Policy Lab at the Munk School of Global Affairs summarized interview findings from the sector and found that "the most often cited hurdle to Fintech innovation was 'regulations and the regulatory framework."[71] Interviewees identified that the narrow focus on protecting consumers created a stifling effect on innovation, where Canadian Fintech companies are perceived to operate in a regulatory environment based on "presumption of prohibition" as opposed to the US environment of "presumption of permission."

An international model that should be implemented is the United Kingdom's regulatory sandbox, which is a "'safe space' in which businesses can test innovative products, services, business models and delivery mechanisms while ensuring that consumers are appropriately protected."[72] While it's too early to evaluate the effectiveness of this program, a controlled test pilot in Canada would continue to protect consumers while also making sure our Fintech innovators aren't under a greater regulatory burden than their international competitors. Achieving this would require provincial and federal regulators to work together to harmonize regulations and subsequent regulatory sandbox exemptions.

Additionally, Ontario's Business Growth Initiative includes a commitment to "modernize the regulatory environment to reduce the administrative burden and lower the cost of doing business."[73] The regulatory review processes under this initiative must make sure ongoing consultations are carried out with Toronto's tech sector. This recommendation would work to correct the status quo, where innovation is being stifled because of the "impression that the industry and the regulators charged with overseeing the industry are working at odds with each other when it comes to innovation and ecosystem development."[74]

Re-distribute government funds from incumbent tech companies to scale-ups and start-ups.

Government (particularly provincial) support must be adjusted in response to recent findings that established large companies have historically been favoured while the support for high-potential young firms has languished. In 2014 the Expert Panel Examining Ontario's Business Support Programs found that "Ontario's business support programs favours [sic] the largest and oldest companies, the companies least likely to be in need of support."[75]

The report shows that in 2011-12, average support for companies with less than $0.5 million in revenue was $4,333, while average support for companies with more than $20 million in revenue was $231,255. In the time period covered by the Business Support Programs report, over 200 companies received more than $1 million annually in total Ontario business support. These companies, which represent 0.1% of all companies receiving Ontario business support, account for 30% of total Ontario business support. Finally, the report shows that in 2011-12, total support for companies less than two years of age was about $0.2 billion, while total support for companies 10 years of age or older was $1.9 billion.

Average Support By Revenue

Legend:
- 0 to $0.49M
- $0.5M to $1.99M
- $2M to $4.99M
- $5M to $9.99M
- $10M to $19.99M
- $20M and over

Government Business Support And Procurement

While these figures pertain to all industries (not just tech), this skewed distribution of business support funding for older and larger companies isn't optimal for supporting Toronto's tech sector. Despite Toronto having 44 large service establishments (500+ employees) in the Toronto CMA and five large manufacturing establishments, the majority (78%) of tech establishments are micro-enterprises with one to four employees.[76] While these small startups need support, the provincial government should focus on providing better support for young high-growth companies to scale up. Specifically, the report noted that the provincial government should focus on high potential young companies.

Support for high potential young companies is especially important because such companies may grow to be critical to the province's economic performance and quality of life. So it's troubling that the prospects of Ontario's young corporations have deteriorated significantly over the seven years from 2005-06 to 2011-12.[77]

Total Support By Company Age

Legend: Under 2 years | From 2 - 5 years | From 6 - 9 years | 10 years +
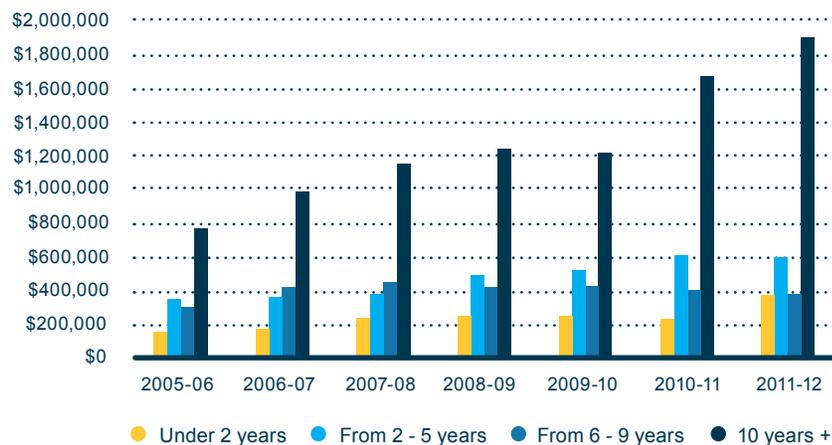
Young Corporations As A Proportion Of All Ontario

- ● % of companies, companies < 10 years
- ● % Total revenues, companies < 10 years
- ● % Total employees, companies < 10 years
- ● % Total R&D spendings, companies < 10 years
- ● % Companies conducting R&D, companies < 10 years
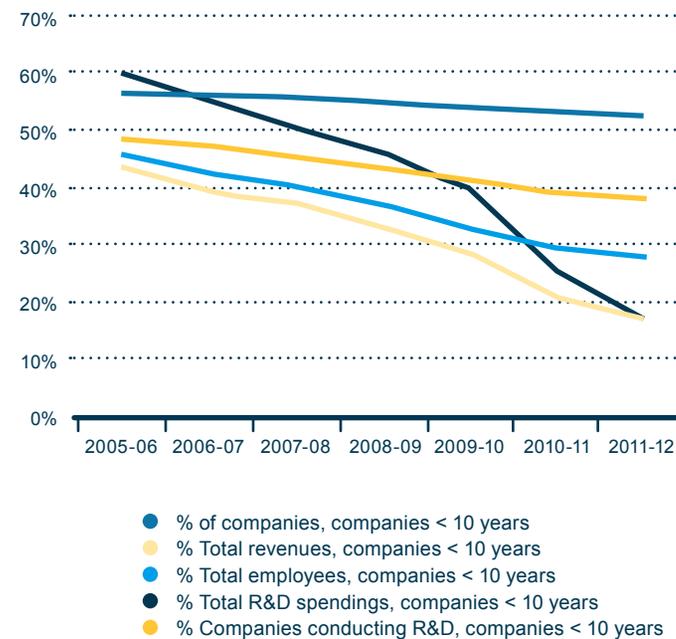
Solve civic problems and strengthen local tech companies via procurement.

Many enterprise startups create products to help improve living in large cities. Unfortunately many don't ever find product market fit or customers. The city could help align entrepreneurs and their products to market by increasing its innovative engagement with the tech sector in sourcing solutions for civic problems.

There are many examples of productive relationships between local policymakers and the tech sector. One example is CivicTech Toronto, which runs weekly meetups and hackathons where policymakers and the tech community collaborate to solve civic problems.[78] Another example is the open data crowdsourcing initiative Open311, which "is a set of technologies and standards for providing open, two-way communication around city service- and issue-tracking. More specifically, Open311 enables a web-based application programming interface (API) to connect with existing 311 systems. This permits applications to be built that interface directly with the city."[79]

These collaborations with the tech sector should be incorporated into a larger initiative to use procurement to better source solutions from Toronto's tech sector. Firms in Toronto have identified lack of procurement support as a pain point. Consultations with the startup sector for the City of Toronto's Startup Ecosystem Strategy identified that participants responded to "Toronto would have a stronger startup eco-system if..." by noting a desire to increase the "leveraging [of] City of Toronto procurement as a means to pilot new technologies/ services."[80] Indeed, the city's strategy included as a gap in the ecosystem that the "City of Toronto, post-secondary institutions and large enterprises could create the necessary on-ramps to enable the growth of startups and eliminate barriers to purchasing processes."[81]

Government Business Support And Procurement

The City of San Francisco's Startup in Residence program (STIR) provides a useful best practice example for the City of Toronto to learn from. Started in 2014, the core mission of STIR is "to bring together government and startups to explore ways to use technology to make government more accountable, efficient and responsive."[82] Managed by the San Francisco Mayor's Office of Civic Innovation, this mission is achieved through posting civic needs online and then working with startups who respond for 16 weeks to "help departments unpack issues with data analysis and prototype solutions refined through user testing. This enables startups to gain insight into civic needs to develop products that support critical community services."[83] This type of deep collaboration lets startups have their products validated, thus enabling further expansion.

> In May 2016 the Toronto Region Board of Trade launched its multi-year Smart Cities Initiative in partnership with the City of Toronto to map out Toronto's smart city priorities and companies.[84] The City of Toronto should continue its record of investing in partnerships, such as adding Ritual as an option of purchasing Toronto Island Ferry tickets and using Kitchener-based Miovision to provide analysis on the Bloor bike lane pilot project.[85] These types of partnerships should be routinized and built into procurement procedures.

There are also encouraging signals from the provincial level, with Ontario's 2016 budget stating the "Province will create a pilot program through which the government will identify needs and purchase successful new technologies from emerging companies to support innovation."[86] All levels of government should try to use procurement processes to better source solutions from the tech sector.

Source: startupinresidence.org, Ibid, Canadian Startup News & Tech Innovation, 2016 Ontario budget.

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Technical Appendix

Technical Appendix

Toronto's university/college-affiliated incubators and accelerators[87]

Ryerson University: Digital Media Zone, the Fashion Zone, Innovation Centre for Urban Energy

University of Toronto: Department of Computer Science Innovation Lab, Impact Centre, Creative Destruction Lab, the Entrepreneurship Hatchery, the Hub Ideation and Experimental Learning Centre, among others

York University: LaunchYU, York Entrepreneurship Development Institute Accelerator

Centennial College: Centre for Entrepreneurship, Student Business Incubator, Wireless Acceleration program in partnership with Wavefront

George Brown College: Digital Media and Gaming Incubator, EmpoweredYouth Startup Hub, Prototyping Lab

Humber College: Humber Launch

Seneca College: The Health Entrepreneurship and Lifestyle Exchange (HELIX) incubator

Technical Appendix

Our research was facilitated by Emsi, which collects and reports on over 12 data sources from Canada.

Other sources were Statistics Canada, the City of Toronto website and Toronto-related reports.

Our definition of tech was inspired by both The New York City tech ecosystem report and the Toronto ICT report.

We applied similar decision criteria, which we've outlined below, to determine if industries should be classified as tech.

Rule 1: Is this industry enabled by tech?
Rule 2: Does this industry primarily produce tech?

And we classified tech jobs using three criteria.

Rule 1: Does this occupation directly produce tech?
Rule 2: Does this occupation facilitate the use of tech by others?
Rule 3: Would this occupation cease to exist without the presence of tech?

We included both employed and self-employed labour markets, as was done in The New York City tech ecosystem report. This is because we agree that "given the recent successes of the peer economy and other cottage industries resulting from advances in technology, it is critical to include this cohort in a comprehensive evaluation of the tech ecosystem."[88]

We used the North American Industry Classification System (NAICS) codes used in Canada as approved by Statistics Canada to categorize all industries. Our use of the NAICS allows us to identify all employees in an industry class using publically available data.

For example, a company that falls in the NAICS class of Software Publishers would be included in the total count for the tech ecosystem. We selected 14 tech industries for our tech ecosystem that support the 170,000 jobs in tech companies that include both tech and non-tech jobs but are all part of the tech ecosystem.[89]

Source: HR&A Advisors, Inc., See below for how we classified tech industries and occupations.

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Table of NAICS

The North American Industry Classification System (NAICS) is the standard used by federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing and publishing statistical data related to the Canadian business economy.

NAICS For Toronto Used In Report

Description	NAICS
Computer and peripheral equipment manufacturing	3341
Communications equipment manufacturing	3342
Semiconductor and other electronic component manufacturing	3344
Navigational, measuring, medical and control instruments manufacturing	3345
Other electrical equipment and component manufacturing	3359
Software publishers	5112
Wired telecommunications carriers	5171
Wireless telecommunications carriers (except satellite)	5172
Satellite telecommunications	5174
Other telecommunications	5179
Data processing, hosting and related services	5182
Other information services	5191
Computer systems design and related services	5415
Scientific research and development services	5417

Table of NOCS

The National Occupational Classification System (NOCS) 2011 is the authoritative resource on occupational information in Canada. Thousands of people use it daily to understand the jobs found throughout Canada's labour market.

NOCS For Toronto Used In Report

Description	NOCS
Architecture and science managers	0212
Computer and information systems manager	0213
Data entry clerks	1422
Electrical and electronics engineers	2133
Chemical engineers	2134
Industrial and manufacturing engineers	2141
Aerospace engineers	2146
Computer engineers (except software engineers and designers)	2147
Other professional engineers, n.e.c.	2148
Information systems analysts and consultants	2171
Database analysts and data administrators	2172
Software engineers and designers	2173
Computer programmers and interactive media developers	2174
Web designers and developers	2175
Chemical technologists and technicians	2211
Biological technologists and technicians	2221
Forestry technologists and technicians	2223
Civil engineering technologists and technicians	2231
Mechanical engineering technologists and technicians	2232
Industrial engineering and manufacturing technologists and technicians	2233
Electrical and electronics engineering technologists and technicians	2241
Electronic service technicians (household and business equipment)	2242

Description	NOCS
Industrial instrument technicians and mechanics	2243
Aircraft instrument, electrical and avionics mechanics, technicians and inspectors	2244
Architectural technologists and technicians	2251
Industrial designers	2252
Computer network technicians	2281
Information systems testing technicians	2283
Medical laboratory technologists	3211
Medical laboratory technicians and pathologists' assistants	3212
Respiratory therapists, clinical perfusionists and cardiopulmonary technologists	3214
Medical radiation technologists	3215
Cardiology technologists and electrophysiological diagnostic technologists, n.e.c	3217
Other medical technologists and technicians (except dental health)	3219
Library and public archive technicians	5211
Film and video camera operators	5222
Broadcast technicians	5224
Audio and video recording technicians	5225
Other technical and co-ordinating occupations in motion pictures, broadcasting and the performing arts	5226
Graphic designers and illustrators	5241
Customer and information services supervisors	6314
Customer services representatives - financial institutions	6551
Contractors and supervisors, electrical trades and telecommunications occupations	7202
Industrial electricians	7242
Electrical mechanics	7333
Electronics assemblers, fabricators, inspectors and testers	9523
Assemblers and inspectors, electrical appliance, apparatus and equipment manufacturing	9524
Assemblers, fabricators and inspectors, industrial electrical motors and transformers	9525
Mechanical assemblers and inspectors	9526
Machine operators and inspectors, electrical apparatus manufacturing	9527

Technical Appendix

The Economic Complexity Index (ECI) is a metric developed by Cesar Hidalgo of MIT and Ricardo Hausmann of Harvard University that uses data about a country's diversity of exports to assess the sophistication of its economy. We use it analogously to assess the sophistication of a city's economy by examining the diversity of industries it employs. Roughly speaking, a city has a more complex economy if it employs not only a diverse range of industries, but also industries that are relatively rare when compared to other cities in the country.

To measure the ECI of Toronto, we looked at 2015 industry employment data from Emsi's Analyst tool for all 33 Census Metropolitan Areas in Canada, broken down by 4-digit NAICS code. For each city, we measure its diversity by counting up the number of industries it employs at levels above national averages. We then take into account how common each industry is across the country by calculating its ubiquity, a count of how many cities employ this industry. We use these two values—diversity and ubiquity—to mutually correct one another. For each city, we calculate the average ubiquity of the industries that it employs, then the average diversity of the cities that employ those industries, and so on, until the numbers converge to a final value. These final values for each city are then adjusted so that their mean is 0 and their standard deviation is 1. The adjusted final value becomes the city's ECI.

For more information about the Economic Complexity Index:
Atlas of Economic Complexity

For a detailed breakdown of the mathematics behind its calculation, see page 24 of the PDF atlas:
The Atlas Of Economic Complexity: Mapping Paths To Prosperity

Technical Appendix

We identified all tech jobs in Toronto using the National Occupational Classification System (NOCS) for Canada, which is used to categorize jobs.

A specific position, such as a computer programmer or interactive media developer, can now be counted across all industries, whether in a tech industry or not. The full list of jobs considered as tech in Toronto (outlined below) allowed us to pull all tech jobs from all industries. The NOCS helped us find the 329,000 tech jobs in Toronto.

Using the NAICS (170,000 jobs found in tech industries) and the NOCS (329,000 jobs in tech jobs), we removed the overlap, as the count of tech jobs in tech industries would be included in both. We did this by searching for the total count of tech jobs within tech industries, or the tech NOCS within the tech NAICS (the breakdown is shown below). We identified an overlap of 98,000 jobs. An overlap example would be a computer programmer in a tech company.

Our team consulted with experts in HR, economics and demographic data analysis to confirm our findings and methodology for this report from Emsi, a CareerBuilder company.

TechToronto, with oversight from our report collaborators, defined the below list of industries and jobs as tech.

Economic Section Calculations

Two factors worth noting when considering the Gini coefficient calculations:

Because people in the tech ecosystem are by definition employed, when calculating the Gini coefficient for Toronto overall we only included the employed population for a more meaningful comparison. The overall Toronto Gini coefficient would have been higher if the unemployed population had been included as well.

Gini coefficients were calculated using the average annual income per occupation, which obscures inequality slightly because it averages out some of the income variance within jobs. Gini coefficients would likely have been slightly higher had the values not been averaged.

All of this being said, when these values are considered relative to one another they can still be used for a meaningful comparison. Readers should simply note that values may be lower than would be expected.

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